# State of the Regional Preserve System in Western San Diego County

**Report Prepared for:**
**San Diego Association of Governments Environmental Mitigation Program**

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Cover: Cover photograph (taken by Patricia Gordon-Reedy), Chaparral habitat recovering from the 2007 Harris Fire, taken at Lyons Valley on December 18, 2010.

# State of the Regional Preserve System in Western San Diego County

**Report Prepared for:**

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## Conversion Factors

International System of Units to U.S. customary units

| Multiply | By | To obtain |
|---|---|---|
| | Length | |
| centimeter (cm) | 0.3937 | inch (in.) |
| millimeter (mm) | 0.03937 | inch (in.) |
| meter (m) | 3.281 | foot (ft) |
| kilometer (km) | 0.6214 | mile (mi) |
| | Area | |
| hectare (ha) | 2.471 | acre |

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as °F = (1.8 × °C) + 32.
Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as °C = (°F – 32) / 1.8.

## Datum

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).
Horizontal coordinate information is referenced to the (North American Datum of 1983 [NAD 83]).

# Supplemental Information

## Abbreviations

| | |
|---|---|
| ac | Acres |
| AECOM | Architecture, Engineering, Construction, Operations, and Management |
| AWM | Agriculture, Weights, and Measures |
| BMPs | Best Management Practices |
| Cal-IPC | California Invasive Plant Council |
| CBI | Conservation Biology Institute |
| CDFA | California Department of Food and Agriculture |
| CDFW | California Department of Fish and Wildlife |
| CNDDB | California Natural Diversity Data Base |
| CSS | Coastal Sage Scrub |
| EDRR | Early Detection Rapid Response |
| EMP | Environmental Mitigation Program |
| ESA | Environmental Science Associates |
| FPA | Focused Planning Area |
| GIS | Geographic Information System |
| GSOB | Goldspotted Oak Borer |
| HCP | Habitat Conservation Plan |
| IA | Implementing Agreement |
| IAS | Invasive Aquatic Species |
| IPSP | Invasive Plant Strategic Plan |
| ITOC | Independent Tax Oversight Committee |
| km | Kilometers |
| lidar | Light Detecting and Ranging |
| LMG | Land Management Grant |
| m | Meters |
| MCAS | Marine Corps Air Station |
| MHCP | Multiple Habitat Conservation Program |
| MHPA | Multi-Habitat Planning Area |
| MOM | Master Occurrence Matrix |
| MSCP | Multiple Species Conservation Program |
| MSP Roadmap | Management and Monitoring Strategic Plan Roadmap |
| MSPA | Management and Monitoring Strategic Plan Roadmap Area |
| NAIP | National Agriculture Imagery Program |
| NCCP | Natural Community Conservation Plan or Natural Community Conservation Planning |
| NDVI | Normalized Difference Vegetation Index |
| NOAA | National Oceanic and Atmospheric Administration |
| NRCS | Natural Resource Conservation Service |
| PAMA | Pre-approved Mitigation Area |
| PAO | Proportion Area Occupied |
| RCD | Resource Conservation District |
| REGSS | Regional Sensitive Species |
| SANDAG | San Diego Association of Governments |
| SanGIS | San Diego Geographic Information Source |
| SC-MTX | Southern California Multi-Taxa Database |
| SDCWA | San Diego County Water Authority |
| SDGE | San Diego Gas and Electric |
| SDMMP | San Diego Management and Monitoring Program |
| SDNHM | San Diego Natural History Museum |
| SL | Species at risk of loss. See Definitions: Category SL Species |
| SO | Species occurrence(s) at risk of loss. See Definitions: Category SO Species |
| SS | Species stable with species-specific management. See Definitions: Category SS Species |

| | |
|---|---|
| STIC | Stream Temperature, Intermittency, and Conductivity data logger |
| SWPT | Southwestern Pond Turtle |
| TNC | The Nature Conservancy |
| UCANR | University of California Agriculture and Natural Resources |
| USFWS | U.S. Fish and Wildlife Service |
| USDA | U.S. Department of Agriculture |
| USFS | U.S. Forest Service |
| USGS | U.S. Geological Survey |
| VF | Vegetation Focus Species. See Definitions: Category VF Species |
| VG | Vegetation General Species. See Definitions: Category VG Species |
| WUI | Wildland Urban Interface |

# Definitions

**1995 vegetation map** – Vegetation mapping of western San Diego County was completed in 1995 as part of the baseline data gathering for the Multiple Species Conservation Program (MSCP) from a combination of aerial photographs and field verification as described in Ogden (1995). Vegetation classifications based on the Holland system (Holland 1986) are available for western San Diego County (west of the watershed divide).

**Best Management Practices (BMPs)** – BMPs are those practices determined to be the most efficient, practical, and cost-effective to guide a particular activity or to address a particular problem.

**Category SL Species** – As defined in the 2017 Management and Monitoring Strategic Plan Roadmap (MSP Roadmap; SDMMP and TNC 2017, page V1.2-33), "species whose persistence in the MSPA is at high risk of loss without immediate management action above and beyond that of daily maintenance activities."

**Category SO Species** – As defined in the 2017 Management and Monitoring Strategic Plan Roadmap (MSP Roadmap; SDMMP and TNC 2017, page V1.2-33), "species whose persistence of one or more significant occurrences in the MSPA is at high risk of loss without immediate management action above and beyond that of daily maintenance activities."

**Category SS Species** – As defined in the 2017 Management and Monitoring Strategic Plan Roadmap (MSP Roadmap; SDMMP and TNC 2017, page V1.2-33), "species with occurrences considered more stable and their persistence is at lower risk of loss compared to SL and SO species; however, these species still require species-specific management actions."

**Category VF Species** – As defined in the 2017 Management and Monitoring Strategic Plan Roadmap (MSP Roadmap; SDMMP and TNC 2017, page V1.2-34), "species with limited distribution in the MSPA and/or having specific vegetation characteristics that need to be managed for persistence on Conserved Lands in the MSPA."

**Category VG Species** – As defined in the 2017 Management and Monitoring Strategic Plan Roadmap (MSP Roadmap; SDMMP and TNC 2017, page V1.2-34), "species less restricted in distribution (compared to VF Species), and/or do not have specific vegetation characteristics that need to be managed for persistence of the species on Conserved Lands in the MSPA."

**Conserved Lands** – As defined in the 2017 Management and Monitoring Strategic Plan (MSP Roadmap; SDMMP and TNC 2017, page xxvii), "Conserved lands are those lands that are legally conserved to (1) Protect natural habitats, species, and open space (including agricultural lands that are important components of the regional habitat preserve design); (2) Contribute to the existing and planned regional habitat preserve system; and (3) Managed to protect the open space or natural resources into the future. The conservation occurs through public or private acquisitions, conservation easements, land dedications, mitigation, mitigation banks, covenants, or other mechanisms that ensure the land will not be developed." The Conserved Lands geodatabase tracks lands conserved in western San Diego County.

**Covered Species** – Those species addressed in a natural community conservation plan or habitat conservation plan for which conservation measures will be implemented and for which authorization for take is sought under Section 2835 of the California NCCP and/or Section 10 of the federal Endangered Species Act.

**Ecological Integrity** – The ability of an ecological system to support and maintain a community of organisms that has species composition, diversity, and functional organization comparable to natural habitats within a region. Measuring the ecological integrity of a specific system at a specific location requires comparing aspects of the ecosystem with undisturbed reference sites or by comparing with measures of historic range of variation for that system. These comparisons give an indication of how degraded the system is at a particular site and define its ecological integrity.

**Ecosystem** – Plant and animal species plus their physical surroundings.

**Focused Planning Area (FPA) –** Developed by cities in the MHCP to show expected levels of conservation that can be achieved by applying available regulatory mechanisms to conserve biologically valuable areas.

**Forb** – A flowering, herbaceous plant.

**Habitat Conservation Plan (HCP)** –A Habitat Conservation Plan (HCP) is a federal Endangered Species Act section 10 planning document designed to accommodate economic development to the extent possible by authorizing the limited and unintentional take of listed species when it occurs incidental to otherwise lawful activities. The plan is designed not only to help landowners and communities but also to provide long-term benefits to species and their habitats. HCPs describe the anticipated effects of the proposed taking, how those impacts will be minimized or mitigated, and how the conservation measures included in the plan will be funded. If the U.S. Fish and Wildlife Service finds an HCP meets the specified criteria, it issues an incidental take permit. This allows the permit holder to proceed with an activity that could otherwise result in the unlawful take of a listed species (https://www.fws.gov/service/habitat-conservation-plans).

**HabiTrak** – HabiTrak is a set of tools developed cooperatively by the Wildlife Agencies (U.S. Fish and Wildlife Service and California Department of Fish and Wildlife), local jurisdictions, special districts, and SANDAG to meet the annual habitat tracking and reporting requirements of the Wildlife Agencies. The reports are used to gauge how individual habitat conservation plans are being implemented and whether the conservation goals are being achieved.

**HUC12** – HUC12 watersheds are the most local sub-watershed unit of the National Watershed Boundary Dataset hosted by USDA's Natural Resource Conservation Service (NRCS). These include the tributaries to the creeks and streams as individual units (USGS 2013). Their scale makes them suitable for management actions such as invasive species eradication and for monitoring threats and stressors.

**Indicator** – A thing, trend, or fact that describes the state or level of something. Ecological indicators communicate information about the status or health of a complex ecosystem in a manner understood by the public and policy makers. Ecological indicators were chosen in this report to represent ecological functions and habitat characteristics considered important for priority species, to serve as a gauge for a larger process or group of species, and to represent how well the regional preserve system supports rare and specialist species targeted for conservation.

**Invasive Nonnative Plants** – Plants from other areas that have invaded and naturalized or have the potential to naturalize and negatively impact the native community.

**Master Occurrence Matrix (MOM)** – An internal database created and managed by the SDMMP to track the status and management of known occurrences of MSP species. The MOM was used in the MSP Roadmap to designate management categories, identify occurrences important for management, develop management goals and objectives, and prioritize implementation of management actions. The MOM will continue to be used to track each species' status and distribution in the MSPA over time.

**Management and Monitoring Strategic Plan for Conserved Lands in Western San Diego County: A Strategic Habitat Conservation Roadmap (MSP Roadmap)** – The MSP Roadmap (along with an online MSP Portal available at sdmmp.com) provides management and monitoring goals and objectives for species, vegetation communities, and threats across the regional preserve system on Conserved Lands in western San Diego County. The MSP Roadmap covers 5-year planning horizons and is evaluated every 5 years to update and prioritize the species list, management categories, and management and monitoring objectives. There have been three planning horizons of the MSP thus far (2012-2016, 2017-2021, and 2022-2026).

**Metric** – A biologically based value that is measured or assessed and serves to identify the status or health of one aspect of the associated indicator.

**MSP Roadmap Area (MSPA)** – Area of western San Diego County covered by the MSP Roadmap and comprising the regional preserve system. This includes Conserved Lands extending from the Eastern Peninsular Mountain Range peaks west to the coast and from the northern border with Orange and Riverside counties south to the International Border with Mexico.

**MSP Species** – The 111 species included in the 2017-2021 MSP Roadmap. These species include 57 plants, 7 invertebrates, 1 fish, 3 amphibians, 5 reptiles, 30 birds, and 8 mammals.

**Multi-Habitat Planning Area (MHPA)** – The area within the permanent MSCP preserve in south San Diego County that will be assembled and managed for its biological resources.

**Multiple Habitat Conservation Program (MHCP)** – A comprehensive conservation planning process that addresses the needs of multiple plant and animal species in northwestern San Diego County. The MHCP is a subregional habitat conservation planning program that was approved in 2003 for 61 Covered Species and their habitats for seven cities. Only the City of Carlsbad has completed an MHCP subarea plan, received a permit from the Wildlife Agencies, and is implementing the plan.

**Multiple Species Conservation Program (MSCP)** – A comprehensive conservation planning process that addresses the needs of multiple plant and animal species in southwestern San Diego County. The MSCP is a subregional habitat conservation planning program that was approved in 1998 for multiple jurisdictions to conserve 85 Covered Species and their habitats. Currently, San Diego County and the Cities of San Diego, Poway, Chula Vista, and La Mesa have completed MSCP subarea plans. Separate MSCPs for North County and East County are under development.

**Natural Community Conservation Planning (NCCP) Program** – CDFW's NCCP (Natural Community Conservation Plan) program is an effort by the State of California and numerous private and public partners that takes a broad-based ecosystem approach to planning for the protection and perpetuation of biological diversity. A NCCP identifies and provides for the regional or area wide protection of plants, animals, and their habitats, while allowing compatible and appropriate economic activity.

**Permittees** – Jurisdictions with completed MSCP or MHCP subarea plans, executed implementing agreements (IA), and permits from the Wildlife Agencies.

**Pre-Approved Mitigation Area (PAMA)** – The PAMA for the South and North County MSCPs include lands prioritized for conservation based on analyses of habitats, species, and connectivity.

**Regional preserve system** – Preserve lands acquired as part of implementing multiple species conservation programs are combined with previously conserved lands (for example, U.S. Forest Service and California State Parks lands) into a regional preserve system in western San Diego County. The regional preserve system protects natural habitats and rare, threatened, and endangered species.

**REGSS Database** – A database of Regional Sensitive Species (REGSS) compiled from species locations recorded in the 1980s and 1990s to develop the MSCP and MHCP plans.

**SDMMP Regional Preserve System Metrics Dashboard ("Metrics Dashboard")** – SDMMP has made information from this report available in an interactive format (available at https://sdmmp.com/metrics/) that allows users to investigate metrics and data for specific indicators. The dashboard has GIS-based tools and databases, links to the MSP Roadmap, and supporting webpages with species, vegetation, and threats information, goals and objectives, project webpages, and other online resources. Visitors can view indicator metrics from a landscape-scale which summarizes metrics across the preserve system, drill in to evaluate management units or preserve-level metrics, and even focus in on plant or animal occurrences for status, threat, and habitat data used in developing metrics.

**Southern California Multi-Taxa Database (SC-MTX)** – The SC-MTX is a publicly accessible, multiple-species database created by USGS in collaboration with the SDMMP that houses both land management and biological monitoring data collected in the South Coast Ecoregion of southern California (includes all or portions of Santa Barbara, Ventura, Los Angeles, San Bernardino, Riverside, Orange, and San Diego counties). The purpose of the SC-MTX is to centralize and standardize monitoring and management data collected by multiple entities, including federal, state, and local agencies, and make the data accessible to stakeholders.

***TransNet*** – *TransNet* is a half-cent sales tax for local transportation projects that was first approved by San Diego County voters in 1988, and then extended in 2004 for another 40 years. The program is administered by SANDAG. During the 60-year life of the program, more than $17 billion will be generated and distributed among highway, transit, and local road projects in approximately equal thirds. The *TransNet* Environmental Mitigation Program (EMP) provides funds through *TransNet* to protect, preserve, and restore native habitats as offsets to disturbance caused by the construction of regional and local transportation projects.

**Wildlife Agencies** – The U.S. Fish and Wildlife Service and California Department of Fish and Wildlife are collectively referred to as the Wildlife Agencies

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## Executive Summary

San Diego County is a global biodiversity hotspot with many endemic species found only in the County or surrounding region. By the late 1980s, rapid urbanization in southern California caused a significant decline in natural habitats and species, and San Diego County emerged as a focal point with many federally threatened and endangered species. In the early 1990s, federal and state listing of species had the potential to conflict with continued economic development. This dilemma prompted the creation of multiple species and habitat conservation programs by federal, state, and local agencies with many partners including scientists, conservation organizations, and the building industry. The intent of these programs was to conserve natural habitats supporting rare, threatened, and endangered species while permitting development of less biologically sensitive lands.

These conservation programs added large tracts of newly conserved lands to existing publicly conserved lands, resulting in a regional preserve system in western San Diego County. The regional preserve system protects lands with biologically important resources in a landscape conservation design to enhance connectivity and natural ecosystem functions. Lands included in the regional preserve system are referred to as "Conserved Lands" and are tracked in a geodatabase. Nonprofit organizations and local, state, and federal jurisdictions own and manage individual preserves in the regional preserve system. Many of the lands owned by local jurisdictions were acquired and conserved in exchange for permits to develop other lands within the plan areas. These landowners have requirements under the approved conservation plans to implement individual preserve-level monitoring and management.

The U.S. Fish and Wildlife Service (USFWS) and California Department of Fish and Wildlife (CDFW), collectively known as the Wildlife Agencies, recognized the need for additional monitoring and management activities across multiple land ownerships in the regional preserve system. Through the 2004 voter-approved sales tax known as *TransNet*, the San Diego Association of Governments (SANDAG) Environmental Mitigation Program (EMP) oversees and funds monitoring and management of the regional preserve system. SANDAG established the San Diego Management and Monitoring Program (SDMMP) to coordinate regional activities in collaboration with the Wildlife Agencies, landowners and managers, scientists, nonprofit organizations, and other partners.

Participation by landowners and managers in SDMMP's regional monitoring and management activities is not required as part of the conservation programs. Most landowners and managers voluntarily participate, with over 100 federal and state agencies, local jurisdictions, biological consulting firms, universities, and nonprofit partners participating in regional monitoring and management activities. The program supports landowners and managers by coordinating regional projects, developing monitoring plans with protocols and sampling designs, creating management plans with best management practices, conducting monitoring and management actions, developing and maintaining databases, and providing competitive grant funding for management of individual preserves.

### Report Overview

This first *State of the Regional Preserve System in Western San Diego County* report details progress in preserve assembly for the four multiple species conservation plan areas and provides metrics for 19 indicators of preserve health. These indicators include four vegetation communities, 11 plant and animal species or species groups, and four indicators of ecosystem processes and landscape-scale threats to species and vegetation communities in the regional preserve system. The state of the regional preserve system in San Diego County is dependent on both the design and assembly of the preserve as well as management and monitoring of Covered Species and vegetation communities. This report addresses both components.

The first section of the report prepared by USFWS authors identifies progress made towards implementing conservation planning in western San Diego County (see Section II Status of the MSCP and MHCP Preserve System and Covered Species). Specifically, it assesses how the Multiple Species Conservation Program (MSCP) in southwestern San Diego County and the Multiple Habitat Conservation Program (MHCP) for seven northwestern county cities are achieving conservation goals. Both programs have approved subregional plans. The other two planning areas (North County and East County), which encompass the rest of San Diego County, have initiated conservation planning but do not have completed plans. This report fulfills a commitment by the Wildlife Agencies to prepare a Triennial Monitoring Report for the adopted conservation plans showing progress in preserve assembly and monitoring.

The second component of the report prepared by U.S. Geological Survey (USGS) authors on behalf of SDMMP focuses on the health and status of species and vegetation communities in the regional preserve system and responses to threats and management actions (see Section III Regional Preserve System Indicators and Metrics). This part of the report satisfies a recommendation by SANDAG's Independent Tax Oversight Committee (ITOC) to "track progress in meeting EMP goals and develop metrics to measure overall health of the preserve against baselines established in the regional conservation plans." *The Management and Monitoring Strategic Plan for Conserved Lands in Western San Diego County: A Habitat Conservation Roadmap* (MSP Roadmap) provides monitoring and management objectives for the regional preserve system over 5-year planning horizons. It covers 111 species, 11 vegetation communities, and 13 types of threats. The MSP Roadmap includes 95 of the 104 Covered Species in the MSCP and/or MHCP.

In this report, indicators and metrics are used to document progress in implementing the MSP Roadmap. Indicators provide information about the status of complex ecosystems, including individual species, vegetation communities, and ecosystem processes, in ways easily understood by the public and policy makers. A metric is a biologically based value that is measured or assessed and serves to identify the status or health of one aspect of the associated indicator. Indicators and metrics are developed for the MSP Roadmap Area (MSPA), which encompasses the regional preserve system, extending from the peaks of the Eastern Peninsular Mountain Range west to the ocean and from the borders of Orange and Riverside counties south to the International Border with Mexico. The MSPA includes all or part of the four San Diego multiple species and habitat conservation planning areas.

Appendix 1 (State of the Regional Preserve System in Western San Diego County: Detailed Methods and Descriptions of Indicators and Metrics) of this report is meant to be standalone and is for those readers who are interested in detailed descriptions of the indicators, and data and methods used to calculate metric condition status, trends, and confidence. The appendix includes information from Section III (Regional Preserve System Indicators and Metrics) contained in the main body of this report. While this results in redundancy between the main report and the appendix, it is intentional to provide the complete context for readers interested in a comprehensive accounting of the indicators and metrics. The appendix does not include information from Sections I, II, and IV in the main body of this report.

In addition to this report, the SDMMP has developed the MSP Portal (available at sdmmp.com) which includes an SDMMP Regional Preserve System Metrics Dashboard ("Metrics Dashboard"). SDMMP has made information from this report available in an interactive format that allows users to investigate metrics and data for specific indicators. The dashboard has geographic information systems (GIS)-based tools and databases, links to the MSP Roadmap, and supporting webpages with species, vegetation, and threats information, goals and objectives, project webpages, and other online resources. Visitors can view indicator metrics from a landscape-scale which summarizes metrics across the preserve system, drill in to evaluate management units or preserve-level metrics, and even focus in on plant or animal occurrences for status, threat, and habitat data used in developing metrics.

### Status of Preserve Assembly and Species Conservation Goals

Preserve assembly is progressing in the MSCP and MHCP plan areas, particularly for the MSCP Plan. As of December 31, 2019, approximately 120,672 acres of the MSCP Preserve have been conserved within the planned preserve. This represents 70 percent of the total preserve acreage goal of approximately 172,000 acres required to be conserved by the federal and state permits. Four of the biological core areas have been fully conserved, with another five at least 75 percent conserved. The seven remaining biological core resource areas are all at least 50 percent conserved. Conservation goals for coastal bluff scrub, Torrey pine forest, and Tecate cypress forest identified in the MSCP Plan have been completed. Conservation goals for chaparral communities, riparian woodland, southern coastal bluff scrub, and maritime succulent scrub are close to completion. Good progress is being made in coastal sage scrub (CSS) and grassland conservation.

In contrast, most conservation goals of the MHCP Plan, which has only one subarea plan completed, have not been met. Approximately 6,834 acres of the MHCP Preserve have been conserved as of December 31, 2019, representing 34 percent of the total preserve acreage goal. Approximately 16,447 acres (51 percent) of the identified core and linkage areas in the MHCP Plan have been conserved

Combined efforts by land managers, Wildlife Agencies, and the SDMMP have led to monitoring of 85 species of conservation concern in the regional preserve system. Monitoring or survey data have been collected for a total of 85 (77 percent) of 111 MSP species, 67 (79 percent) of 85 MSCP Covered Species, and 45 (74 percent) of 61 MHCP Covered Species.

### Overall Condition Status of Regional Preserve System Indicators

The preserve system health or status component of this report uses defined metrics to evaluate progress in meeting MSP Roadmap objectives for 19 indicators of regional preserve system health. These indicators were selected to represent ecological functions and habitat characteristics considered important for priority species, to assess the condition of a larger process or group of species, and to determine the status of rare and specialist species targeted for conservation. Indicators in this initial report include four Vegetation Community Indicators, 11 Species Indicators, and four Ecosystem Processes and Landscape-scale Threat Indicators. Additional indicators are planned for future versions of this report and for the Metrics Dashboard. Species Indicators are categorized further into Landscape Species, Rare and Specialist Species, and Vegetation Community Species. As part of an adaptive management framework, the results of these evaluations feed directly back into the 5-year update of management and monitoring objectives for the 2022-2026 MSP Roadmap.

The overall condition status of each indicator is assessed by one or more metrics (see Section IV Summary). Values for multiple metrics for an indicator are evaluated, sometimes using a weighting scheme, to produce an overall condition value for the indicator for the particular period being assessed. Condition values are either Good, Caution, Concern, or Significant Concern.

The majority of indicators (12 of 19) are ranked as an overall condition of Concern or Significant Concern. It is important to note that Species Indicators include some of the most at-risk species. These at-risk species reflect limiting conditions in the regional preserve system, such as restrictive habitat requirements, limited distributions with small populations, or high levels of threats. They are prioritized for monitoring and management because of concerns over their status and therefore have the highest quality monitoring datasets. Future reports will also include species at lower risk or with less restrictive habitat requirements, reflecting general conditions for more abundant and widespread species. To understand overall condition results for these indicators, it is important to consider the metrics that were used in these rankings. Metrics are used to assess the conservation status of species and vegetation communities, the status of species populations, the ecological integrity of vegetation communities, and the magnitude and pervasiveness of threats.

### Conservation Status for Selected Vegetation Community and Species Indicators

Metrics used to assess conservation status (that is, how well indicators are being conserved) were developed for four Vegetation Community Indicators and five Species Indicators (for example, percent of the chaparral vegetation community conserved and number of conserved extant San Diego thornmint [*Acanthomintha ilicifolia*] occurrences). Most of these indicators have a Good or Caution condition for the metric describing conservation status, and all indicators show improvement in this metric over time.

Mountain Lion (*Puma concolor*) and Southwestern Pond Turtle (*Emys marmorata pallida*) Indicators fall into the Significant Concern category and are highlighted because of conservation concerns. Mountain lions require large, contiguous patches of habitat, which is among the biggest challenges for the regional preserve system. Similarly, for the southwestern pond turtle, there are only a few sites on Conserved Lands where the population produces young turtles that survive and can be recruited as breeders into the population.

### Ecological Integrity and Occurrence Status Metrics

Seventeen metrics were developed to describe the “health” of four Vegetation Community Indicators and 11 Species Indicators. For example, ecological integrity metrics were developed for Vegetation Community Indicators to evaluate how well a diverse community of native plant species is being maintained based on the natural range of variation as a reference point. The ecological integrity of Oak Woodland and Riparian Forest and Scrub Indicators was categorized as Good, whereas Chaparral fell into the Concern category and CSS into Significant Concern. Metrics evaluating the status of 11 Species Indicators included measures of species richness, genetic diversity, occurrence size, successful reproduction, and percent occupancy. Measures of species status were dominated by conditions of Concern and Significant Concern. Those species that are in the Significant Concern category generally have a limited number of small populations, and there is often a downward trend in population size over time.

### Ecosystem Processes and Landscape-scale Threats Metrics

Metrics evaluating Ecosystem Processes and Landscape-scale Threats show that there are large-scale threats affecting the health of the preserve system and impacting the status of species and vegetation communities. Habitat loss and fragmentation have led to loss of connectivity for many species. Since the plans were adopted in the late 1990s and early 2000s, there have been additional major changes in environmental conditions resulting from human activities. The fire regime changed dramatically over the last 30 years, with more frequent large wildfires. The extremely large wildfires of 2003 and 2007 impacted extensive areas of chaparral and CSS, with large amounts of habitat burned twice. Increasing fire frequency has opened up the landscape and facilitated invasion of nonnative grasses and forbs (herbaceous flowering plants). These invasive plants have increased in abundance and are impacting post-fire vegetation recovery. This can be seen in metrics for CSS, Chaparral, Coastal California Gnatcatcher, and Fire Indicators.

Similarly, climate change is contributing to more frequent, intense, and prolonged droughts. This is affecting some of the most-at-risk species, such as Arroyo Toad and Hermes Copper Butterfly Indicators, and both species also face other threats simultaneously. Multiple, interacting, and large-scale threats are a challenge to land managers, who hope that management can be effective and lead to recovery of vegetation communities and species of conservation concern. Progress is illustrated by improving trends for post-fire recovery of Coastal California Gnatcatcher Indicator, recovery of Least Bell's Vireo Indicator populations through habitat restoration and management of brown-headed cowbirds, conservation of linkages, and control of high priority invasive, nonnative plant species.

Without conservation planning and acquisition of large areas of interconnected natural habitats for protection in a regional preserve system, impacts to species and vegetation communities in western San Diego County would be far worse. Finally, without the wealth of research and monitoring data collected over the last 20 years, it would not have been possible to develop these metrics which provide valuable insight into potential future management and monitoring priorities.

To view the SDMMP Metrics Dashboard, visit https://sdmmp.com/metrics/dashboard.php.

# I. Introduction

Southern California is a hotspot of biological diversity (Myers and others 2000) and rare, threatened, and endangered species, particularly in San Diego County (Dobson and others 1997). By the late 1980s, rapid development and urbanization of southern California natural ecosystems led to an increase in species proposed for federal and/or state listing as threatened or endangered. The State of California enacted the Natural Community Conservation Planning (NCCP) Act of 1991 (CDFG 1991) to reduce the need for further listings while still allowing for planned development and economic growth. In 1992, the local jurisdictions in San Diego County enrolled in the State of California's NCCP program and committed to develop and implement regional conservation plans. Since that time, two subregional habitat conservation planning programs have been completed: the Multiple Species Conservation Program (MSCP) in the southwestern portion of the County and the Multiple Habitat Conservation Program (MHCP) for the northwestern portion of the County (fig 1; City of San Diego 1998, AMEC, and others 2003).

The MSCP Plan encompasses 582,243 acres and identifies an approximately 172,000-acre preserve that will be assembled within a broader area that is defined in the subregional plan as the Multi-Habitat Planning Area (MHPA) and in the Metro-Lakeside-Jamul portion of the County's Subarea Plan as the Pre-Approved Mitigation Area (PAMA). The MHCP Plan encompasses 111,908 acres and identifies an approximately 20,000-acre preserve that will be assembled within a broader area that is defined in the plan as a focused planning area (FPA).

The conservation strategies for both plans included identifying generalized biological core and linkage areas (that is, MHPA, PAMA, and FPA), target acres for conserving specific vegetation communities, and species-specific conservation levels. The preserves are designed to conserve a diverse array of natural communities, ecosystem functions, and a wide variety of species; specifically, the 85 species evaluated by the MSCP Plan and the 61 species evaluated by the MHCP Plan (that is, Covered Species; 104 total unique species). The preserves will be assembled through a combination of the following methods: conservation of lands already in public ownership; public acquisition of private lands with regional habitat value from willing sellers; and private actions to conserve habitat, in conformance with development regulations and mitigation of impacts (City of San Diego 1998; AMEC and others 2003).

Implementation of both the MSCP and MHCP programs is accomplished through subarea plans developed by the local jurisdictions. Subarea plans prepared in compliance with these subregional plans are meant to fulfill the mandatory requirements for issuance of a section 10 Habitat Conservation Plan (HCP) permit pursuant to the federal Endangered Species Act and a NCCP permit issued by the California Department of Fish and Wildlife (CDFW). Jurisdictions with completed MSCP subarea plans, executed implementing agreements (IA), and permits from the Wildlife Agencies are San Diego County and the Cities of San Diego, Poway, Chula Vista, and La Mesa (that is, Permittees). Only the City of Carlsbad has completed an MHCP subarea plan, executed an IA, and received a permit from the Wildlife Agencies. In addition to the MSCP and MHCP, the San Diego County Water Authority (SDCWA) and San Diego Gas and Electric

(SDGE) also have completed individual NCCP/HCP plans and received permits. Collectively, these plans cover 2,094,597 acres[1]. Subarea conservation plans, IAs, permits, and other documents can be found at: *https://wildlife.ca.gov/Conservation/Planning/NCCP/Plans and https://ecos.fws.gov/ecp/report/conservation-plans-region-summary?region=8&type=HCP*.

Two additional planning areas are in San Diego County, the North County MSCP and the East County MSCP (fig. 1; *https://www.sandiegocounty.gov/content/sdc/pds/mscp/*). Plans for both areas are being prepared by the County, but neither has been completed as of 2022. An updated Planning Agreement[2] was entered into by the Wildlife Agencies and the County in March 2021 addressing the planning and preparation of these plans, each of which is anticipated to be a joint NCCP and HCP plan. Preliminary information about these planning areas can be found on the County's website at *https://www.sandiegocounty.gov/content/sdc/pds/mscp/*.

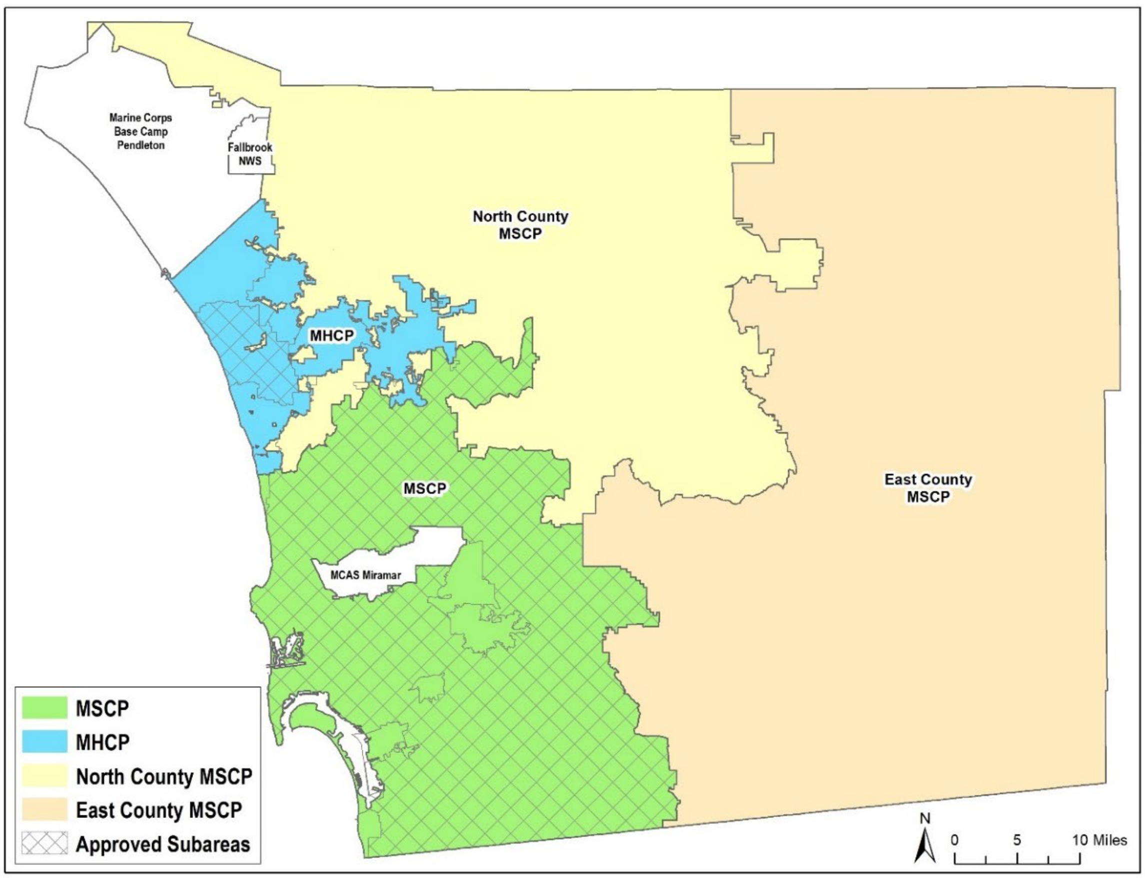


**Figure 1.** Regional planning areas and military installations. Figure and source data provided by USFWS.

[1] This total only includes acres within San Diego County. SDCWA (53,421 ac) and SDGE's (149,839 ac) boundaries extend into Riverside and Orange Counties respectively. The grand total area covered by these four plans is 2,297,857 acres.

[2] The NCCP Act requires the establishment of a planning agreement between the applicant and the Wildlife Agencies to outline the goals and commitments with regard to development of a plan as well as the geographic scope, preliminary list of natural communities and species, and conservation objectives. In addition, the agreement also includes processes for the inclusion of independent scientific input, coordination with the Wildlife Agencies, review of interim projects, and public participation.

Collectively, these conservation programs assemble a regional preserve system with a landscape conservation design identified during the planning process. The regional preserve system also includes previously conserved lands (for example, USFS and California State Parks lands). It is envisioned that over 1,670,898 acres[3] will be conserved within the regional preserve system that spans the County and connects to preserved lands in the adjacent Orange and Riverside counties when all four conservation plans are in place and fully implemented. To date, approximately 1,348,426 acres have been conserved by local, state, and federal agencies as well as non-profit entities (fig. 2; SDMMP 2020; CDFW 2019), including areas both inside and outside of the approved plans. This conservation has been accomplished through public acquisition, existing baseline Conserved Lands, and through mitigation for private and public development projects. The "Conserved Lands" geodatabase (SDMMP 2020) tracks lands conserved in the adopted conservation planning areas (MSCP and MHCP) as well as plan areas that are under development (North and East County).

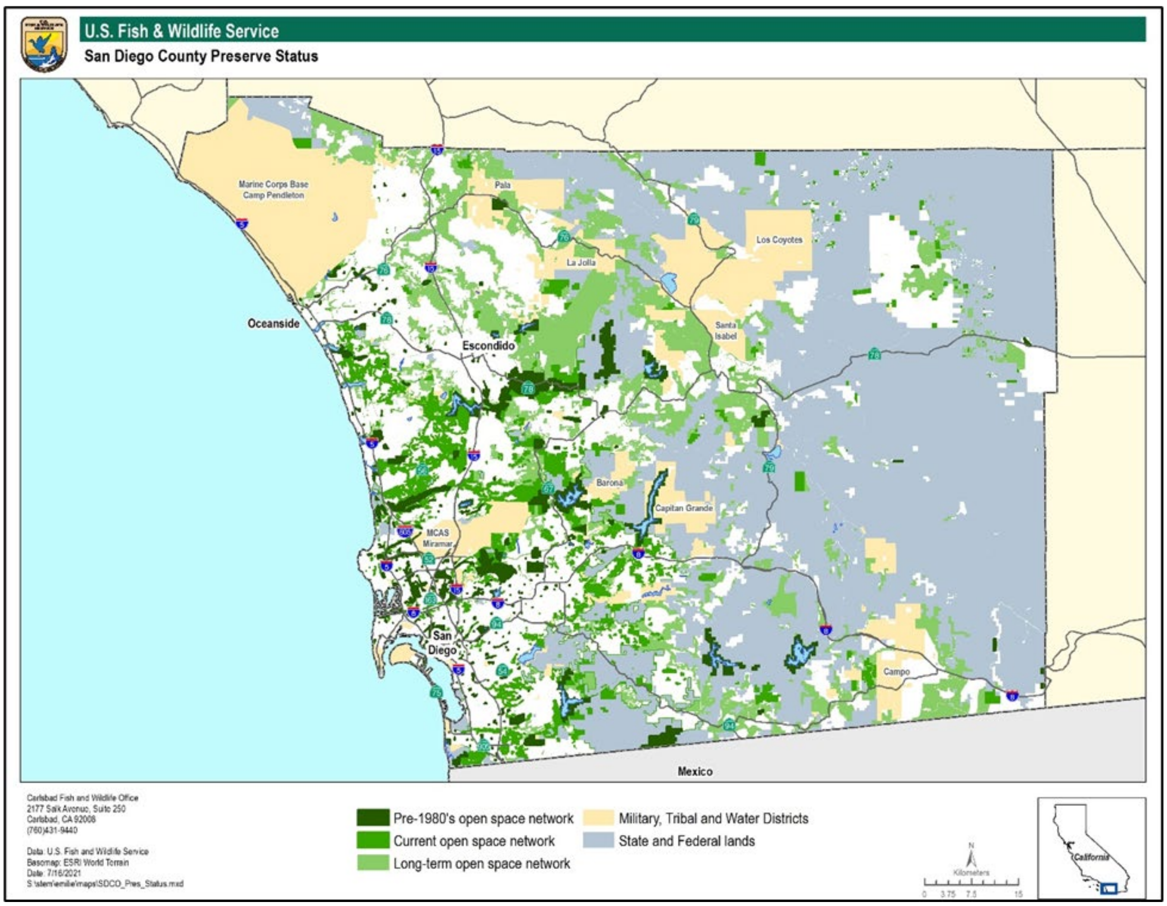


**Figure 2.** San Diego County regional preserve system.

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3 This estimate is based on the approved MSCP and MHCP preserve designs and the preliminary draft preserves identified by the County for the North County and East County MSCP plan areas (https://www.sandiegocounty.gov/content/sdc/pds/mscp/nc/docsNmaps.html#docs), as well as the existing Conserved Lands outside of the designated and/or planned preserves.

Responsibilities for preserve management and monitoring are shared across the landscape by the respective landowners, of which there are many (City of San Diego 1998; AMEC and others 2003). Coordination and collaboration among the preserve managers in the County maintain the quality and functions of the habitats to support healthy ecosystems. Large and small-scale threats are converting habitat types and threatening species persistence at an individual preserve level. However, the status of species and habitats has the potential to be improved through management and restoration actions.

The MSCP and MHCP subregional plans recognized a need for regional coordination of monitoring and management activities across the regional preserve system as well as funding for implementation (City of San Diego 1998; AMEC and others 2003). This need is being met, in part, through the *TransNet* voter-approved sales tax which funds the San Diego Association of Governments' (SANDAG) Environmental Mitigation Program (EMP) and includes monitoring and management of the regional preserve system (SANDAG 2004). SANDAG established the San Diego Management and Monitoring Program (SDMMP) in 2008 to coordinate regional activities in collaboration with the Wildlife Agencies, landowners and managers, scientists, nonprofit organizations, biological consulting firms, and other partners. SDMMP collaborated with partners to prepare the *Management and Monitoring Strategic Plan for Conserved Lands in Western San Diego County: A Habitat Conservation Roadmap* (MSP Roadmap; SDMMP and TNC 2017), which provides prioritized management and monitoring goals and objectives for the regional preserve system. The MSP Roadmap Area (MSPA) in San Diego County extends from the peaks of the Eastern Peninsular Range west to the ocean and from the borders with Orange and Riverside Counties south to the International Border with Mexico (fig. 3). The MSP Roadmap currently addresses 670,189 acres of Conserved Lands within the County[4], of which 156,048 acres are located within areas of the permitted MSCP and MHCP plans.

One of the integral components of the MSCP and MHCP plans is the requirement for long-term monitoring of the regional preserve system and the Covered Species. Both plans require the implementation of a biological monitoring program for species and habitats and the submittal of biological monitoring reports to the Wildlife Agencies by the Permittees (City of San Diego 1998; AMEC and others 2003). To ensure uniformity in data gathering and analysis, the Wildlife Agencies took on the responsibility for coordinating the biological monitoring program, aggregating and analyzing the management and monitoring data collected, and providing information and technical assistance to the Permittees. Analysis and recommendations regarding changes in the monitoring program were to occur every 3 years and be assembled into a 3-year report ("Triennial Monitoring Report"). The first report was prepared for the MSCP in 2012 (USFWS and others, 2012). There is only one Permittee in the MHCP (City of Carlsbad), and, therefore, there has been no need to prepare a consolidated report for the MHCP. However, the City of Carlsbad has prepared Triennial Biological Monitoring Reports since permit issuance for their subarea plan (TAIC 2008; ESA 2012, 2015, 2018, 2021).

[4] This includes Conserved Lands in the North County and East County MSCP planning areas.

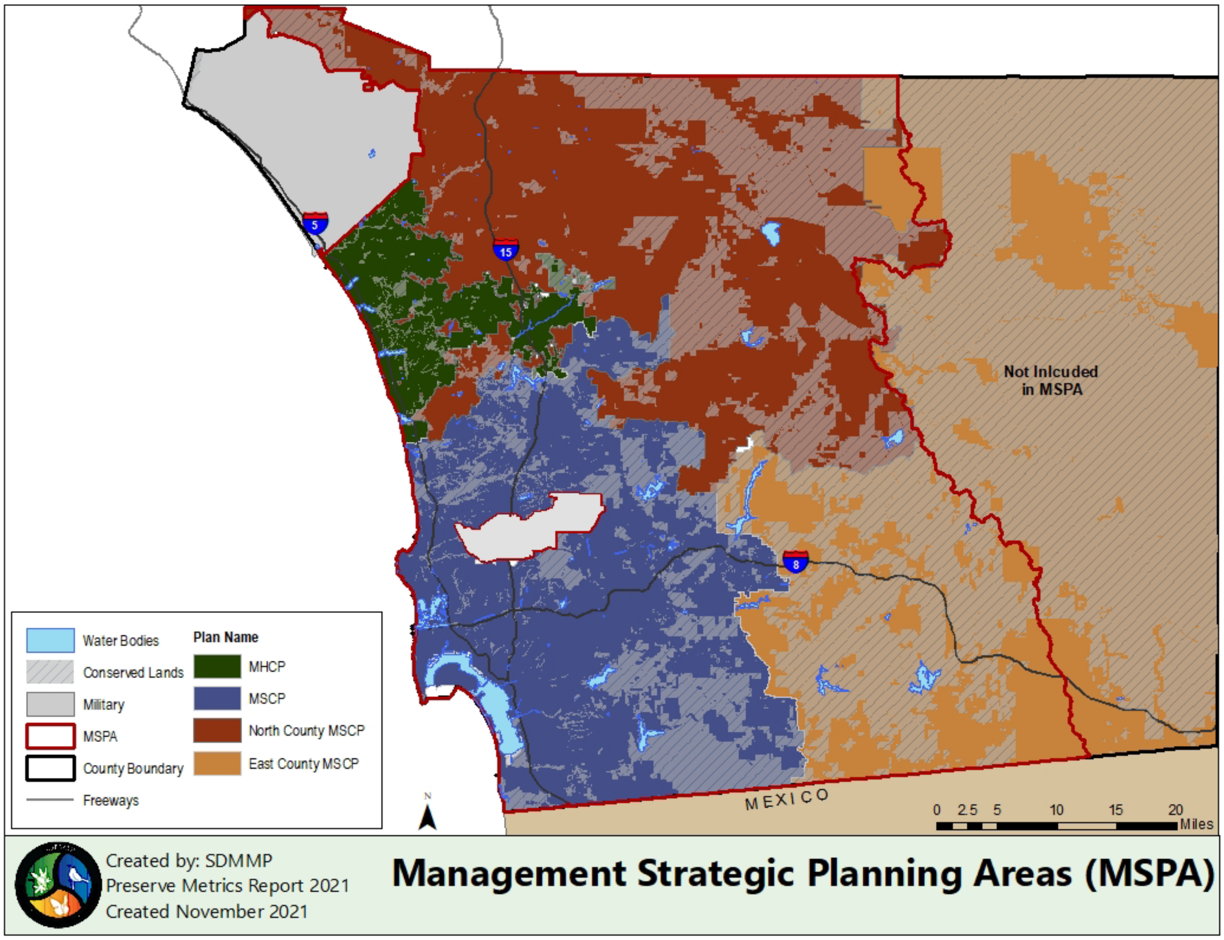


**Figure 3.** Management Strategic Plan Roadmap Area.

SDMMP has no regulatory authority, but it is fulfilling some of the coordination and science support that was originally envisioned in the MSCP and MHCP plans to be provided by the Wildlife Agencies, the Habitat Management Technical Committee, and the Implementation Coordination Committee described in the MSCP subregional plan (City of San Diego 1998). The 2012 Triennial Monitoring Report for MSCP includes a discussion of how SDMMP is supporting and facilitating regional management and monitoring tasks (USFWS and others 2012).

The MSP Roadmap addresses 111 species, 95 of which are Covered Species in the MSCP Plan and/or the MHCP Plan. Sixteen other MSP species are sensitive species identified by local species experts which could potentially be included in the North and East County plans. These species are being used to guide management and monitoring in the region, consistent with the vision laid out the MSCP and MHCP plans (City of San Diego 1998; AMEC and others 2003; SDMMP and TNC 2017). Participation by landowners and managers in regional monitoring and management activities has increased over the years, with over 100 federal and state agencies, local jurisdictions, biological consulting firms, universities, and nonprofit partners participating in SDMMP's regional monitoring and management activities (*https://sdmmp.com/about.php#nav-partners-tab*). The program supports landowners and managers by coordinating regional projects among partners, developing monitoring protocols and sampling designs, preparing prioritized management plans with best management practices, conducting monitoring and management projects, developing and maintaining databases, and providing competitive grant funding for management at individual preserves (SDMMP and TNC 2017; https://sdmmp.com).

This report is not intended to be a compliance audit of the permits issued in conjunction with the MSCP or MHCP plans, but rather a summary of the efforts to assemble the MSCP and MHCP preserves and to implement regional monitoring and management. First, an update on the preserve assembly status is presented by USFWS authors identifying progress made towards conservation goals for vegetation communities, species, and cores and linkages in the MSCP and MHCP plans (City of San Diego 1998; AMEC and others 2003). This report fulfills, in part, a commitment by the Wildlife Agencies to prepare a Triennial Monitoring Report for the conservation plans showing progress in preserve assembly and monitoring activities.

The bulk of this report, prepared by USGS on behalf of SDMMP, focuses on the health and status of the regional preserve system in response to threats and management. This part of the report satisfies a recommendation by SANDAG's Independent Tax Oversight Committee (ITOC; Sjoberg Evashenk Consulting, Inc. 2018) to "track progress in meeting EMP goals and develop metrics to measure overall health of the preserve against baselines established in the regional conservation plans." This report incorporates indicators and metrics to document progress in implementing the MSP Roadmap. These indicators provide information about the status of complex ecosystems in ways easily understood by the public and policy makers. Metrics are biologically based values that are measured or assessed and serve to identify the status or health of one aspect of the associated indicator. This component of the report evaluates progress in meeting MSP Roadmap objectives for indicators that include selected species, vegetation communities, and ecosystem processes and landscape-scale threats (see Introduction to Regional Preserve System Indicators and Metrics). As part of an adaptive management framework, the results of these evaluations are used by SDMMP in the 5-year update of management and monitoring objectives in the MSP Roadmap.

The MSP Portal, developed and managed by SDMMP, (available at sdmmp.com) includes a SDMMP Regional Preserve System Metrics Dashboard ("Metrics Dashboard"). SDMMP, through the MSP Portal, provides resources for land managers and other partners including monitoring datasets, common protocols, and a centralized database. Finally, in addition to this static report, all metric information will be available through the SDMMP website (https://sdmmp.com/metrics/index.php) in an interactive format that allows users to investigate metrics and data for specific indicators. Visitors can view landscape-scale metrics summarized across the preserve system, drill in to evaluate management units or preserve-level metrics, as well as focus in on plant or animal occurrences for status, threat, and habitat association data used in developing metrics.

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# II. Status of the MSCP and MHCP Preserve System and Covered Species

## Preserve Assembly

The status of the preserve assembly (that is, habitat acreage and Covered Species occurrences) within the MSCP and MHCP plans is summarized in the following sections.

### MSCP Preserve

As of December 31, 2019, approximately 120,672 acres of the MSCP Preserve have been conserved (that is, shown as a habitat gain in the conservation acquisition database: HabiTrak; CDFW 2019) within the planned preserve (that is, MHPA or PAMA). This represents 70 percent of the total preserve acreage goal of approximately 172,000 acres required to be conserved by the federal and state permits. In addition, approximately 28,000 acres of land have been conserved outside of the planned preserve. Most of this acreage will be added to the overall MSCP Preserve; however, some may be exchanged for less sensitive lands within the MHPA/PAMA (for example, boundary line adjustment). Table 1 summarizes the acreages of habitat gained both within and outside the MSCP Preserve.

**Table 1.** Status of the MSCP Preserve assembly by habitat type within permitted jurisdictions as of December 31, 2019.

| Habitat type | MSCP conservation goal (acres) | Conserved in preserve* (acres) | Percentage conserved | Conserved outside preserve (acres) |
|---|---|---|---|---|
| Beach** | 443 | 77 | 17 percent | - |
| Saltpan** | 212 | 139 | 66 percent | - |
| Southern Foredunes** | 124 | 10 | 8 percent | - |
| Southern Coastal Bluff Scrub | 139 | 141 | 101 percent | - |
| Coastal Sage Scrub | 71,337 | 46,168 | 65 percent | 8,585 |
| Maritime Succulent Scrub | 890 | 805 | 90 percent | 74 |
| Chaparral | 55,110 | 45,193 | 82 percent | 10,462 |
| Southern Maritime Chaparral | 1,137 | 987 | 88 percent | 61 |
| Coastal Sage-Chaparral Scrub | 1,493 | 1,289 | 86 percent | 1,151 |
| Grassland | 10,058 | 6,020 | 60 percent | 1,670 |
| Southern Coastal Salt Marsh** | 1,695 | 916 | 54 percent | 75 |
| Freshwater Marsh | 498 | 235 | 47 percent | 62 |
| Riparian Forest | 1,077 | 760 | 71 percent | 85 |
| Oak Riparian Forest | 3,053 | 1,437 | 47 percent | 480 |
| Riparian Woodland | 588 | 527 | 89 percent | 8 |
| Riparian Scrub | 4,349 | 2,031 | 47 percent | 113 |
| Oak Woodland | 2,659 | 1,391 | 52 percent | 510 |
| Torrey Pine Forest | 145 | 145 | 100 percent | - |
| Tecate Cypress Forest | 5,591 | 5,601 | 100 percent | - |
| Eucalyptus Woodland | 331 | 193 | 58 percent | 81 |
| Open Water** | 5,217 | 564 | 11 percent | 49 |
| Disturbed Wetland | 747 | 225 | 30 percent | 29 |
| Natural Flood Channel | 755 | 205 | 27 percent | 9 |
| Shallow Bays** | 234 | 82 | 35 percent | 196 |
| Disturbed Land | 352 | 2,457 | 698 percent | 617 |
| Agriculture | 62 | 1,866 | 3,010 percent | 2,699 |
| Total | 172,000 | 120,672 | 70 percent | 28,000 |

*Preserve lands are located within the MHPA/PAMA which encompasses the area of the habitat conservation goals (that is, permit requirements) established within the MSCP Plan boundary (City of San Diego 1998).

**These habitat types are located primarily within the cities of Coronado, Imperial Beach, and Del Mar. These cities are not participating in the MSCP; therefore, these acres may never formally be conserved as part of the MSCP Preserve. However, these habitats are located on public lands and are included as part of the baseline conservation.

## MHCP Preserve

Approximately 6,834 acres of the MHCP Preserve (referred to as FPA in the MHCP Plan documents) have been conserved (that is, shown as a habitat gain in HabiTrak; CDFW 2019) as of December 31, 2019, representing 34 percent of the total preserve acreage goal. In addition, approximately 542 acres of land have been conserved outside of the MHCP Preserve. Table 2 summarizes acreages of habitat gained both within and outside the MHCP Preserve within the City of Carlsbad. Approximately 11,873 acres are conserved within the other MHCP cities, but they are not tracked through HabiTrak as no permits have been issued to these cities by the Wildlife Agencies.

**Table 2.** Status of the MHCP Preserve assembly by habitat type within the City of Carlsbad as of December 31, 2019.

| Habitat type | MHCP conservation goal (acres) | Conserved in preserve* (acres) | Percent conserved | Conserved outside preserve (acres) |
|---|---|---|---|---|
| Beach | 8 | - | 0 percent | - |
| Saltpan | 7 | - | 0 percent | - |
| Coastal Sage Scrub | 5,972 | 1,879 | 31 percent | 33 |
| Maritime Succulent Scrub | 29 | 26 | 88 percent | 6 |
| Chaparral | 6,056 | 899 | 15 percent | 50 |
| Southern Maritime Chaparral | 837 | 405 | 48 percent | 5 |
| Coastal Sage-Chaparral Scrub | 249 | 112 | 45 percent | - |
| Grassland | 1,905 | 764 | 40 percent | 31 |
| Southern Coastal Salt Marsh | 268 | 135 | 50 percent | - |
| Alkali Marsh | 162 | 78 | 50 percent | - |
| Freshwater Marsh | 491 | 161 | 33 percent | 21 |
| Riparian Forest | 672 | 63 | 9 percent | - |
| Riparian Woodland | 246 | 12 | 5 percent | - |
| Riparian Scrub | 1,781 | 402 | 23 percent | 27 |
| Engelmann Oak Woodland | 187 | 7 | 4 percent | - |
| Coast Live Oak | 514 | 41 | 8 percent | 1 |
| Other Oak Woodland | 4 | 5 | 121 percent | - |
| Eucalyptus Woodland | 215 | 97 | 45 percent | 1 |
| Freshwater | 440 | 51 | 12 percent | - |
| Estuarine | 974 | 780 | 80 percent | 1 |
| Disturbed Wetland | 178 | 90 | 51 percent | 8 |
| Natural Flood Channel | 141 | - | 0 percent | - |
| Disturbed Land | 244 | 236 | 97 percent | 33 |
| Agriculture | 185 | 261 | 141 percent | 325 |
| Total | 19,928 | 6,834 | 34 percent | 542 |

*Preserve (that is, FPA) is comprised of a combination of “hard line” preserves, indicating lands that will be conserved and managed for biological resources, and “soft line” planning areas, within which preserve areas will ultimately be delineated and managed based on further data and planning (AMEC and others 2003).

# Biological Core and Linkage Areas

## MSCP Plan Core and Linkage Areas

The MSCP Plan identified 16 core biological resource areas associated with 12 habitat linkages targeted for conservation within the MHPA/PAMA (fig. 4; City of San Diego 1998). To date, at least 50 percent of each core area has been conserved (table 3).

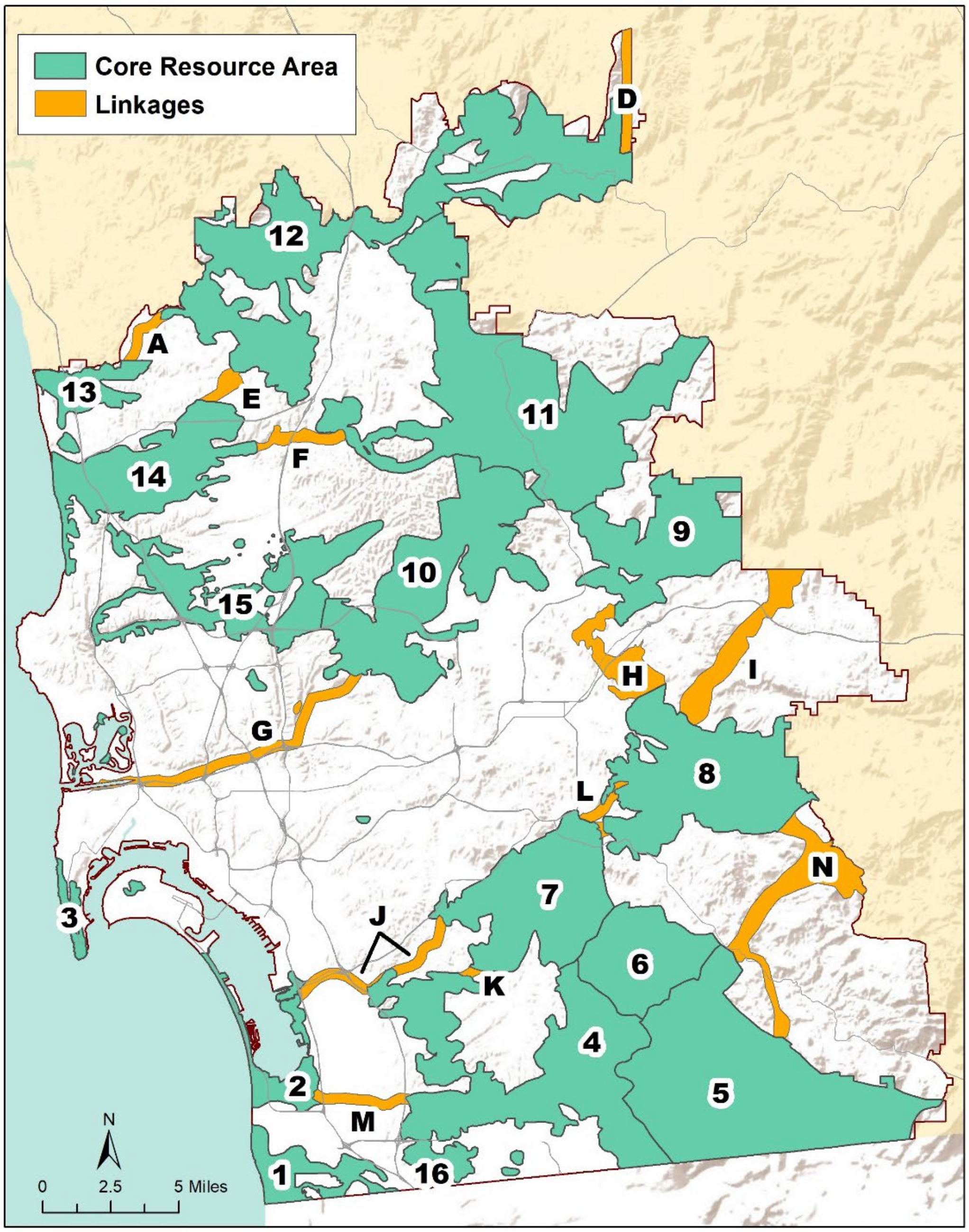


**Figure 4.** MSCP Plan generalized core biological resource areas A through M (green) and linkages 1 through 16 (orange) (City of San Diego 1998). Figure and source data provided by USFWS.

**Table 3.** Summary of conservation within the MSCP Plan core resource areas and linkages.

| Core | Core name | MSCP conservation goal[1] (acres) | Conserved[2] in preserve (acres) | Percent conserved | Conserved outside preserve (acres) | Total conserved (acres) |
|---|---|---|---|---|---|---|
| 1 | Tijuana Estuary/River Valley | 2,925 | 2,207 | 75 percent | 33 | 2,240 |
| 2 | South San Diego Bay/Silver Strand | 1,644 | 1,063 | 65 percent | 10 | 1,073 |
| 3 | Point Loma | 92 | 107 | 116 percent | 0 | 107 |
| 4 | Otay Lakes/Mesa/ River Valley | 12,587 | 6,276 | 50 percent | 785 | 7,061 |
| 5 | Otay Mountain/ Marron Valley | 26,396 | 26,231 | 99 percent | 185 | 26,416 |
| 6 | Jamul Mountain | 7,028 | 4,623 | 66 percent | 444 | 5,067 |
| 7 | Sweetwater/ San Miguel Mountain | 10,116 | 7,615 | 75 percent | 846 | 8,461 |
| 8 | McGinty Mountain/ Sequan Peak/Dehesa | 10,456 | 7,447 | 71 percent | 1,255 | 8,703 |
| 9 | Lake Jennings/ Wildcat Canyon/El Cajon Mtn. | 8,228 | 4,645 | 52 percent | 269 | 4,915 |
| 10 | Mission Trails/Kearny Mesa/East Elliot/Santee | 10,499 | 7,861 | 75 percent | 71 | 7,932 |
| 11 | Poway/San Vicente | 21,079 | 11,374 | 54 percent | 457 | 11,831 |
| 12 | Hodges Reservoir/San Pasqual | 18,739 | 10,430 | 56 percent | 1,027 | 11,457 |
| 13 | San Dieguito Lagoon | 880 | 968 | 110 percent | 147 | 1,115 |
| 14 | Los Peñasquitos Lagoon/ Canyon/Del Mar Mesa | 6,236 | 6,561 | 105 percent | 276 | 6,837 |
| 15 | Vernal Pools, Kearny Mesa | 1,085 | 840 | 77 percent | 44 | 884 |
| 16 | Vernal Pools, Otay Mesa | 425 | 466 | 110 percent | 164 | 630 |
| Linkages | A, D, E, F, G, H, I, J, K, L, M, N | 9,876 | 6,004 | 61 percent | 324 | 6,328 |

[1] From table 3.2 of the MSCP (City of San Diego, 1998).
[2] Based on HabiTrak data to date (CDFW 2019).

Four of the biological core areas (3, 13, 14, and 16) have been fully conserved, with another five (1, 5, 7, 10, and 15) at least 75 percent conserved. The seven remaining biological core resource areas (2, 4, 6, 8, 9, 11, and 12) are all at least 50 percent conserved. Of the habitat linkages targeted within the MHPA/PAMA, 61 percent of the targeted acreage has been conserved, primarily within linkages D, E, F, G, H, I, M, and N (5,972 acres). All other habitat linkages (A, J, K, and L) combined account for only 32 conserved acres.

Considerable conservation needs remain to reach the MSCP Plan targets within the MHPA/PAMA for biological core areas 4, 9, 11, and 12. Of these, core areas 11 and 12 contain the largest extent of non-conserved area (9,705 and 8,309 acres respectively). The largest areas of non-conserved habitat linkage fall within linkages I and N. To meet the goals of the MSCP preserve system, these areas could be a priority for conservation efforts.

## MHCP Plan Core and Linkage Areas

Given the existing high degree of habitat fragmentation in the study area, the MHCP Plan does not identify specific core blocks of habitat and landscape linkages the way the MSCP does (AMEC and others 2003). Instead, the MHCP Plan identifies a general area (Biological Core and Linkage Area [BCLA]; fig. 5) for the study area that is then used as the basis for designing the preserve. The MHCP Plan targets conserving approximately 71 percent of remaining BCLA (AMEC and others 2003). To date, approximately 16,447 acres (51 percent) of the BCLA in the MHCP Plan have been conserved, including the 6,834 acres identified above in table 2 within the City of Carlsbad.

The MHCP Plan also identified a requirement to conserve 400-500 acres of coastal sage scrub southeast of the MHCP Plan boundary in the unincorporated areas of the County within the North County plan boundary (fig. 6). This is in a Core Coastal California Gnatcatcher Conservation Area. The City of Carlsbad has acquired their portion of this offsite requirement (307 acres). In addition, the Wildlife Agencies, the County of San Diego, Department of Defense, and other conservation partners have conserved significant acreage (587 acres) in this area.

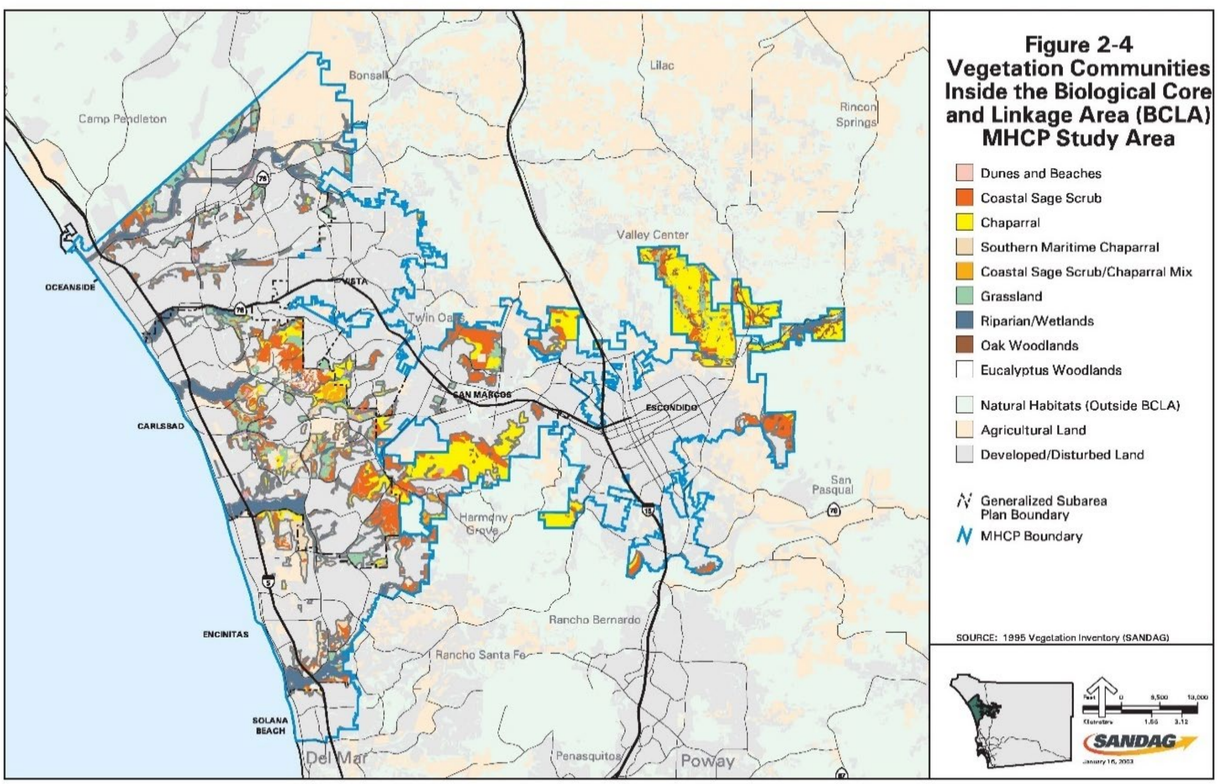


**Figure 5.** MHCP Plan Biological Core and Linkage Areas (Figure 2-4 in Volume 1 of the Final MHCP Plan; AMEC and others, 2003).

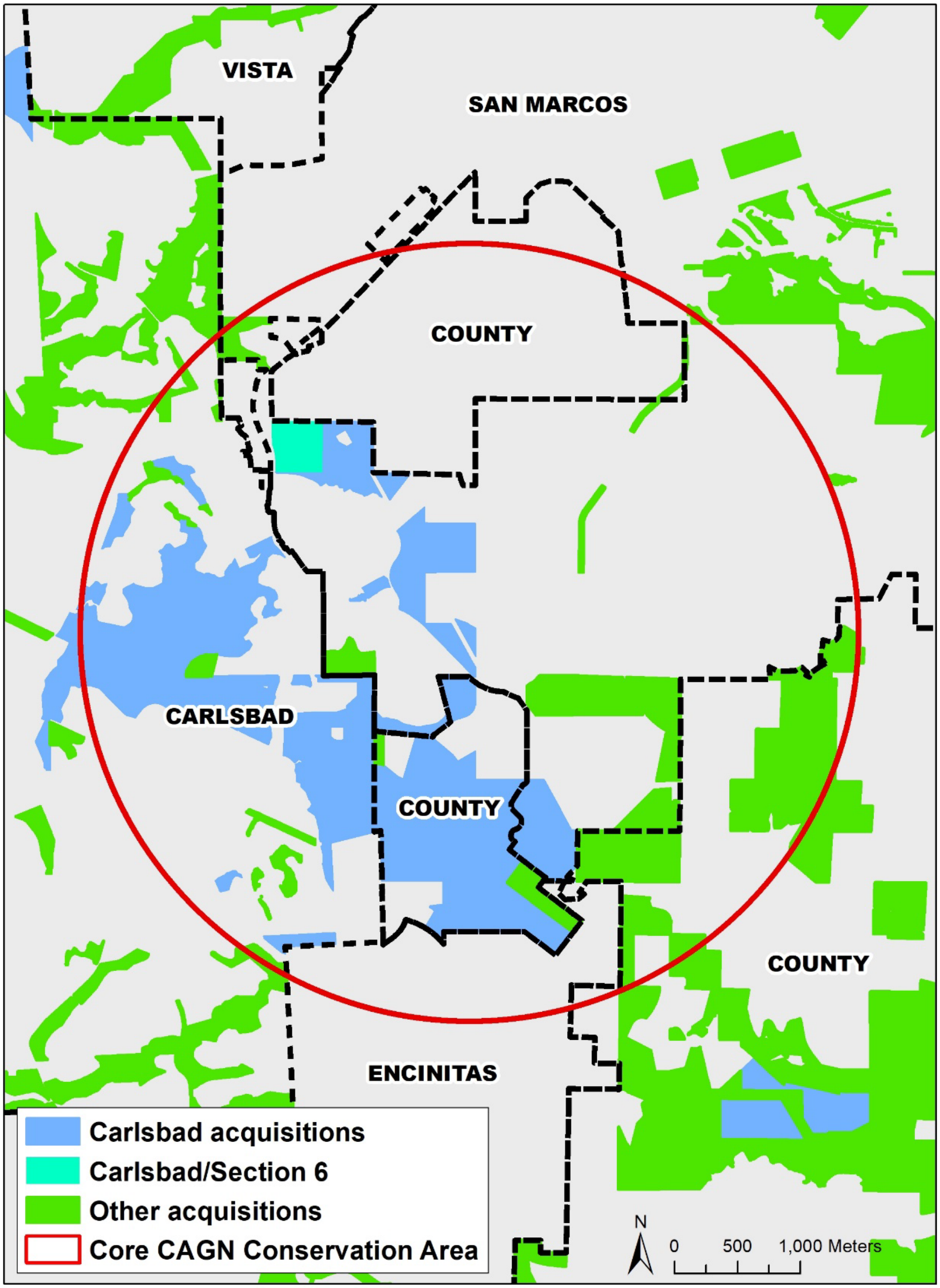


**Figure 6.** Conserved lands within the County Core Coastal California Gnatcatcher Conservation Area identified in the MHCP Plan. Figure and source data provided by USFWS.

## Species Conservation

The following two sections assess the progress the MSCP and MHCP have made towards achieving their species conservation goals. Regional Sensitive Species (REGSS) databases were compiled from species locations recorded in the 1980s and 1990s to develop the MSCP and MHCP plans (Ogden 1995; SANDAG 2020). Location data were obtained from biological technical reports and from focused surveys designed to obtain Covered Species information to develop the conservation plans. REGSS Covered Species locations were plotted on the habitat gains reported in HabiTrak (CDFW 2019) and the Conserved Lands geographic information system (GIS) coverages (SDMMP 2020a) to assess the level of conservation that has occurred to date for each of the Covered Species. Conservation, in this context, refers to whether the REGSS species locations occur on land that has been included in HabiTrak as a gain due to implementation of the MSCP or MHCP plans or occur on land that is owned and managed by a public entity for their biological resources. Conservation, in this context, does not reflect the current condition/viability of the species occurrences or the effectiveness of the management and monitoring. The overall conservation status of a subset of the Covered Species is discussed in detail below in the Indicator Species section.

New data points, both within and outside the MSCP and MHCP preserve systems, have been collected since the MSCP and MHCP plans were finalized, but these summary tables address only those occurrences identified in the original REGSS database. Similar to the preserve assembly, this summary is provided to document progress on the preservation goal established for each Covered Species in the subregional plans. It does not summarize the overall status (for example, condition, trends, and so forth) of each species within the County, which is provided for a subset of the MSP species in the following sections of this report. The new data are from a variety of sources including, but not limited to, baseline surveys conducted by individual jurisdictions, rare plant monitoring coordinated by SDMMP with SANDAG contracted botanists and preserve managers, regional species monitoring projects, and incidental sightings that have been reported to the California Natural Diversity Data Base (CNDDB) and other databases. The new data are aggregated in the Master Occurrence Matrix (MOM) database and maintained by SDMMP (SDMMP 2020b).

Data in the MOM plant and animal databases are used to designate management categories, identify occurrences important for management, develop management goals and objectives, and prioritize implementation of management actions (SDMMP and TNC 2017). MOM will continue to be used to track each species' status and distribution in the MSPA over time. The MSP Roadmap addresses 111 species which includes 78 of the 85 MSCP Covered Species and 58 of the 61 MHCP Covered Species (City of San Diego 1998; AMEC and others 2003; SDMMP and TNC 2017). The MSP species were assigned to one of five management groups based on their status, trends, threats, and biology (SDMMP and TNC 2017; see also management categories in tables 4 and 5 below). This assignment is reviewed every 5 years when the MSP Roadmap is updated (SDMMP and TNC 2017).

## MSCP Plan Species Conservation

Table 4 summarizes the progress made towards achieving the conservation goals identified for each of the Covered Species as outlined in the conditions for coverage found in table 3-5 in the MSCP Plan (City of San Diego 1998).

During the first 13 years, the MSCP stakeholders collected data on 54 of the 85 Covered Species. Please refer to the San Diego MSCP Status Report: 1997-2011 (USFWS and others 2012) for a summary of those efforts. Since that time, monitoring data have been collected for an additional 13 Covered Species for a total of 67 (79 percent) of Covered Species. Management and monitoring data for each species are available through the SDMMP Portal (https://sdmmp.com/species.php). The USFWS is currently in the process of developing a qualitative assessment of the conservation status of all the MSCP Covered Species similar to the USFWS 2012 report.

**Table 4.** Summary of the proportion of MSCP Plan Covered Species locations (REGSS) that occur in the MSCP Preserve, MSP management category, and availability of monitoring data.

| Common name | Scientific name | Proportion of REGSS species locations on Conserved Lands* (locations on preserved land/MSCP goal) | MSP management category[1] | Monitoring data available |
|---|---|---|---|---|
| **Plants** | | | | |
| Aphanisma | *Aphanisma blitoides* | Partial** | SL | Yes |
| California Orcutt grass | *Orcuttia californica* | Minimal (1/6) | SL | Yes |
| Coast wallflower | *Erysimum ammophilum* | Substantial** | SL | Yes |
| Coastal dunes milk vetch[2] | *Astragalus tener* var. *titi* | Minimal*** | NA | No |
| Dehesa bear-grass | *Nolina interrata* | Achieved (33/33) | SO | Yes |
| Del Mar manzanita | *Arctostaphylos glandulosa* ssp. *crassifolia* | Substantial (93/103) | VF | Yes |
| Del Mar mesa sand aster[3] | *Corethrogyne filaginifolia* var. *linifolia* | Partial (24/34) | NA | Yes |
| Dense reed grass[3] | *Calamagrostis koelerioides* | Partial (4/6) | NA | No |
| Dunn’s mariposa lily | *Calochortus dunnii* | Substantial (35/43) | VG | No |
| Encinitas baccharis | *Baccharis vanessae* | Substantial (28/34) | SO | Yes |
| Felt-leaved monardella | *Monardella hypoleuca* ssp. *lanata* | Achieved (5/5) | VF | Yes |
| Gander's ragwort | *Packera ganderi* *(Senecio gander)* | Achieved (4/4) | VG | Yes |
| Gander’s pitcher sage | *Lepechinia ganderi* | Substantial (21/25) | VG | No |
| Heart-leaved pitcher sage | *Lepechinia cardiophylla* | Achieved (1/1) | SL | Yes |
| Lakeside ceanothus | *Ceanothus cyaneus* | Achieved (7/7) | VF | Yes |
| Narrow-leaved nightshade[3] | *Solanum tenuilobatum* | Partial (61/110) | NA | No |

| Common name | Scientific name | Proportion of REGSS species locations on Conserved Lands* (locations on preserved land/MSCP goal) | MSP management category[1] | Monitoring data available |
|---|---|---|---|---|
| Nevin's barberry[2] | *Berberis nevinii* | Achieved (2/2) | NA | No |
| Nuttall's acmispon | *Acimispon prostratus* (*Lotus nuttallianus*) | Minimal*** | SO | Yes |
| Orcutt's bird's-beak | *Dicranostegia orcuttiana* (*Cordylanthus orcuttianus*) | Achieved (6/6) | SL | Yes |
| Orcutt's brodiaea | *Brodiaea orcuttii* | Partial (28/44) | SO | Yes |
| Otay manzanita | *Arctostaphylos otayensis* | Partial (18/25) | VF | No |
| Otay mesa mint | *Pogogyne nudiuscula* | Substantial (78/86) | SL | Yes |
| Otay tarplant | *Deinandra conjugens* | Partial (25/63) | SS | Yes |
| Palmer's ericameria | *Ericameria palmeri* ssp. *palmeri* | Partial (13/28) | VF | Yes |
| Parry's tetracoccus | *Tetracoccus dioicus* | Substantial (29/30) | SS | Yes |
| Spreading navarretia | *Navarretia fossalis* | Achieved (5/5/) | VF | Yes |
| Salt marsh bird's-beak | *Chloropyron maritimum* ssp. *maritimum* *(Cordylanthus maritimus* ssp. *maritimus)* | Achieved (3/3) | SL | Yes |
| San Diego ambrosia | *Ambrosia pumila* | Partial (4/13) | SO | Yes |
| San Diego barrel cactus | *Ferocactus viridescens* | Partial (649/972) | VF | Yes |
| San Diego button-celery | *Eryngium aristulatum* var. *parishii* | Substantial (163/174) | VF | Yes |
| San Diego goldenstar | *Bloomeria clevelandii* (*Muilla clevelandii*) | Partial (55/113) | SS | Yes |
| San Diego mesa mint | *Pogogyne abramsii* | Substantial (8/10) | VF | Yes |
| San Diego thorn-mint | *Acanthomintha ilicifolia* | Substantial (26/30) | SO | Yes |
| San Miguel savory | *Clinopodium chanderi* (*Satureja chandleri*) | Partial (1/2) | SL | Yes |
| Shaw's agave | *Agave shawii* | Partial (1/2) | SL | Yes |
| Short-leaved dudleya | *Dudleya brevifolia* *(Dudleya blochmaniae* ssp. *brevifolia)* | Achieved (8/8) | SL | Yes |
| Slender-pod jewelflower | *Caulanthus stenocarpus* | Partial (17/40) | NA | No |
| Small-leaved rose[4] | *Rosa minutifolia* | Achieved (1/1) | SS | Yes |
| Snake cholla | *Cylindrorpuntia californica californica* | Partial (13/24) | VF | Yes |
| Sticky dudleya | *Dudleya viscida* | Achieved (2/2) | SS | Yes |
| Tecate cypress | *Hesperocyparis forbesii* (*Cupressus forbesii*) | Achieved** | VF | Yes |
| Thread-leaved brodiaea | *Brodiaea filifolia* | Partial** | SS | Yes |
| Torrey pine | *Pinus torreyana* ssp. *torreyana* | Achieved (8/8) | VF | Yes |
| Variegated dudleya | *Dudleya variegata* | Partial (151/207) | SS | Yes |
| Wart-stemmed ceanothus | *Ceanothus verrucosus* | Substantial (43/51) | VF | Yes |

| Common name | Scientific name | Proportion of REGSS species locations on Conserved Lands* (locations on preserved land/MSCP goal) | MSP management category[1] | Monitoring data available |
|---|---|---|---|---|
| Willowy monardella | *Monardella viminea* (*Monardella linoides* ssp. *viminea*) | Partial (31/43) | SL | Yes |
| **Invertebrates** | | | | |
| Riverside fairy shrimp | *Streptocephalus woottoni* | Achieved (2/2) | SL | Yes |
| San Diego fairy shrimp | *Branchinecta sandiegonensis* | Partial** | SL | Yes |
| Thorne's hairstreak butterfly | *Callophrys thornei (Mitoura thornei)* | Achieved** | VF | Yes |
| Wandering skipper/Salt marsh skipper | *Panoquina errans* | Achieved (1/1) | VF | Yes |
| **Amphibians and Reptiles** | | | | |
| Arroyo toad | *Bufo californicus* | Achieved (15/15) | SO | Yes |
| California red-legged frog | *Rana draytonii (Rana aurora draytonii)* | Partial** | SL | Yes |
| Orange-throated whiptail | *Aspidoscelis hyperythra (Cnemidophorus hyperythrus beldingi)* | Partial (514/709) | VG | Yes |
| Southwestern pond turtle | *Emys pallida (Clemmys marmorata pallida)* | Partial (5/7) | SL | Yes |
| Blainville's horned lizard | *Phrynosoma blainvillii [Phrynosoma coronatum (blainvillei population)]* | Partial (131/215) | VF | Yes |
| **Birds** | | | | |
| Bald eagle | *Haliaeetus leucocephalus* | Minimal (1/4) | VG | No |
| Belding's savannah sparrow | *Passerculus sandwichensis beldingi* | Substantial (28/31) | VF | Yes |
| California brown pelican | *Pelecanus occidentalis californicus* | Achieved (2/2) | VG | No |
| California least tern | *Sterna antillarum browni* | Partial (2/3) | SO | Yes |
| Canada goose | *Branta canadensis* | Partial (2/3) | VG | No |
| Coastal cactus wren | *Campylorhynchus brunneicapillus sandiegensis* | Partial (226/348) | SO | Yes |
| Coastal California gnatcatcher | *Polioptila californica californica* | Partial (1,374/1,892) | VF | Yes |
| Cooper's hawk | *Accipiter cooperii* | Partial (34/58) | VG | Yes |
| Elegant tern | *Sterna elegans* | Achieved (2/2) | VG | Yes |
| Ferruginous hawk | *Buteo regalis* | Partial (1/2) | VG | Yes |
| Golden eagle | *Aquila chrysaetos* | Partial (25/37) | SO | Yes |
| Large-billed savannah sparrow | *Passerculus sandwichensis rostratus* | Achieved (2/2) | VG | No |
| Least Bell's vireo | *Vireo bellii pusillus* | Partial (199/298) | SO | Yes |
| Light-footed Ridgway's rail | *Rallus obsoletus levipes* (*Rallus longirostris levipes*) | Achieved (9/9) | SO | Yes |

| Common name | Scientific name | Proportion of REGSS species locations on Conserved Lands* (locations on preserved land/MSCP goal) | MSP management category[1] | Monitoring data available |
|---|---|---|---|---|
| Long-billed curlew | *Numenius americanus* | Substantial (5/6) | VG | No |
| Mountain plover[2] | *Charadrius montanus* | Partial** | NA | No |
| Northern harrier | *Circus cyaneus* | Partial (25/36) | SO | Yes |
| Peregrine falcon | *Falco peregrinus* | Partial (6/8) | VG | Yes |
| Reddish egret | *Egretta rufescens* | Achieved (2/2) | VG | No |
| Southern California rufous-crowned sparrow | *Aimophila ruficeps canescens* | Partial (295/415) | VG | No |
| Southwestern willow flycatcher | *Empidonax traillii extimus* | Achieved (8/8) | SL | Yes |
| Swainson's hawk | *Buteo swainsoni* | Achieved (1/1) | VG | Yes |
| Tricolored blackbird | *Agelaius tricolor* | Partial (6/10) | SL | Yes |
| Western bluebird | *Sialia mexicana* | Partial (3/4) | VG | No |
| Western burrowing owl | *Athene cunicularia hypugaea* (*Speotyto cunicularia*) | Partial (5/16) | SL | Yes |
| Western snowy plover | *Charadrius alexandrinus nivosus* | Substantial (7/9) | SL | Yes |
| White-faced ibis | *Plegadis chihi* | Substantial (12/13) | VG | No |
| **Mammals** | | | | |
| American badger | *Taxidea taxus* | Partial** | SL | Yes |
| Mountain lion | *Puma concolor* *(Felis concolor)* | Partial (17/26) | SL | Yes |
| Southern mule deer | *Odocoileus hemionus fuliginata* | Partial (86/145) | SS | Yes |

*Progress towards achieving conservation goals is based on the proportion of REGSS locations targeted for conservation that occur on Conserved Lands.
**For species with no REGSS locations, percentage of potential habitat on Conserved Lands was used instead – Achieved = 100 percent; Substantial > 75 percent; Partial < 75 percent and > 25 percent; Minimal < 25 percent. Note that while conservation progress is denoted as achieved for some species, the MSCP Plan has continuing conservation requirements for certain Covered Species, such as those subject to a narrow endemic policy.
***93 percent of the potential habitat (southern foredunes) targeted for conservation in the MHPA is located within the cities of Del Mar, Coronado, and Imperial. These cities are not participating in the MSCP Plan; therefore, these acres may never formally be conserved as part of the MSCP Preserve. However, the southern foredunes are located on public lands and are reasonably included as part of the baseline conservation. Within the City of San Diego, the conservation status for these species is "achieved."

[1]MSP Management Categories are described in detail in Vol. 1, Sec. 2.0 of the MSP Roadmap. Codes are as follows:
SL = Species at risk of loss from MSPA; SO = Significant occurrence(s) at risk of loss from MSPA; SS = Species more stable but still requires species-specific management to persist in MSPA; VF = Species with limited distribution in the MSPA or needing specific vegetation characteristics requiring management; VG = Species not specifically managed for but may benefit from vegetation management for VF species; NA = not addressed in MSP Roadmap.
[2]No known locations on Conserved Lands.
[3]Taxonomic status unresolved, either rare subspecies or part of a larger common species group.
[4]The one REGSS occurrence was successfully translocated to the Preserve.

## MHCP Plan Species Conservation

Table 5 summarizes the progress made towards achieving the conservation goals identified for each of the Covered Species relative to the conditions for coverage found in the Conservation Analysis for the MHCP Plan (Volume II Final MHCP Plan; AMEC and others 2003). It includes the entire MHCP area, although only Carlsbad has a permit. The results of management and monitoring efforts for the City of Carlsbad are available on their website at *https://www.carlsbadca.gov/departments/environmental-sustainability/habitat-protection/hmp-reports-studies.*

Monitoring or survey data have been collected for a total of 45 (74 percent) of 61 species since the MHCP Plan was established in 2004. This includes data collected by Center for Natural Lands Management and CDFW, as well as SDMMP and their contractors.

**Table 5.** Summary of the proportion of MHCP Plan Covered Species locations (REGSS) that occur in the MHCP Preserve, MSP management category, and availability of monitoring data.

| Common name | Scientific name | Proportion of REGSS species locations on Conserved Lands[1] (locations on preserved land/ MHCP goal) | MSP management category[2] | Monitoring data available |
|---|---|---|---|---|
| **Plants** | | | | |
| Blochman's dudleya* | *Dudleya blochmaniae (Dudleya blochmaniae* ssp. *blochmaniae)* | Partial (3/4) | SL | Yes |
| California Orcutt grass | *Orcuttia californica* | Minimal (0/1) | SL | Yes |
| Cliff spurge* | *Euphorbia misera* | Achieved (1/1) | VF | Yes |
| Del Mar manzanita | *Arctostaphylos glandulosa* ssp. *crassifolia* | Partial (74/119) | VF | Yes |
| Del Mar mesa sand aster[3] | *Corethrogyne filaginifolia* var. *linifolia* | Partial (12/17) | NA | Yes |
| Encinitas baccharis | *Baccharis vanessae* | Substantial (15/18) | SO | Yes |
| Engelmann oak | *Quercus engelmannii* | Substantial (61/70) | VF | No |
| Little mousetail[3] | *Myosurus minimus* ssp. *apus* | Minimal (0/1) | NA | No |
| Nuttall's acmispon | *Acimispon prostratus* (*Lotus nuttallianus*) | Achieved (6/6) | SO | Yes |
| Nuttall's scrub oak* | *Quercus dumosa* | Substantial (26/29) | VF | Yes |
| Orcutt's spineflower* | *Chorizanthe orcuttiana* | Achieved (1/1) | SL | Yes |
| Orcutt's hazardia* | *Hazardia orcuttii* | Partial (2/5) | SL | Yes |
| Parry's tetracoccus[2] | *Tetracoccus dioicus* | NA | SS | Yes |
| San Diego ambrosia | *Ambrosia pumila* | Achieved (2/2) | SO | Yes |
| San Diego barrel cactus | *Ferocactus viridescens* | Substantial (20/25) | VF | Yes |
| San Diego button-celery | *Eryngium aristulatum* var. *parishii* | Minimal (3/14) | VF | Yes |

| Common name | Scientific name | Proportion of REGSS species locations on Conserved Lands[1] (locations on preserved land/ MHCP goal) | MSP management category[2] | Monitoring data available |
|---|---|---|---|---|
| San Diego marsh elder | *Iva hayesiana* | Achieved (1/1) | VG | No |
| San Diego thorn-mint | *Acanthomintha ilicifolia* | Substantial (10/13) | SO | Yes |
| Short-leaved dudleya | *Dudleya brevifolia (Dudleya blochmaniae* ssp. *brevifolia)* | Partial (3/4) | SL | Yes |
| Spreading navarretia | *Navarretia fossalis* | Minimal (0/2) | VF | Yes |
| Sticky dudleya | *Dudleya viscida* | Partial (8/23) | SS | Yes |
| Summer holly | *Comarostaphylis diversifolia* ssp. *diversifolia* | Partial (43/132) | VG | No |
| Thread-leaved brodiaea | *Brodiaea filifolia* | Partial (18/57) | SS | Yes |
| Torrey pine | *Pinus torreyana* ssp. *torreyana* | Partial (12/18) | VF | Yes |
| Wart-stemmed ceanothus | *Ceanothus verrucosus* | Partial (59/108) | VF | Yes |
| **Invertebrates** | | | | |
| Riverside fairy shrimp | *Streptocephalus woottoni* | Minimal (0/2) | SL | Yes |
| San Diego fairy shrimp | *Branchinecta sandiegonensis* | Partial (1/2) | SL | Yes |
| Harbison's dun skipper* | *Euphyes vestris harbisoni* | Partial (2/3) | SL | Yes |
| Quino checkerspot butterfly[4] | *Euphydryas editha quino* | NA | SL | No |
| Wandering skipper/Salt marsh skipper* | *Panoquina errans* | Achieved (1/1) | VF | Yes |
| **Amphibians and Reptiles** | | | | |
| Arroyo toad[4] | *Bufo californicus* | NA | SO | Yes |
| Orange-throated whiptail* | *Aspidoscelis hyperythra (Cnemidophorus hyperythrus beldingi)* | Partial (25/34) | VG | Yes |
| Southwestern pond turtle | *Emys pallida (Clemmys marmorata pallida)* | Partial (3/6) | SL | Yes |
| Blainville's horned lizard | *Phrynosoma blainvillii [Phrynosoma coronatum (blainvillei population)]* | Achieved (5/5) | VF | Yes |
| Western spadefoot | *Spea hammondii [Scaphiopus hammondii]* | Achieved (3/3) | VF | Yes |
| **Birds** | | | | |
| Belding's savannah sparrow* | *Passerculus sandwichensis beldingi* | Substantial (40/42) | VF | Yes |
| Bell's sparrow | *Artemisiospiza belli belli (Amphispiza belli belli)* | Minimal (2/8) | VF | No |
| California brown pelican* | *Pelecanus occidentalis californicus* | Achieved (5/5) | VG | No |
| California least tern* | *Sterna antillarum browni* | Achieved (19/19) | SO | Yes |
| Coastal cactus wren | *Campylorhynchus brunneicapillus sandiegensis* | Partial (18/34) | SO | Yes |

| Common name | Scientific name | Proportion of REGSS species locations on Conserved Lands[1] (locations on preserved land/ MHCP goal) | MSP management category[2] | Monitoring data available |
|---|---|---|---|---|
| Coastal California gnatcatcher* | *Polioptila californica californica* | Partial (219/315) | VF | Yes |
| Cooper's hawk* | *Accipiter cooperii* | Partial (24/34) | VG | Yes |
| Elegant tern* | *Sterna elegans* | Achieved (6/6) | VG | Yes |
| Golden eagle | *Aquila chrysaetos* | Achieved (7/7) | SO | Yes |
| Large-billed savannah sparrow[4]* | *Passerculus sandwichensis rostratus* | NA | VG | No |
| Least Bell's vireo* | *Vireo bellii pusillus* | Substantial (112/148) | SO | Yes |
| Light-footed Ridgway's rail* | *Rallus obsoletus levipes* (*Rallus longirostris levipes)* | Achieved (8/8) | SO | Yes |
| Osprey* | *Pandion haliaetus* | Partial (5/9) | VG | No |
| Peregrine falcon* | *Falco peregrinus anatum* | Achieved (6/6) | VG | Yes |
| Southern California rufous-crowned sparrow* | *Aimophila ruficeps canescens* | Partial (26/36) | VG | Yes |
| Southwestern willow flycatcher* | *Empidonax traillii extimus* | Partial (2/6) | SL | Yes |
| Yellow-breasted chat* | *Icteria virens* | Partial (34/50) | VF | No |
| Western bluebird | *Sialia mexicana* | Achieved (2/2) | VG | No |
| Western snowy plover* | *Charadrius alexandrinus nivosus* | Achieved (25/25) | SL | Yes |
| White-faced ibis* | *Plegadis chihi* | Substantial (11/14) | VG | No |
| **Mammals** | | | | |
| Mountain lion | *Puma concolor (Felis concolor)* | NA | SL | Yes |
| Northwestern San Diego pocket mouse | *Chaetodipus fallax fallax* | Achieved (1/1) | VG | No |
| Pacific pocket mouse[4] | *Perognathus longimembris pacificus* | NA | SL | No |
| San Diego black-tailed jackrabbit | *Lepus californicus bennetti* | Partial (5/7) | VF | No |
| Southern mule deer | *Odocoileus hemionus fuliginata* | Partial (1/3) | SS | Yes |
| Stephen's kangaroo rat[4] | *Dipodomys stephensi* | NA | SO | No |

*Species adequately conserved and permitted under the Carlsbad Subarea Plan.
[1]Progress towards achieving conservation goals is based on the proportion of REGSS locations targeted for conservation that occur on Conserved Lands.
[2]MSP Management Categories are described in detail in Vol. 1, Sec. 2.0 of the MSP Roadmap. Codes are as follows: SL = Species at risk of loss from MSPA; SO = Significant occurrence(s) at risk of loss from MSPA; SS = Species more stable but still requires species-specific management to persist in MSPA; VF = Species with limited distribution in the MSPA or needing specific vegetation characteristics requiring management; VG = Species not specifically managed for but may benefit from vegetation management for VF species; NA = not addressed in MSP Roadmap.
[3]Taxonomic status unresolved, either rare subspecies or part of larger common species group.
[4]No known locations on Conserved Lands.

#### Status of the MSCP and MHCP Preserve System and Covered Species References Cited


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# III. Regional Preserve System Indicators and Metrics

## Introduction

This section of the report prepared by USGS authors on behalf of SDMMP focuses on the health and status of species and vegetation communities in the regional preserve system and responses to threats and management actions. This section incorporates indicators and metrics to document progress in implementing the MSP Roadmap. Indicators provide information about the status of complex ecosystems in ways easily understood by the public and policy makers. A metric is a biologically based value that is measured or assessed and serves to identify the status or health of one aspect of the associated indicator.

SDMMP was established in 2008 to facilitate and assist SANDAG, local jurisdictions, Wildlife Agencies, landowners and managers, and other stakeholders in implementing regional monitoring and management of Conserved Lands in the MSPA in western San Diego County. These Conserved Lands consist of lands acquired for conservation as part of the implementation of the MSCP and MHCP plans (see Preserve Assembly) as well as publicly owned lands protected by federal and state agencies and local jurisdictions prior to the adoption of the conservation plans and in planning areas where conservation plans are in development. SDMMP and regional monitoring and management activities are funded by SANDAG's *TransNet* half-cent sales tax (SANDAG 2004). This ordinance was initially approved by voters in 1988 to fund local transportation projects. In 2004, voters approved a 40-year extension to obtain funds for public transit and for highway and local street improvements. Included in this extension was funding for the EMP to mitigate habitat impacts for future regional transportation projects and to reduce overall costs for major transportation projects by accelerating environmental review by state, federal, and regional agencies (SANDAG 2004). This funding included an allocation for regional habitat acquisition and management and monitoring activities to help implement the MSCP and MHCP plans.

Under the conservation plans, there are requirements that landowners and land managers implement individual preserve-level monitoring and management (City of San Diego 1998; AMEC and others 2003). The SDMMP coordinates regional monitoring and management across preserve boundaries in the MSPA. Regional monitoring allows for evaluation of conserved resources across western San Diego County, providing greater inference and understanding of the status of species and habitats/vegetation communities. Regional monitoring also reduces some monitoring obligations for landowners and managers with regional monitoring data available to land managers to use in management decisions (SDMMP and TNC 2017).

SDMMP's goal is to coordinate with partners to implement objectives and actions identified and prioritized in the MSP Roadmap (SDMMP and TNC 2017). The MSP Roadmap is a comprehensive, landscape-scale adaptive management and monitoring framework for prioritized species and vegetation communities in western San Diego County. It establishes biological goals and measurable objectives for the region that are consistent with the conservation goals of the MSCP and MHCP plans. It is a collaborative effort with many partners participating in developing and implementing these objectives and actions. The MSP Roadmap categorizes and prioritizes 111 plant and animal species, 11 vegetation communities, and 13 threats and stressors for monitoring and management. The MSCP and MHCP plans combined cover 104 plant and animal species, 95 of which are included in the MSP Roadmap (City of San Diego 1998; AMEC and others 2003; SDMMP and TNC 2017). The MSP Roadmap identifies geographic locations for management and monitoring activities, provides timelines for implementation, and describes a process for coordination and implementation (SDMMP and TNC 2017).

USGS provides staff support for the SDMMP and is contracted to implement regional monitoring projects. SANDAG also provides funding for regional monitoring and/or management projects carried out by other partners including city and county land managers, USFWS, CDFW, academic institutions, nonprofit conservation and land management organizations, biological consulting firms, and citizen outreach organizations (SDMMP and TNC 2017). SANDAG has a competitive *TransNet* EMP Land Management Grant Program that provides grants to land managers and other partners to carry out MSP Roadmap management priorities (https://www.sandag.org/index.asp?classid=17&projectid=447&fuseaction=projects.detail#:~:text=TransNet%20EMP%20Land%20Management%20Grant,future%20listing%20of%20endangered%20species). Some regional management is also implemented directly through SANDAG contracts with government agencies and biological consulting firms. Other local, state, and federal funding sources and grants are also used to implement regional monitoring and management activities (SDMMP and TNC 2017).

In the 1990s, regional surveys were conducted by biological consulting firms to collect sensitive species data to develop the conservation plans. After adoption of the plans, some preserve-level surveys and monitoring were undertaken by land managers, universities, and nonprofit organizations using funding available from local, state, and federal agencies. In the 1990s and early 2000s, USGS developed research projects that included regional monitoring for selected species and taxonomic groups. Monitoring data from these combined efforts as well as observation records from publicly available local, state, and federal species databases, museums, and herbarium collections were compiled and integrated into SDMMP's MOM species location database (SDMMP 2020). Monitoring data are submitted to SDMMP and in most cases are publicly available at the MSP Portal. USGS, in collaboration with the SDMMP, created the Southern California Multi-Taxa Database (SC-MTX) to house some of these data, and many of the monitoring datasets are stand-alone databases with species and covariate data. Analyses, modeling, reports, and publications are prepared by SDMMP, USGS, university scientists, and other monitoring entities.

The MSP Portal, developed and managed by SDMMP, (https://sdmmp.com/index.php) identifies the goals and objectives for species, vegetation communities, and threats contained in the MSP Roadmap (SDMMP and TNC 2017). It provides a tracking tool for goals and objectives, databases, and mapping tools. The MSP Roadmap is a living document with management and monitoring objectives updated every 5 years. The EMP's annual workplan and funding for regional monitoring and management projects are based on the MSP Roadmap objectives and approved by the EMP and SANDAG's Board of Directors.

In 2018, an audit of SANDAG, including the EMP, was released by ITOC (Sjoberg Evashenk Consulting, Inc. 2018). A recommendation for the regional management and monitoring program was to:

> *"Measure progress in meeting EMP goals and develop metrics to measure overall health of the preserve against baselines established in regional conservation plans as well as report those results to the public."*

This report, along with the Metrics Dashboard (available through the SDMMP website: https://sdmmp.com/metrics/index.php), follows through on that recommendation and provides indicators to evaluate the health of the regional preserve system. Indicators are aspects of the preserve system that are easily measured to provide information on ecological health and status (Edson and others 2016). Indicators are associated with the overall condition of the preserve system, are vulnerable to impacts from threats, and may provide an early sign of decline in preserve system health. Indicators include species, vegetation communities, and ecosystem and landscape-scale processes that when altered by humans can act as threats to the natural ecosystem. Metrics are a feature of an indicator that can be measured to provide an assessment of condition. For each indicator, one or more metrics have been developed based on monitoring and management data.

SDMMP worked with the EMP Working group and many partners, including USGS scientists, Wildlife Agencies, and land managers, to select indicators and develop metrics to include in this report. Prior to the ITOC Audit, the EMP and SDMMP began working on developing a means of communicating metrics of ecosystem health. Once the ITOC recommendation came out in 2018, there were frequent EMP Working Group meetings and a workshop to gather input from the EMP, Wildlife Agencies, landowners and managers, scientists, nonprofit conservation organizations, biological consulting firms, and other interested stakeholders (fig. 7). In addition, smaller group meetings were held with scientists and experts to review metrics and ensure that data were properly interpreted; metrics were prepared to inform future monitoring and management priorities.

Indicators were selected to evaluate the state of the preserve system based on the MSP Roadmap's regional monitoring and management priorities and objectives (Fig. 8; SDMMP and TNC 2017). The MSP Roadmap has objectives to monitor species, vegetation communities, and ecosystem or landscape-scale processes that when altered by human actions can become threats to species and vegetation communities (for example, altered fire regime, climate change, invasive species, altered hydrology). Species Indicators were selected to determine how well the regional preserve system is protecting species of high conservation concern, such as species with small populations or a restricted distribution, specific habitat/vegetation requirements, and/or that face the highest levels of threats. Species Indicators were also selected to evaluate functioning of the preserve system (for example, connectivity). To assess the state of the preserve system, it was also important to include vegetation communities that comprise a large part of the regional preserve system and provide habitat for many species. Vegetation Community Indicators may also represent rare and sensitive habitats that support high priority species. Finally, Ecosystem Processes and Landscape-scale Threat Indicators were selected to assess ecosystem functions and levels of threats in the preserve system. An important consideration in selecting indicators was the amount and type of information available from regional monitoring and management projects.

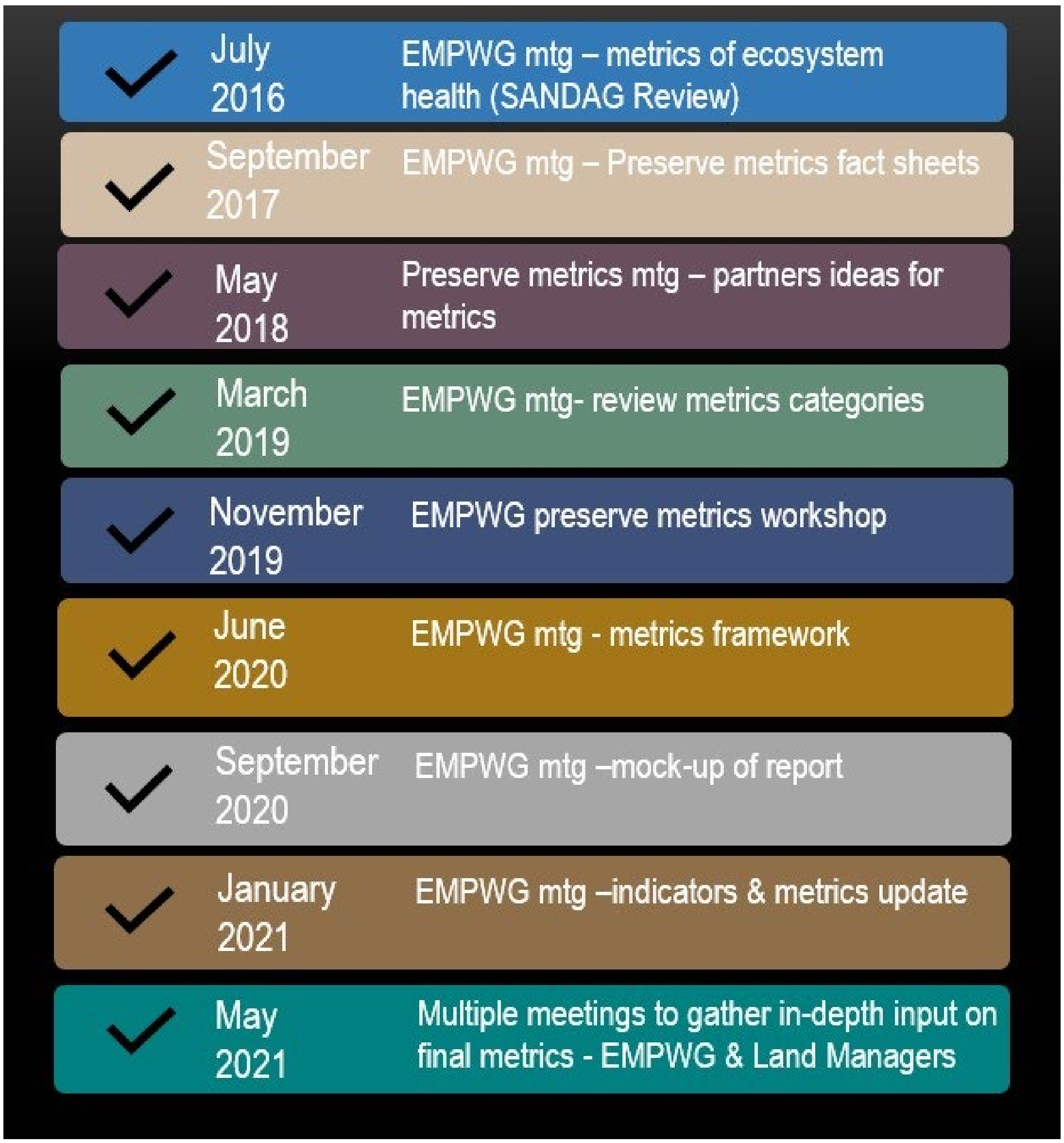


**Figure 7.** Timeline and topics of meetings to gather input for State of the Preserve indicators and metrics.

Since 2013, SANDAG-funded management and monitoring has been guided by the MSP Roadmap which prioritized species based on the severity of threats. The MSP Roadmap categorized species in five categories: SL, SO, SS, VF, and VG (SDMMP and TNC 2017). Species-specific categories (SL, SO, and SS) contain species that were identified for targeted management and intensive monitoring because they are at the highest risk of loss from the MSPA. SL species are species that are at risk of loss entirely from the regional preserve system, SO species are species where one or more occurrences are at high risk of loss, and SS species are species that still require specific management and monitoring to prevent moving into the SL or SO categories. The vegetation-based VF category contains species that are still of concern but are not at immediate risk of loss and can be managed by monitoring to track their status and enhancing vegetation when needed to improve habitat in priority areas. VG species benefit incidentally from vegetation management targeted for other species but are not monitored as they are of low conservation concern. SL and SO species were prioritized for funding in the MSP Roadmap and most of the available data are for species in these management categories. Because of the variation in the amount of available data, the indicators in this report focus on species that are imperiled and likely to fall into either the Concern or Significant Concern category (see definitions below). Therefore, while this report is useful to inform management and monitoring, it does not include many species that are still abundantly distributed in the County. In the future, additional species, including some that are monitored and doing relatively well, will be included.

## Indicator and Metric Definitions

This report's framework is based on One Tam's document "*Measuring the Health of a Mountain: A Report on Mount Tamalpais' Natural Resources*" (Edson and others 2016; see onetam.org). One Tam developed a methodology to understand the current and changing conditions of Mount Tamalpais' wildlife, plants, and landscapes. Similarly, SDMMP identified Species Indicators, Vegetation Community Indicators, and Ecosystem Processes and Landscape-scale Threat Indicators as the general categories to evaluate. Within these categories, there are a number of indicators (fig. 8), and each indicator includes one or more metrics with desired condition, progress in meeting MSP Roadmap goals, and thresholds defined. Some indicators and metrics are still being developed and will be added to future editions of this report (shown as black text in fig. 8).

The list below is a short definition of terms used for the main body of this report and the appendix that are directly from or modified from the One Tam (Edson and others 2016) document:

- **Indicator Category:** A group of similar indicators that act to organize interconnected or like concepts. Categories include Species Indicators, Vegetation Community Indicators, and Ecosystem Processes and Landscape-scale Threat Indicators.
- **Indicator:** A thing, trend, or fact that describes the state or level of something. Ecological indicators communicate information about the status or health of a complex ecosystem in a

manner understood by the public or policy makers (Angermeier and Karr 2019). In this report, Species, Vegetation Community, and Ecosystem Processes and Landscape-scale Threat Indicators represent the status or health of the regional preserve system. Indicators were chosen to represent ecological functions and habitat characteristics considered important for priority species, to serve as a gauge for a larger process or group of species, and to represent how well the regional preserve system supports rare and specialist species targeted for conservation. Examples include coastal sage scrub (CSS), southwestern pond turtle, San Diego thornmint, and connectivity.

- **Metric:** A biologically based value that is measured or assessed and serves to identify the status or health of one aspect of the associated indicator.
- **Condition:** The condition or health status category for an individual metric or the overall metrics value for an indicator. The current condition is based upon the most recent, reliable data available and differs by metric. Metric condition values are determined using thresholds developed for each metric. Threshold values are based on an evaluation of available data, published research results and scientific recommendations, best management practices, conservation plan and MSP Roadmap objectives, and expert opinion. The overall condition for an indicator is determined by looking at the condition values across metrics and may include weighting metric values considered most important and then combining the results into an overall condition value.
    - Condition values are categorized as either **Good**, **Caution**, **Concern**, or **Significant Concern**. These categories and the thresholds associated with each category were designed for each metric to indicate an ecologically relevant status of the metric.
- **Trend** information is provided, where available, based on changes in the metric or indicator condition values over time. Trend refers to whether the condition of the metric or the overall condition of the indicator is stable or getting better or worse compared to the desired condition. Sometimes the condition trend might not align with the trend in metric values. For example, the number of fires in an area may increase, but the metric is declining because an increase in fire frequency is not the desired condition. In other cases, the trend may be independent of the current condition if, for example, values for the metric are declining, but the condition is still in the Good category.
    - **Improving**: Condition of a metric or overall condition for an indicator is getting closer to the desired condition compared with baseline data.
    - **No Change**: Condition of the metric or overall condition for an indicator is unchanging.
    - **Declining**: Condition of a metric or overall condition of an indicator is getting farther from the desired condition compared with baseline data.

- **Unknown**: Not enough information is available to state a trend (at least three repeated measurements over time are typically needed to determine the trend).
- **Confidence** is an indication of the quality of data available for assessing the condition and trend. Confidence is categorized as:
    - **High**: Monitoring data used to measure a metric are recent, reliable, and comprehensive.
    - **Moderate**: Monitoring data used to measure a metric lack some aspect of being recent, reliable, or comprehensive.
    - **Low:** Data are not sufficiently recent, reliable, or comprehensive, although some data are available based on an expert or scientific opinion evaluation.
- **2027 Progress Towards Desired Condition:** A short-term progress milestone for each metric was created to align with the MSP Roadmap goal (SDMMP and TNC 2017) and timeline, and to inform immediate management and monitoring actions. The next planning cycle for management and monitoring objectives is 2022-2026. This 2027 progress milestone aligns with the start of the planning horizon after 2026.
- **Stressors:** Threats to the indicator that are preventing the desired condition from being attained. These threats align with the threats addressed in the MSP Roadmap (SDMMP and TNC 2017).

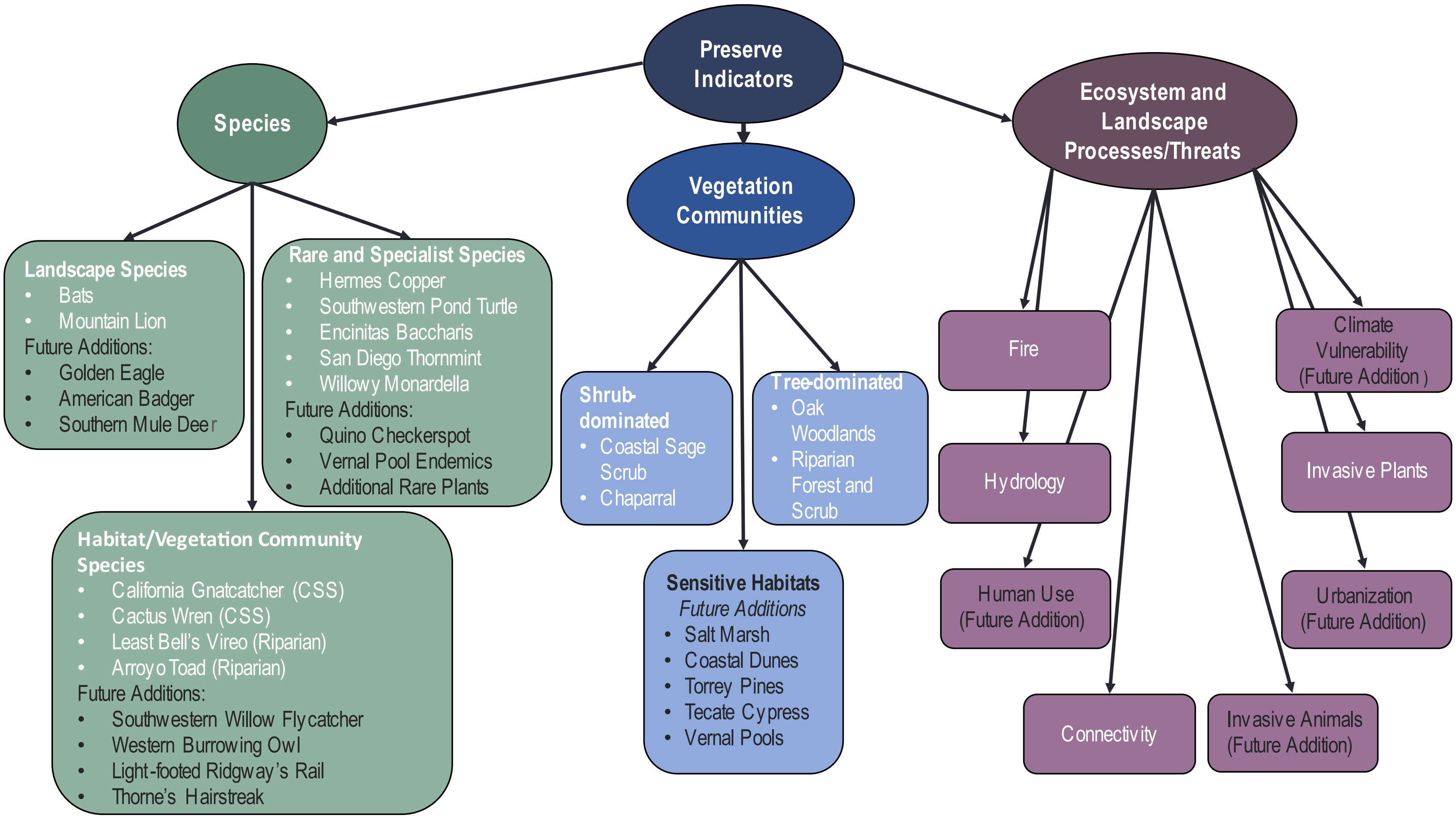


**Figure 8.** An organizational chart of indicator categories (shown in ovals) and indicators (shown in rectangles) used in this report. Each indicator included has one or more measurable metrics associated with it. Indicators in black font will be added to future editions of this report.

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## Vegetation Community Indicators

Four of the five most widespread vegetation communities in western San Diego County, which are also addressed in the MSCP and MHCP plans, are included as indicators of the state of the regional preserve system: Chaparral, CSS, Oak Woodland, and Riparian Forest and Scrub (Holland 1986). A fifth vegetation community, Grassland, is indirectly included through the evaluation of Chaparral and CSS. Native Chaparral and CSS have been invaded by nonnative annual grasses in some areas and even converted to grassland. There is only a small amount of native perennial grassland which, at this analysis scale, is lumped with nonnative grasses into grassland vegetation. Ecological integrity measures the health of a vegetation community and is the extent to which the structure, composition, and function of the vegetation community operates within the bounds of historical variation (Lawson and Keeley, 2019). Chaparral and CSS areas recently converting to nonnative grassland are considered low ecological integrity for this report. This initial report does not include metrics evaluating the health of native grasslands that often include an important native forb component. These five vegetation communities provide habitat for many plant and animal species, including species specializing in a particular vegetation type and generalist species occurring in a variety of vegetation types. These vegetation categories can be subdivided into alliances and associations based on plant species composition and abundance (Sproul and others 2011). These nuances can be important in defining habitat relationships for specific plant and animal species. Here, the health of the two shrub-dominated (Chaparral and CSS) and two tree-dominated (Oak Woodland and Riparian Forest and Scrub) Vegetation Community Indicators are evaluated at the broader scale without these finer subdivisions.

USGS and SDMMP are in the process of developing monitoring plans for CSS, chaparral, and grassland vegetation communities. After these plans are completed, these agencies will develop riparian and oak woodland monitoring plans and then focus on relatively rare vegetation communities such as salt marsh and coastal dunes. Vegetation monitoring plans will include monitoring components for MSP Roadmap VF plant and animal species (SDMMP and TNC 2017). VF species are of conservation concern but do not require species-specific management actions. Instead, VF species are monitored and managed as needed through enhancement and restoration of the vegetation community with which they are associated. This report includes an important MSP Roadmap CSS VF species in the Species Indicators section, the coastal California gnatcatcher (*Polioptila californica californica*) (SDMMP and TNC 2017).

The health of vegetation communities largely defines the health of the regional preserve system. This is because vegetation communities are the most essential habitat element for most plant and animal species. Vegetation communities are dynamic, with changes in species composition associated with landscape-scale processes such as climate, fire, hydrology, and invasive species. The influence of landscape-scale processes on the health of vegetation communities is considered in the vegetation community accounts. Ecosystem Processes and

Landscape-scale Threats are also considered more generally as indicators of preserve system health (see Ecosystem Processes and Landscape-scale Threat Indicators).

For each indicator, a summary of the overall current condition status and individual metrics is included below. This is not intended to be a full presentation of all data or methods used to assess the condition, trend, and confidence. Instead, it should be used as a quick reference guide. For a full description of data and methods for each indicator and metric, see Appendix 1: State of the Regional Preserve System in Western San Diego County: Detailed Methods and Description of Indicators and Metrics.

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## Chaparral – Vegetation Community Indicator (Shrub-dominated Habitat)


Chaparral is the most extensive vegetation community in San Diego County with a baseline of 705,181 acres mapped in the MSPA in 1995, including 350,604 acres (50 percent) conserved at that time (City of San Diego and others 1995; CalFire 2015). Currently, 412,330 acres (58 percent) of chaparral mapped in 1995 are conserved in the MSPA (SDMMP 2020). Chaparral habitat supports a rich diversity of plant and animal species, some of which are found only in chaparral and others that use a variety of vegetation types including chaparral. There are 50 MSP species (13 animals and 37 plants) that inhabit or use chaparral (SDMMP and TNC 2017). Species such as Rainbow manzanita (*Arctostaphylos rainbowensis*), Del Mar manzanita (*Arctostaphylos glandulosa* ssp. *crassifolia*), and Lakeside ceanothus (*Ceanothus cyaneus*) are found only in chaparral vegetation communities.

As recognized by the MSCP and MHCP, conservation is an essential first step to maintaining healthy chaparral habitat. The MSCP Plan targeted conservation of 49 percent of all chaparral communities mapped in 1995 (City of San Diego 1998), and the MHCP Plan aims for 70 percent conservation (AMEC and others 2003). Two other conservation plan areas (North and East County) in San Diego County do not have completed plans, so conservation targets are unknown. Thresholds in this report for the regional preserve system may change in future versions to reflect new targets once the North and East County plans are complete. These thresholds are not intended to supersede conservation plan targets.

While chaparral vegetation has been conserved, there are threats to these communities that can be partially mitigated by management. Habitat loss and fragmentation combined with human population growth and activities threaten chaparral ecosystem functions and plant and animal biodiversity (Keeley 2018; Jennings 2018). California's climate is projected to become warmer and drier with more frequent, intense, and prolonged droughts (Diffenbaugh and others 2015). Climate change may alter plant species distributions. An upward shift in elevation of chaparral species was observed in response to changing weather patterns in the Santa Rosa Mountains of southern California (Kelly and Goulden 2008). Extensive chaparral shrub mortality is associated with extreme drought (Kelly and Goulden 2008; Keeley and others 2009). This in turn can increase fire frequency and intensity (Jin and others 2014) and contributed to the extremely large wildfires in San Diego County during 2003 and 2007 (Keeley and Zedler 2009). Repeated fires have facilitated nonnative grass invasions that reduce density of chaparral shrubs in some areas and threaten vegetation type conversion to nonnative grassland (Keeley and Brennan 2012; Lawson and Keeley 2019).

Based on the 2020 vegetation map (County of San Diego 2021), 231,697 acres (56 percent) of the 412,330 acres of conserved chaparral in the MSPA burned at least once in the last 30 years, and 51,781 acres (12.5 percent) burned two or more times (AECOM 2014; County of San Diego 2021; CalFire 2019; SDMMP 2020). This is a large increase in the amount of conserved chaparral affected by fire compared with 1995, when 8,852 acres (2.5 percent) of the 350,604 acres of conserved chaparral burned two or more times during the previous 30 years.

Chaparral was selected as an indicator because it provides important habitat for many species, including species of conservation concern, and the health of chaparral is a critical element to the health of the regional preserve system.

### Desired Condition

MSP Roadmap Goal (SDMMP and TNC 2017):

*Maintain, enhance, and restore chaparral on Conserved Lands in the MSPA that supports or has the potential to support MSP species and to incidentally benefit a diverse array of other species so that the vegetation community has high ecological integrity, and these species are resilient to environmental stochasticity, catastrophic disturbances, and threats, such as very large wildfires and prolonged droughts, and will be likely to persist over the long term (>100 years).*

### Current Condition Status

The current overall condition status is based on the most recent, reliable data available and differs by metric. Trends in the current condition describe whether the condition is getting closer to (Improving trend) or getting farther from (Declining trend) the desired condition compared to baseline data. For chaparral conservation acreages (Metric 1: percent conserved), the 1995 vegetation map was used as the baseline because it was the basis for the local plans (City of San Diego and others 1995). For fire frequency (Metric 3), 1965-1995 is the baseline period with which the current fire regime is compared (1989-2019). SDMMP decided that a 30-year period was a useful measure of fire frequency for chaparral because areas that have burned two or more times in 30 years are more susceptible to vegetation type conversion to nonnative grassland (Keeley and others 2011; Keeley and Brennan 2012). This metric is dependent on vegetation mapping data and compares the 30-year periods prior to the 1995 vegetation map and current time (2019). In addition, the amount of area burned in 1995 is representative of the historical fire frequency (based on the recorded history beginning in the early 20th century) in San Diego County (see the Fire Indicator in the Ecosystem Processes and Landscape-scale Threats section for more information). While there is some overlap between the baseline and current analysis periods, the change in fire frequency between the two time periods can be used as one indication of chaparral fire health. (Appendix 1: Section Chaparral).

Overall, combining the three metrics, the Chaparral Vegetation Community Indicator was given a current condition status of Caution. While the percent of chaparral conserved (Metric 1) is meeting targets, ecological integrity (Metric 2) and fire frequency (Metric 3) have not reached desired conditions (table 6). The years listed in table 6 indicate the timeframe used for the trend, and the most recent year indicates current status. The amount of chaparral conserved has increased compared to the 1995 baseline vegetation mapping. Ecological integrity was mapped using 2014 light detecting and ranging (lidar) and aerial imagery. A trend in ecological integrity is not currently available because data are not available for another time period. Future reports will identify a trend by repeating these analyses with additional years of data. The confidence for all metrics was Moderate because of uncertainty in vegetation mapping. Mapping for many areas in the County has not been updated since the 1990s. As more information becomes available, additional metrics on the composition of native and nonnative plants and the acreage restored or enhanced will be added.

**Table 6.** Current overall condition status for the Chaparral Vegetation Community Indicator and period of baseline to current years comparison for metric conditions, trends, and confidence levels.

| Indicator/metric (baseline - current years) | Condition | Trend | Confidence |
|---|---|---|---|
| Chaparral overall condition status | Caution | Unknown | Moderate |
| Metric 1: percent conserved (1995-2020) | Good | Improving | Moderate |
| Metric 2: ecological integrity (2014) | Concern | Unknown | Moderate |
| Metric 3: fire frequency (1995-2019) | Caution | Declining | Moderate |

Detailed information about the metrics in this section is available in Appendix 1. Information includes further explanation of why indicators were selected, how the metrics were assessed, and why datasets were chosen. The appendix also includes a larger discussion on the condition, trend, and confidence of this indicator. More information about the Chaparral Vegetation Community Indicator metrics can be found in Appendix 1: Section Chaparral.

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## Coastal Sage Scrub – Vegetation Community Indicator (Shrub-dominated Habitat)


Photo: Sarah McCutcheon, USGS

CSS is the second most extensive vegetation community in San Diego County, with a baseline of 189,303 acres mapped in 1995, including 41,416 acres (22 percent) conserved at that time (CalFire 2015; County of San Diego 2021). Currently, 88,172 acres (47 percent) of CSS mapped in 1995 are conserved (SDMMP 2020). CSS habitat supports a large variety of species, including 39 MSP species (14 animals and 25 plants) that inhabit only CSS or use CSS as well as other vegetation types (SDMMP and TNC 2017). Coastal cactus wren (*Campylorhynchus brunneicapillus sandiegensis*) and coastal California gnatcatcher (*Polioptila californica californica*) are obligate species of CSS that are of particular focus in the local conservation plans (City of San Diego 1998; AMEC and others 2003).

The MSCP and MHCP plans indicate that conservation is an essential first step to maintaining healthy CSS habitat. Both plans both have a conservation goal of 62 percent of baseline CSS habitat in the MHPA and FPA, respectively (City of San Diego and others 1995; City of San Diego 1998; AMEC and others 2003).

CSS is considered a fragile and rapidly declining habitat, with habitat loss, fragmentation, and degradation as major threats to this community (Westman 1981; Minnich and Dezzani 1998). Connectivity between remaining patches is crucial to regional biodiversity. While the acreage of conserved CSS has grown over the last 25 years, so too have the threats. One of the largest threats to CSS is an altered fire regime. More frequent, intense, and large wildfires over the last two to three decades have led to the invasion of nonnative annual grasses into CSS and even type conversion to nonnative grassland (Minnich and Dezanni 1998; Diffendorfer and others 2007; Keeley and Brennan 2012). Nonnative annual grasses reduce the amount of open ground and shrub cover and increase competition for resources like water and sunlight (D’Antonio and Vitousek 1992; Minnich and Dezzani 1998). This invasion has reduced the ability of native grasses, forbs, and shrub seedlings to germinate and grow in openings. Invasion of grasses is an indicator of poor health and functioning of the shrubland habitat (Diffendorfer and others 2007; Lawson and Keeley 2019). Type conversion can be accelerated by nitrogen deposition both with and without an altered fire regime (Talluto and Suding 2008; Cox and others 2014).

Some of these threats can be partially mitigated by management actions. Conserved CSS could benefit from management that helps maintain or improve vegetation composition, structure, and integrity to promote a higher regional biodiversity and persistence of species (Diffendorfer and others 2007; Lawson and Keeley 2019).

CSS was selected as an indicator because it provides important habitat for many species, including species of high conservation priority, and the health of CSS is a critical element to the health of the regional preserve system.

### Desired Condition

MSP Roadmap Goal (SDMMP and TNC 2017):

*Maintain, enhance, and restore CSS on Conserved Lands in the MSPA that supports or has the potential to support MSP species and to incidentally benefit a diverse array of other species so that the vegetation community has high ecological integrity, and these species are resilient to environmental stochasticity, catastrophic disturbances and threats, such as very large wildfires, invasive plants, and prolonged drought, and will be likely to persist over the long term (>100 years).*

### Current Condition Status

Current overall condition status is based on the most recent data available when this report was written. For the percent conserved (Metric 1, table 7), 1995 baseline vegetation mapping was compared to the 2020 Conserved Lands layer. The baseline comparison for CSS metrics is the 1995 vegetation map because it was the basis of the MSCP and MHCP plans and was used to set conservation targets. There is only 1 year of data available (2014) for ecological integrity (Metric 2). In 2014, lidar data and NAIP imagery were acquired for San Diego County. A trend in ecological integrity is not currently available because data are not available for another time period. Future reports will identify a trend by repeating these analyses with additional years of data. For fire frequency (Metric 3), 1965-1995 was used as the baseline to compare with more recent fire history. A 30-year period was determined to be a useful measure of fire frequency for CSS because areas that have burned two or more times in 30 years are more susceptible to vegetation type conversion to nonnative grassland (Keeley and others 2011; Keeley and Brennan 2012). This metric is dependent on vegetation mapping data, so the 30-year periods prior to the 1995 vegetation map are compared to the current time (2019). In addition, the amount of area burned in 1995 is representative of the historical level of fire (based on the recorded fire history beginning in the early 20$^{th}$ century) in San Diego County (see the Fire Indicator in the Ecosystem Processes and Landscape-scale Threats section for more information). While there is some overlap between the baseline and current analysis periods, the change in fire frequency between the baseline and the current periods can be used as one indication of CSS fire health.

The current overall condition status for the CSS Vegetation Community Indicator is Concern (table 7). There are three metrics for CSS, ranging from Caution for the percent conserved (Metric 1) to Significant Concern for ecological integrity (Metric 2) and fire frequency (Metric 3). The trend for Metric 1 is Improving as more conserved land was added to the regional preserve system since 1995; however, the frequency of fire is increasing, and therefore, the condition of CSS is Declining (condition is moving farther from the desired conditions). The confidence for all metrics was Moderate because of uncertainty in the vegetation mapping. Many areas have not been mapped since the 1990s. As more information becomes available, additional metrics on the composition of native and nonnative plants and the acreage restored or enhanced will be added.

**Table 7.** Current overall condition status for the CSS Vegetation Community Indicator and period of baseline to current years comparison for metric conditions, trends, and confidence levels.

| Indicator/Metric (baseline - current years) | Condition | Trend | Confidence |
|---|---|---|---|
| CSS overall condition status | Concern | Unknown | Moderate |
| Metric 1: percent conserved (1995-2020) | Caution | Improving | Moderate |
| Metric 2: ecological integrity (2014) | Significant Concern | Unknown | Moderate |
| Metric 3: fire frequency (1965-2019) | Significant Concern | Declining | Moderate |

Detailed information about the metrics in this section is available in Appendix 1. Information includes further explanation of why indicators were selected, how the metrics were assessed, trend, and confidence of this indicator. More information about the CSS Vegetation Community Indicator metrics can be found in Appendix 1: Section Coastal Sage Scrub.

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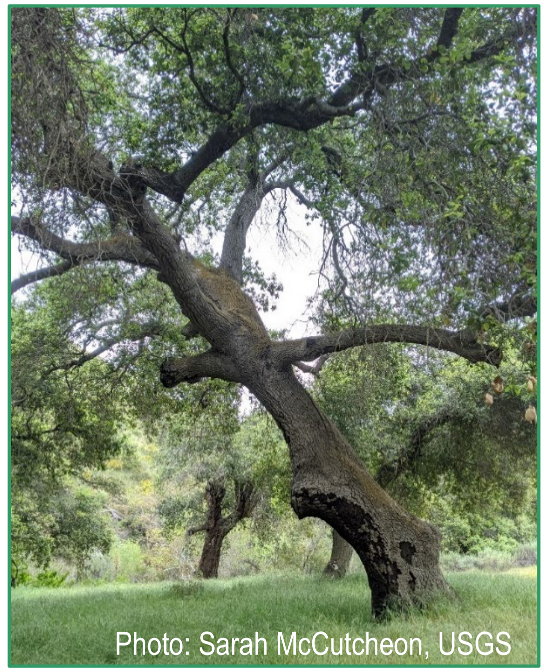
## Oak Woodland – Vegetation Community Indicator (Tree-dominated Habitat)




Oak woodland is the fourth largest vegetation community in the MSPA (City of San Diego and others 1995; County of San Diego 2021). There was a total of 125,556 acres of oak woodland mapped in 1995 within the MSPA (City of San Diego and others 1995; CalFire 2015). At that time, 32,179 acres (26 percent) of oak woodland were conserved. Currently, 43,600 acres (35 percent) are conserved in the MSPA (SDMMP 2020). This is an improvement from the 26 percent (32,179 acres) of baseline oak woodland conserved in 1995. Sixteen MSP species are associated with oak woodlands.

The MSCP and MHCP plans identify conservation of oak woodland habitat as a goal. The MSCP Plan targeted for conservation 47 percent of the oak woodland within the MHPA (City of San Diego and others 1995; City of San Diego 1998), while the MHCP Plan had a goal of 83 percent conserved in the FPA (AMEC and others 2003). The other two conservation planning areas (North County and East County) with the most oak woodland have not yet established conservation targets.

There are numerous threats impacting oak woodland in San Diego County, some of which can be partially mitigated by management actions. These threats are habitat loss and degradation, an altered fire regime, intense and prolonged drought, and invasive, nonnative beetles and fungal pathogens (Tyler and others 2006; Coleman and Seybold 2008; Coleman and others 2011; Lynch and others 2013a,b). Fire is the primary natural process affecting upland stands of oak woodland and short fire return intervals can eliminate coast live oak (*Quercus agrifolia*) woodland stands (Sproul and others 2011).

Oak woodland was selected as an indicator because it provides important habitat to many species, and the health of oak woodland is a critical element to the health of the regional preserve system.

#### Desired Condition

MSP Roadmap Goal (SDMMP and TNC 2017):

*Maintain, enhance, and restore oak woodland on Conserved Lands in the MSPA that support or have the potential to support MSP species so that the vegetation communities have high ecological integrity, and these species are resilient to invasive pests and disease pathogens,* *environmental stochasticity, threats, and catastrophic disturbances, such as very large wildfires and intense and prolonged drought, and will be likely to persist over the long term (>100 years).*

### Current Condition Status

Baseline conditions for conservation targets of oak woodland were taken from the 1995 vegetation map because this was the basis of the targets set in the MSCP and MHCP plans. Current conditions of conservation reflect Conserved Lands' status in 2020. For ecological integrity, only one year of data is available, 2014, when lidar and NAIP imagery was acquired in San Diego County. A trend in ecological integrity is not currently available because data are not available for another time period. Future reports will identify a trend by repeating these analyses with additional years of data.

The current overall condition status of the Oak Woodland Vegetation Community Indicator was evaluated as Caution (table 8). While conservation targets have not yet been reached (percent conserved; Metric 1), the health of conserved oak woodland is in Good condition (ecological integrity; Metric 2). Ecological integrity was measured as the percent of healthy (living) trees and while high in 2014, showed clusters of die-offs that may be early indicators of the start of a decline in ecological integrity. Large-scale changes are likely to have occurred since 2014 with the increase in intensity and duration of drought, as well as the spread of fungal pathogens and invasive, nonnative pests. Additional analyses over multiple years are required to understand the exact impacts of many of the newly emerging and ongoing threats. As more information becomes available, additional metrics on the composition of native and nonnative plants and the acreage restored or enhanced will be added.

**Table 8**. Current overall condition status for the Oak Woodland Community Vegetation Indicator and period of baseline to current years comparison for metric conditions, trends, and confidence levels.

| Indicator/metric (baseline – current years) | Condition | Trend | Confidence |
|---|---|---|---|
| Oak woodland overall condition status | Caution | Unknown | Moderate |
| Metric 1: percent conserved (1995-2020) | Concern | Improving | Moderate |
| Metric 2: ecological integrity (2014) | Good | Unknown | Moderate |

Detailed information about the metrics in this section is available in Appendix 1. Information includes further explanation of why indicators were selected, how the metrics were assessed, and why datasets were chosen. The appendix also includes a larger discussion on the condition, trend, and confidence of this indicator. More information about the Oak Woodland Vegetation Community Indicator metrics can be found in Appendix 1: Section Oak Woodland.

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## Riparian Forest and Scrub – Vegetation Community Indicator (Tree-dominated Habitat)


Riparian forest and scrub comprise the fifth largest vegetation community in the MSPA (City of San Diego and others 1995; County of San Diego 2021). There was a total of 23,822 acres of riparian forest and scrub mapped in 1995 within the MSPA (City of San Diego and others 1995; CalFire 2015). Currently, 11,878 acres (50 percent) are conserved in the MSPA (SDMMP 2020). This is an improvement from the 35 percent (8,404 acres) of baseline riparian habitat conserved as of 1995 (SDMMP 2020; City of San Diego and others 1995). This community supports 15 MSP species (one fish, two amphibians, two reptiles, four birds, two mammals, and four plants) (SDMMP and TNC 2017). Some of these species are riparian obligate species that inhabit riparian vegetation exclusively, such as least Bell's vireo and southwestern willow flycatcher (*Empidonax traillii extimus*), while others use riparian as well as other vegetation types, such as mountain lion.

The MSCP and MHCP plans identify conservation as a goal for riparian forest and scrub habitat. The MSCP plan targeted 81 percent of the mapped riparian forest and scrub in the MHPA for conservation (City of San Diego and others 1995), and the MHCP plan's goal is to conserve 75 percent within the FPA (AMEC and others 2003). The other two conservation planning areas (North County and East County) have not yet established conservation targets.

### Stressors

There are numerous threats to riparian forest and scrub in San Diego County, some of which can be partially mitigated by management. Most watersheds have altered hydrology that impacts natural riverine processes (Brown and others 2015). Upstream urbanization has caused increased dry season water flows, forming perennial streams in historically ephemeral drainages, resulting in incised and deepened, rather than broad and shallow, braided channels (Stohlgren and others 1998; White and Greer 2006; Taniguchi and Biggs 2015). Invasive plants and animals are a problem throughout the major watersheds and require intensive management efforts (Mission RCD 2013, 2018). Invasive, nonnative plants displace native vegetation (Mullin and others 2000), as evidenced by the prevalence of giant reed (*Arundo donax)* and tamarisk (*Tamarix* spp.) within the MSPA. Significant die-offs of willows and other riparian vegetation have occurred in San Diego County because of invasive, nonnative polyphagous/Kurashio shot hole borer beetles

(*Euwallacea* sp.) and their symbiotic *Fusarium* fungal pathogen (Eskalen and others 2013; Boland 2016; Boland and Woodward 2019). The invasion of these beetles and *Fusarium* fungal pathogens into the Tijuana River Valley has led to extensive willow dieback and the invasion of nonnative plants (Boland 2016; Boland and Woodward 2019). This beetle is also known from other major drainages in the County (UCANR 2021). Repeated wildfires can also degrade riparian communities by opening the landscape for expansion of invasive, nonnative plants (Pettit and Naiman 2007). Prolonged and extended drought can weaken trees to other stressors (McDowell and others 2008).

Riparian Forest and Scrub was selected as an indicator because it provides important habitat to many species, including species of high conservation priority, and the health of riparian vegetation is a critical element to the health of the regional preserve system.

### Desired Condition

MSP Roadmap Goal (SDMMP and TNC 2017):

*Maintain, enhance, and restore riparian forest and scrub on Conserved Lands in the MSPA that supports or has the potential to support MSP species and to incidentally benefit a diverse array of other species so that the vegetation community has high ecological integrity, and is resilient to pests and pathogens, environmental stochasticity, nonnative plants, and catastrophic disturbances, such as very large wildfires and intense and prolonged drought, and will be likely to persist over the long term (>100 years).*

### Current Condition Status

Baseline acreages for conservation targets were taken from the 1995 vegetation map, and current conservation levels were calculated using the 2020 Conserved Lands layer. Ecological integrity has only one year of data available, and a trend will be included in future versions of this report as more data are available and analyses are completed.

The current overall condition status for the Riparian Forest and Scrub Vegetation Community Indicator is Good, based on the two metrics selected (table 9). While the conservation targets (Metric 1: percent conserved) have not been fully met, progress on conservation is improving. The health of trees in riparian areas (Metric 2: ecological integrity) is in the Good category. It is important to note that the health of riparian vegetation was evaluated using 2014 data. Significant mortality may have occurred since 2014 due to the nonnative Kuroshio and Polyphagous shot hole borers and *Fusarium* Disease Complex. Additional analyses are needed to understand any changes. As additional information becomes available, new metrics evaluating species’ richness and the amount of restored and/or enhanced riparian vegetation will be added at that time.

**Table 9.** Current overall condition status for the Riparian Forest and Scrub Vegetation Community Indicator and period of baseline to current years comparison for metric conditions, trends, and confidence levels.

| Indicator/metric (baseline – current years) | Condition | Trend | Confidence |
|---|---|---|---|
| Riparian forest and scrub overall condition status | Good | Unknown | Moderate |
| Metric 1: percent conserved (1995-2020) | Caution | Improving | Moderate |
| Metric 2: ecological integrity (2014) | Good | Unknown | Moderate |

Detailed information about the metrics in this section is available in Appendix 1. Information includes further explanation of why indicators were selected, how the metrics were assessed, and why datasets were chosen. The appendix also includes a larger discussion on the condition, trend, and confidence of this indicator. More information about the Riparian Forest and Scrub Vegetation Community Indicator metrics can be found in Appendix 1: Section Riparian Forest and Scrub.

### Riparian Forest and Scrub Vegetation Community Indicator References Cited


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## Species Indicators

This first report on the state of the regional preserve system in western San Diego County includes information for a small subset of MSP species (Species Indicators) that are monitored and managed. In selecting Species Indicators, SDMMP focused on those species for which there is have high quality monitoring data, that are of high conservation priority, and that allow SDMMP to evaluate different aspects of the preserve system for maintaining healthy plant and animal communities. The effects of threats and stressors on Species Indicators are described in this report and are also used as metrics for some Species Indicators. The Species Indicator categories below reflect important components of the state of the regional preserve system relating to landscape connectivity, the ability of the preserve to maintain species with very restricted distributions and highly specialized habitat requirements, and the status of species with habitat requirements for specific vegetation communities. Species evaluated in this report fall into one of the three following Species Indicator subcategories.

**Landscape Species:** These species roam widely across western San Diego County and inhabit a variety of vegetation communities. They often make long distance movements, and these movements can be constrained by habitat loss and fragmentation from urban development. Habitat fragmentation can limit movement by species traveling both on the ground and in the air, such as bats moving between roosting and foraging areas. Connectivity can be further constrained by freeways and highways and by human activities. Maintaining connectivity for Landscape Species by conserving and restoring natural habitat linkages and improving road crossing infrastructure can facilitate movement by other species in the regional preserve system. The two Landscape Species Indicators included in this initial report are Bats and Mountain Lion.

**Rare and Specialist Species:** This subcategory includes species with specialized habitat requirements that are more restrictive than just an association with a particular vegetation community. While these species may occur in a single vegetation community or multiple vegetation types, their distribution is further limited to specific environmental conditions. Specialist species require a limited range of environmental conditions, such as ponds with adjacent burrowing habitat for turtles or a specific host plant species for insects to complete their life cycle. This category also includes species that are naturally rare or are endemic to the MSPA. Rare plants in this category generally have specialized soil requirements, are rare in occurrence, or are endemic to San Diego County, bordering counties, and northern Baja California, Mexico. Many of the Rare and Specialist Species were selected to assess how well the regional preserve system is protecting species of high conservation concern. The five Rare and Specialist Species Indicators included in this initial report are Encinitas Baccharis, San Diego Thornmint, Willowy Monardella, Hermes Copper, and Southwestern Pond Turtle.

**Vegetation Community Species:** This subcategory includes species inhabiting specific vegetation communities. These species may be primarily found in one of the following vegetation categories: CSS, chaparral, grassland, riparian, oak woodland, salt marsh, dunes and coastal strands, and vernal pools. These species may be broadly distributed but are typically found in a particular vegetation community that provides for their habitat requirements. The four Vegetation Community Species Indicators included in this initial report are Coastal Cactus Wren, Coastal California Gnatcatcher, Arroyo Toad, and Least Bell’s Vireo.

## Bats – Species Indicator
## (Landscape Species)


Bats were selected as an indicator of landscape connectivity as they use many areas across a landscape (Ball 2002; Rainho and Palmeirim 2011) and can be sensitive to habitat fragmentation from urban and agricultural development (Ball 2002; Miner and Stokes 2005; Frey-Ehrenbold and others 2013). They also have important ecosystem functions in controlling insect populations, pollination, and seed dispersal. San Diego County is a biodiversity hot spot for bats with 22 species documented, many of conservation concern (Stokes and others 2005; SDNHM 2018). Of particular concern in San Diego County are pallid bat (*Antrozus pallidus*) and Townsend's big-eared bat (*Corynorhinus townsendii*).

The loss of bats from the urban-wildland interface can indicate fragmentation and degradation of foraging habitats, such as riparian forest and scrub and oak woodlands (Miner and Stokes 2005; Fenton 2003). Bats use ecological neighborhoods that include different parts of the landscape for day and night roosts and maternity colonies (for example, caves, mines, bridges, rocky crevices, trees), as well as for foraging (Ball 2002).

There are many threats to bats in western San Diego County, including urbanization causing habitat loss, fragmentation, and degradation (Miner and Stokes 2005; Jones and others 2009). Other threats include human disturbance at roosts (Miner and Stokes 2005); light pollution (Azam and others 2015; Seewagon and Adams 2021); pesticides and environmental contaminants (Jones and others 2009; Torquotti and others 2021); changing climate with increasing drought and warmer temperatures (Jones and others 2009; Adam and Hayes 2008; Sherwin and others 2012); and invasive, nonnative plants (Bateman and others 2008).

### Desired Condition

MSP Roadmap Goal (SDMMP and TNC 2017):

*Maintain a diverse bat community and enhance pallid (Antrozous pallidus) and Townsend's big-eared (Corynorhinus townsendii) bat populations by increasing diurnal, nocturnal, and maternity roosts, protecting roosts from destruction and human disturbance, and improving foraging habitat within traveling distance of roosts to increase resilience to environmental and demographic stochasticity, maintain genetic diversity, and improve chances of persistence over the long-term (>100 years).*

### Current Condition Status

The current overall condition status of the Bats Species Indicator is Caution based on the two metric condition values selected (table 10). More high-quality data are needed to determine trends. While it is uncertain whether bat diversity is declining across the MSPA (Metric 1), there are indications some populations may be declining, such as for pallid and Townsend's big-eared bats (Metric 2) (Miner and Stokes 2005; SDNHM 2018). Future metrics are planned to assess threats to roosting and foraging habitats for the bat community and effectiveness of management actions.

**Table 10.** Current overall condition status for the Bats Species Indicator and period of baseline to current years comparison for metric conditions, trends, and confidence levels.

| Indicator/metric (baseline – current years) | Condition | Trend | Confidence |
|---|---|---|---|
| Bats overall condition status | Caution | Unknown | Low |
| Metric 1: species richness* (2002-2019) | Good | Unknown | Low |
| Metric 2: percent of sites with pallid bat and/or Townsend's big-eared bat detections (2002-2019) | Caution | Unknown | Low |

*Number of taxa

Detailed information about the metrics in this section is available in Appendix 1. Information includes further explanation of why the indicator was selected, how the metrics were assessed, and why datasets were chosen. The appendix also includes a larger discussion on the condition, trend, and confidence of this indicator. More information about the Bats Species Indicator metrics can be found in Appendix 1: Section Bats.

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## Mountain Lion – Species Indicator (Landscape Species)


The mountain lion (*Puma concolor*) is the top carnivore in southern California and is important in maintaining biodiversity and integrity of natural communities. These large cats are wide-ranging and use a variety of habitats, preferring riparian and avoiding open grassland and urban areas (Dickson and others 2005; Burdett and others 2010; Jennings and others 2015; Zeller and others 2017; Dellinger and others 2020).

Mountain lions are a key indicator of preserve system connectivity; they have very large territories, and young lions disperse long distances (Beier 1995; Zeller and others 2017; Dellinger and others 2020). In San Diego County, the average male territory is 375 $km^2$ (92,665 acres), and for females, it is 193 $km^2$ (47,691 acres) (Vickers and others 2017).

There are a variety of threats facing mountain lions in southern California generally, and in San Diego County specifically. Southern California's human population grew rapidly over the last half century, leading to extensive habitat loss and fragmentation from urban and agricultural development (Vickers and others 2015). Despite conservation of large blocks of habitat, many mountain lion populations are small and isolated by freeways and surrounded by development (Vickers and others 2015, 2017; Dellinger and others 2020). Mountain lions have unusually high mortality rates in southern California, primarily from vehicle strikes and human conflicts (for example, depredation permits) (Vickers and others 2015). The lion mortality rate in the East Peninsular Range in San Diego County is one of the highest in the state (Vickers, pers. com.). These threats can be partially mitigated by conservation and management. Protecting suitable habitat and improving connectivity for mountain lions could also benefit other species, especially those that are wide roaming (Zeller and others 2017). The combination of these factors has contributed to the loss of genetic diversity and connectivity among most populations (Ernst and others 2014; Gustafson and others 2018). There are 10 genetically distinct mountain lion populations in California and Nevada (Gustafson and others 2018). There is a risk of population extirpations in southern California in the foreseeable future due to an increase in inbreeding and small population sizes, which increase vulnerability to stochastic processes (Benson and others 2019). A recent study of California mountain lions calculated, based on habitat and genetics modeling, that contiguous conserved habitat ≥10,000 $km^2$ (2.47 million acres) is needed to maintain a genetically diverse and viable population (Dellinger and others 2020). Dellinger and others (2020) projected that the Eastern Peninsular Range, most of which is in San Diego County, has 4,777 $km^2$ (1.18 million acres; 62 percent) protected out of 7,683 $km^2$ (1.90 million acres) of suitable mountain lion habitat. Persistence long term for mountain lion populations in San Diego County is dependent on re-establishing connections to the Santa Ana and San Gabriel/San Bernardino populations (Dellinger and others 2020). In 2019, the State of California was petitioned to list the coastal and southern California mountain lion populations as endangered (Center for Biological Diversity and Mountain Lion Foundation 2019).

### Desired Condition

MSP Roadmap Goal (SDMMP and TNC 2017):

*Enhance and expand conservation of areas occupied by mountain lions in San Diego County in large interconnected blocks (≥12,400 acres) of high quality habitat with larger patches where habitat quality is lower, surrounded by a limited number of high use roads, and increase connectivity (and reduce potential road mortality) between occupied and suitable habitat areas to allow expansion and movement of mountain lions within San Diego County and adjacent counties to increase effective population size to sustainable levels, and work to reduce depredation on livestock, to ensure persistence in the MSPA over the long-term (>100 years).*

### Current Condition Status

The current overall condition status for the Mountain Lion Species Indicator in the MSPA is rated as Significant Concern (table 11). Both Metrics 1 (genetic diversity) and 2 (conserved habitat) are ranked as Significant Concern and were weighted equally. The overall trend for Mountain Lion Indicator is Unknown. It appears that genetic diversity may be declining, although another measurement is required to determine a trend. Confidence is High as data sources are recent, reliable, and comprehensive. More information will become available after a long-term mountain lion monitoring plan is developed and implemented, and future reports will include additional metrics on population size, survivorship, evaluation of threats to survival and connectivity, and management to reduce threats.

**Table 11.** Current overall condition status for Mountain Lion Species Indicator and period of baseline to current years comparison for metric conditions, trends, and confidence levels.

| Indicator/metric (baseline – current years) | Condition | Trend | Confidence |
|---|---|---|---|
| Mountain lion overall condition status | Significant Concern | Unknown | High |
| Metric 1: genetic diversity (1996-2016) | Significant Concern | Unknown | High |
| Metric 2: conserved habitat (1995-2020) | Significant Concern | Improving | High |

Detailed information about the metrics in this section is available in Appendix 1. Information includes further explanation of why the indicator was selected, how the metrics were assessed, and why datasets were chosen. The appendix also includes a larger discussion on the condition, trend, and confidence of this indicator. More information about the Mountain Lion Species Indicator metrics can be found in Appendix 1: Section Mountain Lion.

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## Encinitas Baccharis – Species Indicator (Rare and Specialist Species)

Encinitas baccharis (*Baccharis vanessae*) is a small, inconspicuous shrub in openings and the understory of chaparral vegetation communities, although it can be rather large in some situations and habitats. It is a rare endemic restricted to San Diego County coastal and foothill areas (USFWS 2011; SDMMP 2021).

The primary threat to Encinitas baccharis has been urban development leading to habitat loss, fragmentation, and degradation (USFWS 2011). This species had declined by the 1980s and was listed by the State of California as endangered in 1987 and by the USFWS as threatened in 1996. Encinitas baccharis is dioecious, requiring male and female plants in close proximity to allow pollination by insects and wind to produce fertile seeds for reproduction. Encinitas baccharis has a limited distribution dominated by small occurrences with less than 100 plants (USFWS 2011; SDMMP 2020, 2021). This represents a serious threat to the species given the dioecious nature of the plant. Encinitas baccharis is a relatively short-lived plant and may be a poor competitor with taller shrubs. Older plants have reduced reproductive capacity, another potential threat for small populations (USFWS 2011).

Disturbance, such as fire, opens up dense chaparral habitat for Encinitas baccharis to colonize and produce young plants (USFWS 2011). A recent study found no strong genetic structure among populations, indicating there may be additional unknown populations or long-distance seed dispersal (Milano and Vandergast 2018). Field visits have not located many young plants in currently monitored occurrences, although botanists have located some seedlings and young plants in three San Diego County occurrences (SDMMP 2021; USFWS 2021). Low numbers of seedlings and young plants, and the presence of aging plants, raises concerns about successful reproduction (USFWS 2011, 2021), especially since soil seed banks are considered short-lived (USFWS 2011). Other threats include human-altered fire regime leading to a lack of fire in coastal areas and dense chaparral with few openings for Encinitas baccharis to colonize (USFWS 2011; SDMMP 2021). Increasing frequency, intensity, and duration of droughts from a changing climate can reduce plant germination, seed production, and survival (Williams and Hobbs 1989; USFWS 2011). A few occurrences are affected by increasing cover of competitive native plants, trail disturbance, fuel modification, off-trail trampling, and nonnative grasses and forbs (SDMMP 2021; USFWS 2021). Threats to conserved Encinitas baccharis occurrences can be partially mitigated by management.

Encinitas baccharis was selected as an indicator to assess how well the regional preserve system is protecting a rare endemic shrub species of high conservation concern. Encinitas baccharis is also representative of other shrubs and subshrubs that are fire-adapted, relatively rare, and patchily distributed in the understory and small openings of chaparral communities in western San Diego County.

### Desired Condition

MSP Roadmap Goal (SDMMP and TNC 2017):

*Maintain or enhance existing Encinitas baccharis occurrences to ensure multiple conserved occurrences with self-sustaining populations to increase resilience to environmental and demographic stochasticity, maintain genetic diversity, and ensure persistence over the long term (>100 years) in chaparral vegetation communities.*

### Current Condition Status

The overall condition status for the Encinitas Baccharis Indicator is Caution based on consideration of the three metric condition values (table 12). There are signs of potential improvement of the species status due to the discovery and conservation of new occurrences (Metric 1) and some increases in population size, although most occurrences are small and some are declining (Metric 2; SDMMP 2021). Besides the threat of small and isolated occurrences with little sign of recent recruitment, other landscape-scale threats are an altered fire regime and long-term drought. Monitoring shows some serious threats that can be managed at occurrences including competitive native plants, nonnative annual grasses and forbs, trails, trampling, and dumping (Metric 3).

**Table 12.** Current overall condition status for Encinitas Baccharis Species Indicator and period of baseline to current years comparison for metric conditions, trends, and confidence levels.

| Indicator/metric (baseline – current years) | Condition | Trend | Confidence |
|---|---|---|---|
| Encinitas baccharis overall condition status | Caution | Unknown | Moderate |
| Metric 1: conserved occurrences (1996-2020) | Good | Improving | Moderate |
| Metric 2: occurrence status (1995-2020) | Significant Concern | Unknown | Low |
| Metric 3: threats to occurrences (2016-2020) | Caution | Unknown | High |

Detailed information about the metrics in this section is available in Appendix 1. Information includes further explanation of why the indicator was selected, how the metrics were assessed, and why datasets were chosen. The appendix also includes a larger discussion on the condition, trend, and confidence of this indicator. More information about the Encinitas Baccharis Species Indicator metrics can be found in Appendix 1: Section Encinitas Baccharis.

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United States Fish and Wildlife Service (USFWS), 2021, 5-Year Review: *Baccharis vanessae* (Encinitas baccharis).

## San Diego Thornmint – Species Indicator (Rare and Specialist Species)


Photo: Patricia Gordon-Reedy, CBI

San Diego thornmint (*Acanthomintha ilicifolia*) is a small annual plant endemic to San Diego County and northern Baja California, Mexico (USFWS 2009). It was listed as endangered by the State of California in 1982 and as threatened by the USFWS in 1998. Thornmint is restricted to gabbro and clay soils often limiting plants to clay lens habitat in openings in CSS, chaparral, and native grassland (CBI and others 2018). As with many annual plants, populations can fluctuate widely in size from year to year (SDMMP 2021). Some San Diego thornmint occurrences have declined in size or been extirpated in recent years, and many occurrences face a high level of threats (SDMMP 2021).

Over the last 50 years, San Diego thornmint populations have declined and been extirpated due to habitat loss, fragmentation, and degradation (USFWS 2009). Significant advances have been made in conserving occurrences since the late 1990s, although a number are no longer extant (USFWS 2009; SDMMP 2020, 2021). Annual monitoring of conserved occurrences shows many are small and vulnerable to extinction (SDMMP 2021). Occurrence size varies dramatically in response to precipitation and winter temperatures, and favorable environmental conditions can increase occurrence sizes over time. San Diego thornmint faces high levels of threats from fire, loss of genetic connectivity, invasive nonnative plants, and frequent prolonged and intense droughts (DeWoody and others 2018; Milano and Vandergast 2018; CBI and others 2021a; SDMMP 2021). Nonnative annual plants are causing declines in the number of plants in thornmint occurrences; in particular, *Brachypodium distachyon*, a grass that grows well in clay soils and produces a dense thatch (CBI and others 2021). Best management practices to control invasive, nonnative plants are effective at enhancing and restoring thornmint occurrences (CBI and others 2021; SDMMP 2021).

San Diego thornmint was selected as an indicator to assess how well the regional preserve system is protecting a rare endemic species of high conservation concern and with very restrictive habitat requirements. San Diego thornmint is representative of other herbaceous annual plants found on clay soils in CSS, chaparral, and native grassland vegetation communities in western San Diego County.

### Desired Condition

MSP Roadmap Goal (SDMMP and TNC 2017):

*Maintain large occurrences, enhance small occurrences, and establish new occurrences of San Diego thornmint to buffer against environmental stochasticity, maintain genetic diversity, and promote connectivity, thereby enhancing resilience over the long-term (>100 years) in native habitats.*

### Current Condition Status

The current overall condition status for the San Diego Thornmint Species Indicator is Caution, with an Improving trend, based on the consideration of all three metrics (table 13). While Metric 2 (occurrence status) and Metric 3 (threats to occurrences) have not changed over time, there has been a large increase in the number of conserved occurrences (Metric 1). For Metric 2, occurrence status (size) has recently increased in response to management and favorable environmental conditions in 2019 and 2020 after intensive drought in 2014 and 2015. This indicates that the condition of thornmint could improve over time with management and favorable weather conditions. Determination of whether there is an overall long-term improving trend in occurrence status (Metric 2) requires more years of monitoring and is currently assessed as No Change. Threats remain relatively high at conserved San Diego thornmint occurrences (Metric 3). The condition of thornmint can improve over time with management and supports an overall improving trend, although more years of data are required to evaluate this potential trend into the future. Additional metrics related to management may be developed in the future.

**Table 13.** Current overall condition status for the San Diego Thornmint Species Indicator and period of baseline to current years comparison for metric conditions, trends, and confidence levels.

| Indicator/metric (baseline – current years) | Condition | Trend | Confidence |
|---|---|---|---|
| San Diego thornmint overall condition status | Caution | Improving | Moderate |
| Metric 1: conserved occurrences (1998-2020) | Good | Improving | Moderate |
| Metric 2: occurrence status (1986-2020) | Caution | No Change | Moderate |
| Metric 3: threats to occurrences (2014-2020) | Concern | No Change | High |

Detailed information about the metrics in this section is available in Appendix 1. Information includes further explanation of why the indicator was selected, how the metrics were assessed, and why datasets were chosen. The appendix also includes a larger discussion on the condition, trend, and confidence of this indicator. More information about the San Diego Thornmint Species Indicator metrics can be found in Appendix 1: Section San Diego Thornmint.

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## Willowy Monardella – Species Indicator

## (Rare and Specialist Species)


Willowy monardella (*Monardella viminea*) is a perennial subshrub in the mint family (Lamiaceae). It is a rare endemic restricted to a very small area of central San Diego County. Willowy monardella is found in sandy and rocky washes, floodplains, and benches of perennial streams that flow only after heavy rains (Elvin and Sanders 2003).

From the 1970s to 1990s, monardella population extirpations were caused by urban development, road construction, and sand and gravel mining (USFWS 2008). Willowy monardella was listed by the State of California as endangered in 1979 and by the USFWS as endangered in 1998 (CNDDB 2012, USFWS 2008). Most occurrences are on Marine Corps Air Station Miramar (MCAS Miramar), where they are protected and have active management (Kasselbaum 2015). Occurrences continue to decline in number of plants, even when protected from development (Vernadero Group 2018; SDMMP 2021). Most occurrences on Conserved Lands are small and isolated, although several, in the larger canyons that encompass nearby military and private lands, are part of bigger occurrences. A genetic study of occurrences on MCAS Miramar and in the regional preserve system identified no distinct genetic clusters and little evidence for low genetic diversity, except for a small occurrence in Spring Canyon (Milano and Vandergast 2018). The low genetic diversity in the Spring Canyon occurrence on Conserved Lands suggests that it may not be connected with a larger occurrence upstream on private lands. Willowy monardella is threatened by high fire frequency, invasive nonnative plants, competitive native plants, drought, altered hydrology, and flooding (White and Greer 2006; Kasselbaum 2015; USFWS 2008, SDMMP 2021). A management plan has been developed for this species to enhance and restore occurrences (CBI and others 2021). Willowy monardella was selected as an indicator to assess how well the regional preserve system is protecting a rare endemic species of high conservation concern and very limited distribution. This species also represents extremely rare alluvial scrub communities in central San Diego County.

#### Desired Condition

MSP Roadmap Goal (SDMMP and TNC 2017):

*Maintain or enhance existing willowy monardella occurrences and establish new occurrences, as needed, to ensure multiple conserved occurrences with self-sustaining populations to increase resilience to environmental and demographic stochasticity, maintain genetic diversity, and ensure persistence over the long term (>100 years).*

### Current Condition Status

The current overall condition status for the Willowy Monardella Species Indicator is Concern based on consideration of all three metrics (table 14). There has been progress in conserving occurrences in the regional preserve system and MCAS Miramar (Metric 1). However, six populations are classified as small and one as medium on Conserved Lands (Metric 2), which is a Significant Concern. The medium occurrence and two of the small occurrences are part of larger occurrences on adjacent private lands and MCAS Miramar. Willowy monardella also faces a high degree of threat (Metric 3), which is a Concern. Additional metrics related to management may be developed in the future.

**Table 14.** Current overall condition status for Willowy Monardella Species Indicator and period of baseline to current years comparison for metric conditions, trends, and confidence levels.

| Indicator/metric (baseline – current years) | Condition | Trend | Confidence |
|---|---|---|---|
| Willowy monardella overall condition status | Concern | Unknown | Moderate |
| Metric 1: conserved occurrences (1998-2020) | Caution | Improving | Moderate |
| Metric 2: occurrence status (1998-2020) | Significant Concern | Declining | High |
| Metric 3: threats to occurrences (2014-2020) | Concern | No Change | High |

Detailed information about the metrics in this section is available in Appendix 1. Information includes further explanation of why the indicator was selected, how the metrics were assessed, and why datasets were chosen. The appendix also includes a larger discussion on the condition, trend, and confidence of this indicator. More information about the Willowy Monardella Species Indicator metrics can be found in Appendix 1: Section Willowy Monardella.

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## Hermes Copper – Species Indicator

## (Rare and Specialist Species )


Hermes copper (*Lycaena hermes*) is a rare butterfly endemic to San Diego County and northern Baja California, Mexico (Marschalek and Klein 2010). It occurs in CSS and mixed chaparral habitats and is restricted to a single host plant, spiny redberry (*Rhamnus crocea*), for larval development. Adults obtain nectar primarily from flat-topped buckwheat (*Eriogonum fasciculatum*). This butterfly produces one brood per season. Eggs are laid singly on stems of spiny redberry and overwinter until larvae emerge in the spring (Marschalek and Deutschman 2008).

Hermes copper populations started disappearing after the 1960s due to habitat loss and fragmentation from urban development (Marschalek and Klein 2010). Population extirpations accelerated in 2003 and 2007 with large-scale wildfires (Marschalek and Klein 2010) and in more recent years with intense and prolonged drought (Marschalek and Deutschman 2008, Marschalek 2020). Hermes copper was federally listed as endangered in December 2021 (USFWS 2021). Hermes copper was selected as an indicator to assess how well the regional preserve system is protecting a rare endemic species with specialized habitat requirements and that is of high conservation concern and limited distribution. This species is representative of some butterflies that specialize on a single host plant, have limited reproductive output, and are vulnerable to fire and changing climate.

### Desired Condition

MSP Roadmap Goal (SDMMP and TNC 2017):

*Protect, enhance, and restore Hermes copper occupied habitats and historically occupied habitats and the landscape connections between them to create resilient, self-sustaining populations that provide for persistence over the long-term (>100 years).*

### Current Condition Status

Many sites supporting Hermes copper have been conserved, but the butterfly continues to decline. Currently there are only four known extant populations in the eastern portion of the historic species range (Marschalek 2020; D. Marschalek, personnel communication, September 7, 2021). The locations of these populations are Roberts Ranch South, Boulder Creek, Potrero Bureau of Land Management (northwest of Potrero) and a private property northeast of Potrero. However, there is only one population that appears to have reasonable numbers.

Wildfires caused the extirpation of 11 of 18 populations in 2003 and two of four populations in 2007 (Marschalek and Klein 2010). Only one site was re-colonized from adjacent unburned habitat. Most other burned sites had no source populations close enough to re-establish the extirpated populations (Marschalek and Klein 2010, Marschalek and Deutschman 2017). Distance to the source depends on the actual distance, as well as the landscape matrix and behavior of the species. Extreme droughts in 2002, 2007, 2014, 2015, and 2018 are associated with population declines and extirpations in 2014, 2015, and 2018 (Marschalek and Deutschman 2008, Marschalek 2020).

The current overall condition status of the Hermes Copper Species Indicator is Significant Concern based on consideration of the two metrics selected (table 15). In 2020, Hermes copper populations had disappeared from all but three sites occupied in 2010 (Metric 1), and the remaining populations dwindled to small numbers (Metric 2; Marschalek 2020). Additional metrics will be developed in the future as more information becomes available.

**Table 15.** Current overall condition status for Hermes Copper Species Indicator and period of baseline to current years comparison for metric conditions, trends, and confidence levels.

| Indicator/Metric (baseline – current years) | Condition | Trend | Confidence |
|---|---|---|---|
| Hermes copper overall condition status | Significant Concern | Declining | High |
| Metric 1: occupied sites (2010-2020) | Significant Concern | Declining | High |
| Metric 2: population status (2010-2020) | Significant Concern | Declining | High |

Detailed information about the metrics in this section is available in Appendix 1. Information includes further explanation of why the indicator was selected, how the metrics were assessed, and why datasets were chosen. The appendix also includes a larger discussion on the condition, trend, and confidence of this indicator. More information about the Hermes Copper Species Indicator metrics can be found in Appendix 1: Section Hermes Copper.

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## Southwestern Pond Turtle – Species Indicator (Rare and Specialist Species)


Southwestern pond turtle (*Actinemys [Emys] pallida*) is the only freshwater turtle native to coastal southern California. Impacts from urban development, introduced species, and altered hydrology have caused a decline in this taxon (Clark and others 2010; Thomson and others 2016; Brehme and others 2018; Brown and others 2020a). Once widespread, pond turtles are now rare in California and especially in San Diego County, with only a few stable populations in the upper portions of the watersheds (Thomson and others 2016; Brown and others 2020a). This species has been petitioned for listing under the federal Endangered Species Act (Center for Biological Diversity 2012; Thomson and others 2016) and has been the focus of many monitoring and restoration efforts in western San Diego County (Madden -Smith and others 2005; Brown and others 2015, 2020a).

Over the last 20 years, SDMMP has coordinated with partners to investigate, monitor, and restore southwestern pond turtle populations, including conducting baseline surveys from 2002 to 2005 (Madden-Smith and others 2005; Brown and others 2015, 2020a). The number of conserved populations is low but has been growing since the initiation of conservation and restoration efforts (Madden-Smith and others 2005; Brown and others 2020a). Invasive, nonnative species removal efforts help bolster southwestern pond turtle populations (for example, at Sycuan Peak Ecological Reserve, Escondido Creek), but new invasions into the preserve system and expansion of nonnative, aquatic predators continue to be problematic. Drought has also impacted southwestern pond turtle in many locations (Madden-Smith and others 2005; Brown and others 2015, 2020a; Purcell and others 2017). USGS began monitoring surface water availability in 2015 to identify where there is likely to be suitable breeding habitat during drought years (Brown and others 2020b). Altered hydrology impacts the pond turtle through reduction of habitat in upper portions of the watershed (for example, water removal or impoundment, sedimentation, reduced water temperatures below dams) as well as facilitation of invasive species in lower watersheds through aseasonal flow (Madden-Smith and others 2005; Brown and others 2015, 2020; Thomson and others 2016). Current efforts to create new populations on Conserved Lands with permanent water resources will help provide climate resiliency (Purcell and others 2017; Brown and others 2020a). The southwestern pond turtle was selected as an indicator of how well the regional preserve system is protecting a species of high conservation priority in riparian and wetland habitats. Because this species requires permanent or semi-permanent water with little human impact and free of nonnative predators, it can be used as an indicator of healthy aquatic communities (Thomson and others 2016).

### Desired Condition

MSP Roadmap Goal (SDMMP and TNC 2017):

*Protect and enhance existing populations of southwestern pond turtle to self-sustaining levels (that is, 200+ individuals, even sex ratio, evidence of recruitment) in areas that meet the conditions for long-term management (low human access; high naturalness) and create new self-sustaining occurrences to ensure persistence over the long-term (>100 years).*

### Current Condition Status

The current overall condition status of the Southwestern Pond Turtle Species Indicator is Concern (table 16). There are four metrics for southwestern pond turtle. The current overall status is derived by considering the scores across the four metrics. The lack of sites with juvenile turtles is of Significant Concern (Metric 1). Invasive aquatic animals remain a Concern, despite intensive management at some sites (Metric 2). Low water availability due to prolonged, intense drought is a Concern (Metric 3). There is a lack of successfully reproducing populations on Conserved Lands, although this is improving with management (Metric 4). The two metrics with highest confidence (Metrics 1 and 4) have Improving trends due to intensive management. While there are still very few populations on Conserved Lands, restoration and translocation efforts have increased the number of occurrences with juvenile pond turtles within the regional preserve system. More metrics may be added for future analyses.

**Table 16.** Current overall condition status for Southwestern Pond Turtle Species Indicator and period of baseline to current years comparison, metric conditions, trends, and confidence levels.

| Indicator/Metric (baseline – current years) | Condition | Trend | Confidence |
|---|---|---|---|
| Southwestern pond turtle overall condition status | Concern | Improving | Moderate |
| Metric 1: presence of adult vs juvenile pond turtles (2000-2020) | Significant Concern | Improving | High |
| Metric 2: invasive aquatic species impact score (2000-2020) | Concern | No Change | Moderate |
| Metric 3: water availability score (2015-2020) | Concern | Unknown | Moderate |
| Metric 4: managed occurrences on Conserved Lands (2000-2020) | Significant Concern | Improving | High |

Detailed information about the metrics in this section is available in Appendix 1. Information includes further explanation of why the indicator was selected, how the metrics were assessed, and why datasets were chosen. The appendix also includes a larger discussion on the condition, trend, and confidence of this indicator. More information about the Southwestern Pond Turtle Species Indicator metrics can be found in Appendix 1: Section Southwestern Pond Turtle.

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## Coastal Cactus Wren – Species Indicator (Vegetation Community Species)


Photo: Alexandra Houston.

Cactus wren (*Campylorhynchus brunneicapillus)* inhabits deserts throughout the southwestern United States and northern and central Mexico (Proudfoot and others 2000; Hamilton and others 2011). The coastal cactus wren is an ecologically distinct subpopulation found in coastal sage scrub containing cacti in coastal southern California (Rea and Weaver 1990). Coastal populations share song characteristics and have a similar ecology but appear isolated from desert populations (Atwood and Lerman 2007). Desert cactus wrens are more abundant, whereas coastal cactus wrens started declining in southern California in the 1920s, with rapid decline since the 1980s (Rea and Weaver 1990; Proudfoot and others 2000; Hamilton and others 2011). This decline is largely attributed to habitat loss, fragmentation, and degradation from urban and agricultural development. The coastal cactus wren is a focus of conservation planning in southern California (City of San Diego 1998; AMEC and others 2003).

Coastal cactus wren populations have become small and isolated due to habitat loss and fragmentation (Rea and Weaver 1990; Solek and Szijj 2004; Mitrovich and Hamilton 2006; Preston and Kamada 2012). Small populations are vulnerable to loss of genetic diversity from higher levels of breeding among closely related individuals (that is, inbreeding) with potential reduced reproductive success and survival (Frankham and others 2014). A recent study found 20 distinct genetic clusters in southern California (Barr and others 2015), with five of these clusters found in San Diego County: in central Orange County/Marine Corps Base Camp Pendleton; in San Pasqual Valley/Lake Hodges; in Lake Jennings; in Sweetwater/Encanto; and in Otay. All five genetic clusters have effective population sizes below 100, and three clusters range from 19 to 29 (Barr et al. 2015). In the last two decades, large-scale wildfires and frequent and intense droughts have contributed to population declines in San Diego County (Hamilton 2009; TNC and SDMMP 2015; Lynn and Kus 2021). Other threats include invasive, nonnative plants, human-subsidized predators (for example, cats and corvids), and urban edge impacts to remnant cactus patches (Solek and Szijj 2004; Preston and Kamada 2012). The coastal cactus wren is included as an indicator of the condition of cactus scrub, a rare habitat in coastal southern California and northern Baja California, Mexico. Cactus scrub has a unique plant community composition and provides important habitat for many species, especially those that nest in cacti for protection from predators. Coastal cactus wren is also a flagship species for multiple species conservation planning in southern California and has been selected as an indicator of how well the regional preserve system is achieving conservation of a species of very high conservation priority.

### Desired Condition

MSP Roadmap Goal (SDMMP and TNC 2017):

*Protect, enhance, and restore suitable cactus scrub habitat for coastal cactus wrens to increase effective population size in each genetic cluster to a short-term sustainable level (for example 50-100 wrens), rehabilitate habitat destroyed by wildfire, improve habitat quality to maintain populations during drought, enhance connectivity within and between genetic clusters to increase genetic diversity and rescue small populations, and manage human-subsidized predators to ensure the long-term persistence (>100 years) of cactus wrens on Conserved Lands in the MSPA.*

### Current Condition Status

The current overall condition status of the Coastal Cactus Wren Species Indicator is Concern based on an assessment of the two metric conditions (table 17). While occupied plots (Metric 1) currently fall within the Caution category, there is concern that cactus wrens occur only in a fraction of their former range. They are not monitored in areas where they have been extirpated (for example, cactus patches along the coast). Coastal cactus wrens are sparsely distributed in available habitat in small populations vulnerable to local extinction from stochastic processes and stressors such as drought (Metric 1; Lynn and Kus 2021). Habitat quality (Metric 2) fell in the Concern category. Additional metrics will be added as more information becomes available.

**Table 17.** Current overall condition status for Coastal Cactus Wren Species Indicator and period of baseline to current years comparison for metric conditions, trends, and confidence levels.

| Indicator/metric (baseline – current years) | Condition | Trend | Confidence |
|---|---|---|---|
| Coastal cactus wren overall condition status | Concern | No Change | High |
| Metric 1: occupied plots (2009-2020) | Caution | No Change | High |
| Metric 2: habitat quality (2015-2020) | Concern | No Change | High |

Detailed information about the metrics in this section is available in Appendix 1. Information includes further explanation of why the indicator was selected, how the metrics were assessed, and why datasets were chosen. The appendix also includes a larger discussion on the condition, trend, and confidence of this indicator. More information about the Coastal Cactus Wren Species Indicator metrics can be found in Appendix 1: Section Coastal Cactus Wren.

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## Coastal California Gnatcatcher – Species Indicator (Vegetation Community Species)


Coastal California gnatcatcher (*Polioptila californica californica*) is the northernmost subspecies of California gnatcatcher, occurring in coastal southern California and northwestern Baja California, Mexico (Atwood 1991). It is restricted to CSS vegetation, where it forages on insects, forms long-term pair bonds, and maintains a year-round territory (USFWS 1993; Preston and others 1998). By the late 1980s, urban and agricultural development in southern California had resulted in extensive habitat loss, fragmentation, and degradation (Atwood 1992; USFWS 1993). The coastal California gnatcatcher was listed as federally threatened in 1993 (USFWS 1993) and is a California Species of Special Concern (CDFW 2019). The coastal California gnatcatcher is considered the "flagship" species for the NCCP Act and the development of multiple species conservation plans in southern California.

The bulk of the coastal California gnatcatchers are in San Diego County, followed by Riverside and Orange counties and with small numbers in Los Angeles County (Atwood 1992). Since the federal listing, gnatcatchers have been found in San Bernardino and Ventura counties (USFWS 2010). Based on a recent study, the US population forms one genetic cluster with signs of emerging genetic differentiation at the northern end of the range where birds are more isolated by urban development. Vandergast and others (2019) found that there is a loss of genetic diversity when cover of suitable habitat within 30 km (mean gnatcatcher dispersal distance) of a population falls below 10 percent.

Coastal California gnatcatchers are subject to other threats including intense and extended drought, large-scale wildfires (Winchell and Doherty 2014; Kus and Houston 2021), and invasion of CSS by nonnative annual grasses and forbs (USFWS 2010). CSS is increasingly being degraded as altered fire frequency fueled by nitrogen deposition and other disturbances facilitates invasion by nonnative annual grasses (D'Antonio and Vitousek 1992; Minnich and Dezzani 1998; Talluto and Suding 2008; Cox and others 2014).

The coastal California gnatcatcher is included as an indicator of the condition of CSS, a declining habitat in coastal southern California and northern Baja California, Mexico (see also CSS Indicator section). CSS has a unique plant community composition and provides important habitat for many species. As the flagship species for multiple species conservation planning in southern California, the coastal California gnatcatcher has been selected as an indicator of how well the regional preserve system is achieving conservation of a species of highest conservation priority.

### Desired Condition

MSP Roadmap Goal (SDMMP and TNC 2017):

*Protect, maintain, enhance, and restore CSS habitat to high ecological integrity for coastal California gnatcatcher to support a large stable gnatcatcher population with genetic connectivity and resilience to drought, wildfire, and invasive nonnative plants to ensure persistence of gnatcatchers and to incidentally benefit other CSS species over the long term (>100 years).*

### Current Condition Status

The current overall condition status of the Coastal California Gnatcatcher Species Indicator is Concern based on the two metric condition assessments of Concern (table 18). The Percent Area Occupied (PAO) in San Diego County is low (Metric 1) with wildfires reducing PAO relative to unburned areas (Metric 2). There are insufficient data to determine a trend in PAO for subregional monitoring of gnatcatchers in San Diego County, whereas post-fire recovery is progressing overall. Additional metrics on habitat quality and management will be added to future reports as more information becomes available.

**Table 18.** Current overall condition status for Coastal California Gnatcatcher Species Indicator and period of baseline to current years comparison, metric conditions, trends, and confidence levels.

| Indicator/metric (baseline – current years) | Condition | Trend | Confidence |
|---|---|---|---|
| Coastal California gnatcatcher overall condition status | Concern | Improving | High |
| Metric 1: proportion area occupied (2016-2020) | Concern | Unknown | High |
| Metric 2: recovery from fire (2015-2020) | Concern | Improving | High |

Detailed information about the metrics in this section is available in Appendix 1. Information includes further explanation of why the indicator was selected, how the metrics were assessed, and why datasets were chosen. The appendix also includes a larger discussion on the condition, trend, and confidence of this indicator. More information about the Coastal California Gnatcatcher Species Indicator metrics can be found in Appendix 1: Section Coastal California Gnatcatcher.

### Coastal California Gnatcatcher Species Indicator References Cited

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## Arroyo Toad – Species Indicator

## (Riparian Vegetation Community Species)


The federally-endangered arroyo toad (*Anaxyrus californicus*) requires riparian habitats with shallow, slow-moving water. The species utilizes open sandy wash and bedrock habitat where the warm, shallow water and sunny banks allow the arroyo toad larvae and juveniles to develop quickly (Cunningham 1962; Sweet and Sullivan 2005). In predator-free upper watersheds, arroyo toad also persists in riparian habitats with deep pools but still requires open sandy banks for egg deposition. These habitats, along with the arroyo toad, were once common in the coastal draining streams of San Diego County (Stephenson and Calcarone 1999; USFWS 2011). The arroyo toad was listed as federally-endangered in 1994 (USFWS 1994) and is a State of California Species of Special Concern (Thomson and others 2016).

Over the last 20 years, USGS and partners have been studying the arroyo toad in San Diego County. The studies have identified impacts from invasive species, altered hydrology, and prolonged drought (Madden-Smith and others 2003; Miller and others 2012; Brehme and others 2018; Brown and others 2020). Because of habitat degradation and invasive predators, the arroyo toad is largely restricted to the ephemeral systems which preclude nonnative, invasive predators such as bullfrogs, crayfish, and largemouth bass. These predators require permanent or semi-permanent water (see Hydrology Indicator in the Ecosystem Processes and Landscape-scale Threats section; Miller and others 2012).

The recent prolonged drought has limited the arroyo toad's ability to recruit and expand even after habitat restoration and land acquisition for conservation (Brown and others 2020). In the regional preserve system, only 15 populations/distinct locations have recently produced young (USFWS 2015; Brown and others 2020). With loss of habitat to development and reservoirs, and impacts from altered hydrology and invasive species, the arroyo toad requires active management and restoration to be successful on Conserved Lands within San Diego County (White and Greer 2006; USFWS 2011; SDMMP and TNC 2017).

Arroyo toad is included as an indicator of riparian habitat health. The species provides a gauge of how well riparian habitats of southern California coastal rivers are functioning within its historic range. Periodic disturbances in these rivers and streams create alluvial stream reaches with shallow, low flow and provide breeding habitat for the arroyo toad. The arroyo toad also reflects how well the regional preserve system is protecting a species of high conservation priority.

### Desired Condition

MSP Roadmap Goal (SDMMP and TNC 2017):

*Protect and enhance existing significant occurrences of arroyo toad to self-sustaining levels and re-establish occurrences in locations where they previously existed to ensure persistence over the long-term (>100 years).*

### Current Condition Status

The current overall condition status of the Arroyo Toad Species Indicator is Significant Concern based on three metric conditions (table 19). As part of a Declining trend, there were only four HUC12 watersheds (15 sites) occupied by arroyo toad young in 2020 compared to 2008, when 22 HUC12s watersheds were occupied (Metric 1). This is attributed to an increase in drought as well as aseasonal flows in areas affected by urban runoff (Metric 2). Invasive aquatic species (Metric 3) are of concern as predatory invasive animals are found in eight of the 15 occupied watersheds. Additional metrics will be added as more information becomes available.

**Table 19.** Current overall condition status for Arroyo Toad Species Indicator and period of baseline to current years comparison for metric conditions, trends, and confidence levels.

| Indicator/metric (baseline – current years) | Condition | Trend | Confidence |
|---|---|---|---|
| Arroyo toad overall condition status | Significant Concern | Declining | Moderate |
| Metric 1: number of sites occupied by young of the year (2008-2020) | Significant Concern | Declining | Moderate |
| Metric 2: water availability score (2008-2020) | Concern | Unknown | High |
| Metric 3: invasive aquatic species impact score (2000-2020) | Concern | No Change | Moderate |

Detailed information about the metrics in this section is available in Appendix 1. Information includes further explanation of why the indicator was selected, how the metrics were assessed, and why datasets were chosen. The appendix also includes a larger discussion on the condition, trend, and confidence of this indicator. More information about the Arroyo Toad Species Indicator metrics can be found in Appendix 1: Section Arroyo Toad.

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## Least Bell's Vireo – Species Indicator

## (Vegetation Community Species)


Photo: Alexandra Houston, USGS

Least Bell's vireo (*Vireo bellii pusillus*) is a small migratory songbird currently restricted to breeding in willow-dominated and other riparian habitats in southern California and northern Baja California, Mexico (USFWS 1986; Kus and others 2020). This species prefers early successional riparian scrub and woodland and was once abundant in lowlands throughout California (USFWS 1986). Starting in the 1930s, least Bell's vireo declined more dramatically than any other California songbird species in response to loss of riparian habitat. The species was listed by the State of California as endangered in 1980 and by the USFWS as endangered in 1986 (USFWS 1986; CNDDB 2019).

The primary cause of the vireo's decline was large-scale loss and alteration of riparian habitats throughout California for agricultural and urban development, flood control projects, gravel extraction, and grazing (USFWS 1986, 1998; Kus and others 2020). Nest parasitism by brown-headed cowbirds (*Molothrus ater*) is also an important factor in the vireo's decline (Kus and Whitfield 2005). Brown-headed cowbirds invaded California from the Great Plains in the early 1900s and rapidly increased in abundance, causing significant impacts to vireo populations (USFWS 2006). By the 1970s, least Bell's vireo had disappeared from most of its range, and by 1985 there were only 291 known territories in southwestern California (USFWS 1986). San Diego County has supported the largest vireo population from time of listing to present (USFWS 2006). Many nonnative plants, such as Arundo/giant reed (*Arundo donax*), have invaded riparian vegetation communities. These invasive plants can lead to the loss and degradation of vireo breeding habitat and impact recovery of vireo populations (USFWS 2006).

Riparian habitat conservation and restoration along with brown-headed cowbird management have increased least Bell's vireo populations in western San Diego County (Kus and Whitfield 2005; USFWS 2006; Kus and others 2020; Kus 2021). Cowbird control, as well as habitat conservation and restoration efforts to recover least Bell's vireo have also benefitted the other riparian bird species in southern California.

Least Bell's vireo is included as an indicator of riparian habitat health as the species provides an example of how well early successional riparian scrubland in lowland rivers and streams is functioning. Least Bell's vireo also reflects how well the regional preserve system is protecting a species of high conservation priority.

### Desired Condition

MSP Roadmap Goal (SDMMP and TNC 2017):

*Protect, enhance, and restore least Bell's vireo occupied and suitable habitat to create resilient, self-sustaining populations that provide for persistence over the long-term (>100 years).*

### Current Condition Status

The current overall condition status of the Least Bell's Vireo Species Indicator is Good based on the single metric of occupied grid cells surveyed on the San Luis Rey River. This metric is classified as Good condition and Improving trend (table 20). Additional metrics will be added as more information becomes available, including expanding Metric 1 to encompass additional riparian systems beyond the San Luis Rey River. As additional data are compiled, other metrics are planned to document conservation of suitable habitat and the success of riparian restoration projects and cowbird trapping programs on vireo population recovery.

**Table 20.** Current overall condition status for Least Bell's Vireo Species Indicator and period of baseline to current years comparison for metric conditions, trends, and confidence levels.

| Indicator/Metric (baseline – current years) | Condition | Trend | Confidence |
|---|---|---|---|
| Least Bell's vireo overall condition status | Good | Improving | High |
| Metric 1: occupied grid cells (1984-2020) | Good | Improving | High |

Detailed information about the metric in this section is available in Appendix 1. Information includes further explanation of why the indicator was selected, how the metric was assessed, and why the dataset was chosen. The appendix also includes a larger discussion on the condition, trend, and confidence of this indicator. More information about the Least Bell's Vireo Species Indicator is available in Appendix 1: Section Least Bell's Vireo.

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# Ecosystem Processes and Landscape-scale Threats Indicators

Landscape-scale and interacting natural processes shape San Diego's native plant and animal communities and ecosystems. Some processes, such as wildfire, have become altered by human activities and now pose a threat to native species and ecosystem functions. Similarly, hydrological processes have been modified by urbanization and water infrastructure projects. Nonnative plant and animal species, when introduced into San Diego County from other areas of the world, have invaded and expanded across the landscape to become a threat to natural community composition and ecosystem functioning. Human-mediated loss of connectivity across Conserved Lands can disrupt species movement and natural ecosystem processes. Within the regional preserve system, human altered features and processes are responsible for major landscape-scale degradation of habitat quality, native species biodiversity, and ecosystem functioning. Understanding the change caused by these threats and their magnitude over time is essential for successful adaptive management of the regional preserve system.

This report covers four Ecosystem Processes and Landscape-scale Threats Indicators (Hydrology, Connectivity, Fire, and Invasive Nonnative Plants) and the changes these processes have brought to Conserved Lands over time. Other Ecosystem Processes and Landscape-scale Threats Indicators, such as Human Use, Urbanization, and Invasive Animals, will be included in future State of the Preserve reports. Climate change will be covered more explicitly in the future, but as it is likely to amplify the impacts of many of the existing threats (for example fire, hydrology, and invasive plants), it is covered indirectly in this report. MSP species face cumulative effects from large-scale interacting threats, often with one threat worsening the impacts from another threat. For example, fire disturbance provides a mechanism for invasive, highly flammable nonnative plants to establish a fire-plant feedback loop that may lead to the degradation and type conversion of native vegetation communities across the landscape.

Threat-specific strategic plans have been completed for the regional preserve system as part of the MSP Roadmap (SDMMP and TNC 2017) or are in various stages of preparation. These plans provide management strategies and prioritized actions to protect Conserved Lands and Covered Species from further impact. The development of these plans is coordinated by SDMMP in collaboration with partners, including USGS. Various entities such as Wildlife Agencies, land managers, biological consultants, nonprofit organizations, and universities participate in developing and implementing the plans. Invasive plant and connectivity strategic plans have been used over the last decade to guide management across the regional preserve system. An invasive, nonnative animal strategic plan, which prioritizes actions and best management practices, has been completed. A fire management strategy is being implemented, and preparation of a fire ignition and risk reduction plan will address most at-risk resources from fire. A grazing monitoring plan is in preparation to help reduce invasive, nonnative plant coverage and limit flashy fuels on Conserved Lands. Species-specific management plans that identify and evaluate threats and provide prioritized management actions to reduce threats and enhance or restore species have been developed or are being developed for many at-risk species.

Regional coordinated efforts combined with ongoing preserve level management can mitigate the impacts of threats at the preserve level and cumulatively reduce impacts across the landscape. Additional information about threats can be found on the SDMMP website at: *https://sdmmp.com/threats.php.*

## Hydrology – Ecosystem Processes and Landscape-scale Threats Indicator


Natural stream hydrology in the San Diego region was historically driven by both runoff and groundwater inputs. Many streams had wide, dynamic channels with sand or gravel substrates, and most were ephemeral (Taniguchi and Biggs 2015). Dams, water diversions, and increased impervious surfaces associated with urbanization have altered stream morphology and threaten watershed functions in semiarid southern California (Hawley and others 2012; Booth and Fischenich 2015).

Other factors impacting stream hydrological and sedimentation regimes include wildfire, which increases channel sedimentation (Moody and Martin 2009), and invasion of nonnative plant species, such as giant reed, which reduces available surface water (Jain and others 2015) while increasing flooding during periods of heavy rainfall (Spencer and others 2013). Beavers (*Castor canadensis*) can also increase stream temperatures, impair water quality, facilitate invasive species, and alter sediment distribution (Weber and others 2017).

These impacts reduce the amount of surface water in the upper watersheds and increase channelization and runoff in lower watersheds (Booth and Fishcenich 2015, Taniguchi and Biggs 2015). Incised channels and urban runoff can increase permanent water, harboring and facilitating the spread of invasive, nonnative aquatic species which do not live in ephemeral streams (for example, crayfish, bullfrogs) (White and Greer 2006; Wohlgemuth and Hubbert 2008; Moody and Martin 2009). All these issues combined can degrade habitat for many native aquatic species (Brown and others 2020). Alternatively, increased runoff from urbanization may also help maintain riparian habitat (White and Greer 2006) that supports some riparian bird species (Lee and Rotenberry 2015).

Overall hydrology health can be addressed through enhanced restoration, removal of impacts (dams, diversions, point sources), and acquisition of healthy riparian habitat (Booth and Fischenich 2015).

#### Desired Condition

MSP Roadmap Goal (SDMMP and TNC 2017):

*Reduce the impact of urban runoff and aseasonal flow on the highest priority MSP species and maintain riparian habitat so that species can persist over the long term (>100 years) in areas upstream and downstream of urban land uses. Reduce the impact of invasive nonnative species through restoration of natural streamflow.*

### Current Condition Status

The current overall condition status of the Hydrology Indicator is Concern based on consideration of the four metric condition values, with a slightly higher weighting for Metrics 2 and 3 (table 21). Dams and water diversions are causing hydrologic impairment (Metric 1), and across the landscape, there is low to moderate native species richness, and invasive aquatic species are of considerable concern (Metric 4). The percentage of watershed burned in the last 20 years (Metric 2) is high, and impervious surfaces (Metric 3) associated with development are increasing runoff. Additional metrics may be added as more information becomes available.

**Table 21.** Current overall condition status for Hydrology Indicator and period of baseline to current years comparison for metric conditions, trends, and confidence levels.

| Indicator/metric (baseline – current years) | Condition | Trend | Confidence |
|---|---|---|---|
| Hydrology overall condition status | Concern | Unknown | Moderate |
| Metric 1: hydrologic impairment (2015-2020) | Caution | Unknown | High |
| Metric 2: watershed percent area burned (1980-2020) | Concern | Declining | High |
| Metric 3: impervious surfaces (2015-2020) | Concern | Unknown | Moderate |
| Metric 4: native vs invasive aquatic species index (2000-2020) | Concern | Unknown | Moderate |

Detailed information about the metrics in this section is available in Appendix 1. Information includes further explanation of why the indicator was selected, how the metrics were assessed, and why datasets were chosen. The appendix also includes a larger discussion on the condition, trend, and confidence of this indicator. More information about the Hydrology Indicator metrics can be found in Appendix 1: Section Hydrology.

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## Connectivity – Ecosystem Processes and Landscape-scale Threats Indicator


Maintaining connectivity among natural areas is essential to maintaining functional landscapes and evolutionary processes (Noss 1987, 1991; Saunders and others 1991; Beier and Noss 1998). Connectivity is critical to promoting dispersal among habitat patches, maintaining gene flow, facilitating local adaptation, and promoting resilience to many threats, including fire, floods, disease, and climate change (Austin and others 2004; Anacker and others 2013).

Loss of connectivity has been shown to reduce biodiversity in natural ecosystems (Brudvig and others 2009; Brückmann and others 2010; Horváth and others 2019) and in the MSPA is adversely affecting several species of high conservation priority (for example, coastal cactus wren [Barr and others 2015] and mountain lion [Benson and others 2019]). There are 27 species (17 plants, one amphibian, two reptiles, three birds, and four mammals) in the MSPA at risk from loss of connectivity and/or habitat fragmentation (SDMMP and TNC 2017).

In San Diego County, roads and urban development have created barriers to species movement, especially for wide-ranging species that have large home ranges. Roads fragment habitat and create barriers that impede mobility and result in increased wildlife mortality (Jackson and Fahrig 2011). In addition, habitat loss and fragmentation from urbanization combined with large wildfires in the last 20 years have resulted in further loss of habitat and reduced connectivity for some species, such as the coastal cactus wren (Barr and others 2015) and Hermes copper butterfly (Marschalek and others 2016). Fragmentation by anthropogenic or natural disturbances can result in genetic isolation, putting some species at risk of inbreeding and potential extirpation over the longer term (Trombulak and Frisell 2000; Van der Ree and others 2011). As habitat becomes fragmented, populations or subpopulations may become separated or even isolated in the remaining smaller habitat patches. Smaller populations are at greater risk of extirpation due to stochastic or anthropogenic events, like human-caused fire (Lacy 2000).

### Desired Condition

MSP Roadmap Goal (SDMMP and TNC 2017):

*A connected landscape amongst core habitat areas within the MSPA and other regional conservation areas to: (1) Ensure the persistence of species across the preserve system and (2) Maintain ecosystem functions across the landscape.*

### Current Condition Status

Connectivity of the landscape has many facets that should be measured to fully understand condition and trend. Currently, SDMMP is in progress to evaluate data on road crossings, infrastructure, and the effectiveness of linkages in western San Diego County. These data were not available to include in this version of the report but will be included in the future. This Indicator will be expanded to include several more metrics and analyses. At this point, a single metric is used as a starting point for further discussion.

The current overall condition status of the Connectivity Indicator is Significant Concern based on the percentage of linkage area conserved (table 22). Linkages considered important to maintain connectivity between core areas in the MSP have been identified by the MSP Roadmap (SDMMP and TNC 2017). Currently, 14 percent of the identified linkage acreage has been conserved.

**Table 22.** Current overall condition status for the Connectivity Indicator and period of baseline to current years comparison for metric conditions, trends, and confidence.

| Indicator/metric (baseline – current years) | Condition | Trend | Confidence |
|---|---|---|---|
| Connectivity overall condition status | Significant Concern | Improving | Moderate |
| Metric 1: percent of linkage area conserved (1995-2020) | Significant Concern | Improving | Moderate |

Detailed information about the metrics in this section is available in Appendix 1. Information includes further explanation of why the indicator was selected, how the metrics were assessed, and why datasets were chosen. The appendix also includes a larger discussion on the condition, trend, and confidence of this indicator. More information about the Connectivity Indicator metrics can be found in Appendix 1: Section Connectivity.

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## Fire – Ecosystem Processes and Landscape-scale Threats Indicator


Photo: Robert Fisher, USGS

Southern California shrublands and forests are adapted to a natural fire regime (Keeley and Fotheringham 2001), and wildfire is integral to the health of the regional preserve system. The natural fire regime has been altered by human activities (Syphard and others 2007a,b). Wind-driven fires have impacted large areas of habitat and pose a threat to Covered Species in western San Diego County (SDMMP and TNC 2017). A longer fire season is predicted by the mid-21st century due to warmer, drier weather and Santa Ana wind conditions extending from September and October into November and December (Miller and Schlegel 2006; Yue and others 2014).

In fire-adapted communities, changes to the fire regime, such as fire frequency, can pose a threat to species persistence (Pausas and others 2004; Keeley 2005; Syphard and others 2007b; Keeley and others 2011). Anthropogenic disturbances, such as development in fire-prone areas creating extensive Wildland Urban Interface (WUI; Syphard and others 2007a,b; Moritz and others 2014), and an increase in human-caused fire ignitions (Syphard and Keeley 2015), can alter ecosystem processes and have a negative impact on even fire-adapted plant and animal species and natural communities. Impacts include habitat destruction, limitations to food availability, altered community structure, and direct mortality (SDMMP and TNC 2017). Southern California shrublands are susceptible to type conversion to nonnative, annual grasslands through repeated burning over a short time interval (Minnich and Dezzani 1998; Keeley 2002; Keeley and Brennan 2012; Pausas and Keeley 2014). With the removal of native vegetation and the enrichment of soil after fire, rapidly establishing nonnative grasslands can initiate a positive feedback of increasing fire frequency because of the fine fuels they create that ignite easily and readily carry fire (Keeley and Brennan 2012).

Results of post-fire monitoring show that wildfires have a negative impact on small animals such as salamanders, small snakes, coastal cactus wrens, and coastal California gnatcatchers (SDMMP and TNC 2017). For example, significant portions of Hermes copper butterfly habitat burned in 2003 and 2007, causing the loss of 13 populations and further restriction of the species' range (Marschalek and Klein 2010).

#### Desired Condition

MSP Roadmap Goal (SDMMP and TNC 2017):

*To maintain the long-term ecological integrity and viability of ecosystems, MSP species, and vegetation communities on Conserved Lands by managing the current human altered fire regime* *to promote a more natural fire regime with lower fire frequency and reduced impacts (direct and indirect) to natural resources.*

### Current Condition Status

Establishing a baseline for fire frequency is not straightforward. Humans have been influencing the natural fire regime for thousands of years. Fire perimeter records have only been kept since 1878 and are not reflective of pre-European settlement fire conditions. Pre-European values are also not likely to be useful or realistic targets. Ideally, a goal for fire frequency would be based on how much fire the landscape can tolerate before there is degradation or permanent change. Analyses to develop fire frequency values for healthy ecosystems are in progress and will be available in future reports. Thresholds and baseline values may change as new information becomes available. Instead, targets and thresholds for the metrics were chosen based on the long-term fire record and other available data.

The historical fire record was graphed using overlapping 30-year intervals (fig. 9). Starting in 1909 until the period ending in 1999, there was an average of 331,569 acres burned in a 30-year period (not restricted to Conserved Lands) with a standard deviation of 47,000 acres. The two most-recent 30-year periods (1979-2009 and 1989-2019) had a significant increase in the total acreage burned to average of 887,583 acres, well outside of two standard deviations from the

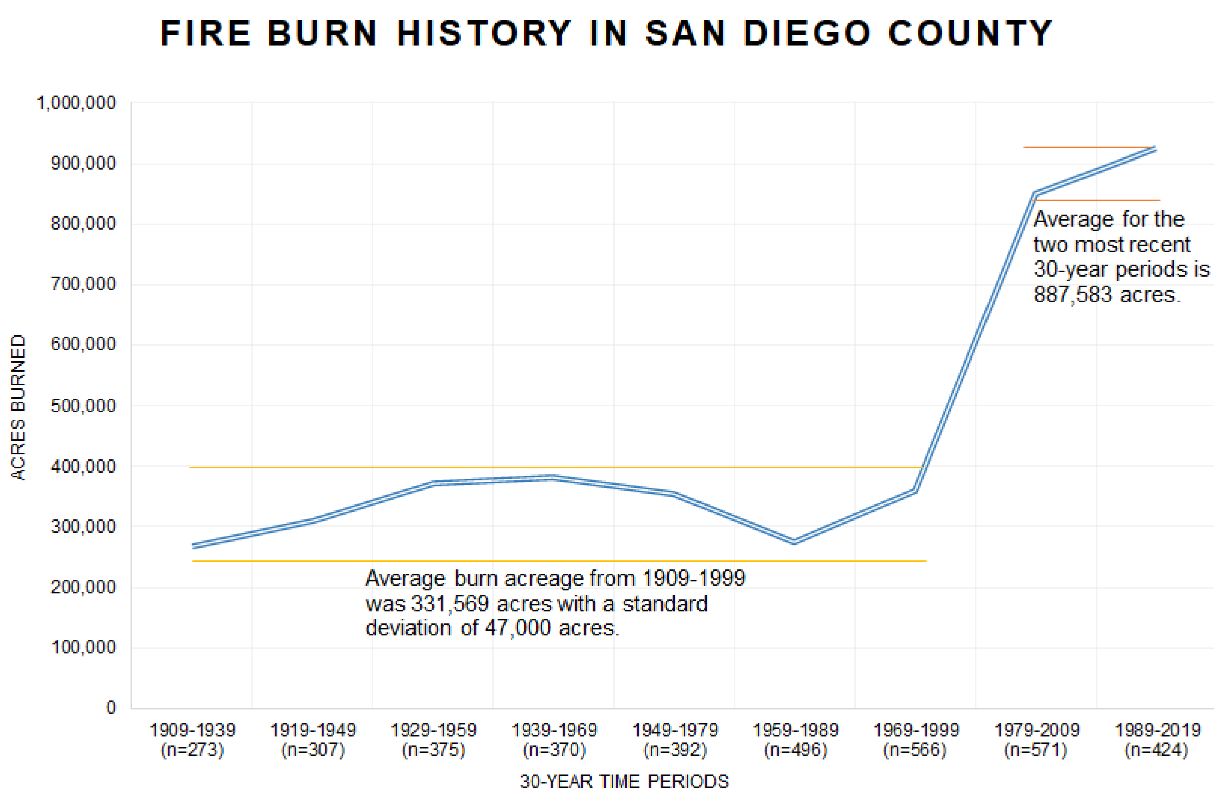


**Figure 9.** Acres burned at least one time in overlapping 30-year periods for recorded fire history from 1909-2019.

mean for historical data. Because vegetation mapping data are available for 1995 and that year falls within the range of fires in the period of record, the time period 1969-1999 was chosen as the baseline for fire and vegetation-specific fire metrics (chaparral Metric 3 and CSS Metric 3). The current condition status uses the most recent data available (1989-2019). Metric values were restricted to the regional preserve system.

From 1989 to 2019, 476,273 acres (36 percent) of total Conserved Lands burned at least once. In 2019, 9 percent of Conserved Lands had burned two or more times in 30 years, compared to 1989, when only 2 percent of Conserved Lands had burned two or more times in 30 years. Two percent of Conserved Lands burned three or more times in between 1989 and 2019, above the baseline from recorded fire history.

The current overall condition status of the Fire Indicator is Significant Concern based on consideration of the three metric condition values (table 23). All three metrics fell into the Significant Concern category because there has been a significant increase in the percent of Conserved Lands burned (Metric 1) and they burned more frequently than in the past (Metrics 2 and 3). All metrics are moving away from the desired condition and baseline values and, therefore, were given a trend of Declining. The confidence for all metrics is High because high-quality, established datasets were used. Additional metrics will be added as more information becomes available.

**Table 23.** Current overall condition status for Fire Indicator and period of baseline to current years comparison, metric conditions, trends, and confidence levels.

| Indicator/metric (baseline – current years) | Condition | Trend | Confidence |
|---|---|---|---|
| Fire overall condition status | Significant Concern | Declining | High |
| Metric 1: percent of Conserved Lands burned at least once (1969-2019) | Significant Concern | Declining | High |
| Metric 2: percent of Conserved Lands burned two or more times (1969-2019) | Significant Concern | Declining | High |
| Metric 3: percent of Conserved Lands burned three or more times (1959-2019) | Significant Concern | Declining | High |

Detailed information about the metrics in this section is available in Appendix 1. Information includes further explanation of why the indicator was selected, how the metrics were assessed, and why datasets were chosen. The appendix also includes a larger discussion on the condition, trend, and confidence of this indicator. More information about the Fire Indicator metrics can be found in Appendix 1: Section Fire.

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## Invasive Nonnative Plants – Ecosystem and Landscape-scale Threats Indicator


Invasive, nonnative plants are plants from other areas that have invaded and naturalized or have the potential to naturalize and negatively impact the native community. Invasive, nonnative plants impact local rare, threatened, and endangered plant and animal species in San Diego County, as well as the habitat and vegetation communities on which many species rely (SDMMP and TNC 2017). Invasive, nonnative plants can affect native habitats by decreasing native species diversity, reducing or eliminating important native species, degrading water quality, increasing soil erosion, and altering the fire cycle (Vitousek and others 1997; D'Antonio and Meyerson 2002; Pejcher and Mooney 2009; Vila and others 2011). In San Diego County, the invasive, nonnative plant threat can be grouped into two categories: ubiquitous species that have, in some cases, become naturalized (for example, *Brachypodium distachyon*, purple false brome or stiff brome) and novel species that have the potential to be eradicated. Of the 111 MSP species, 63 are threatened by nonnative, invasive plants, including 42 rare plant species. These 63 species have specific invasive plant management and monitoring objectives (SDMMP and TNC 2017).

Invasive, nonnative plant species are introduced accidentally or intentionally, and each has the potential to harm native species. In 2012, the "*Management Priorities for Invasive Non-native Plants: A Strategy for Regional Implementation, San Diego County*" (Invasive Plant Strategic Plan [IPSP]) was released by CBI, California Invasive Plant Council (Cal-IPC), and Dendra, Inc. In the plan, invasive, nonnative plants were assessed and ranked by their prevalence and harmfulness (CBI and others 2012). Since 2015, using information from the IPSP, the *TransNet* EMP-funded Regional Early Detection Rapid Response Program (Regional EDRR Program) has surveyed, treated, and monitored 25 nonnative, invasive plant species on Conserved Lands in San Diego County. The Regional EDRR Program is supported by SANDAG (through funding to the County Department of Agriculture, Weights, and Measures [AWM]) to treat high priority nonnative, invasive plant occurrences throughout San Diego County. The recommended course of action for each nonnative, invasive plant species depends on the species distribution and abundance in western San Diego County; the geographic scale of coordinated implementation (region, watershed, management unit, reserve, or site); management feasibility, including costs, impacts, and likelihood of success; and current management status for the species (CBI and others 2012). In addition to the Regional EDRR Program, 44 *TransNet* EMP Land Management Grants have targeted 89 different nonnative, invasive plant species since 2006.

### Desired Condition

MSP Roadmap Goal (SDMMP and TNC 2017):

*Reduce the cover/acreage of nonnative, invasive plants and eradicate species, when possible. This will be achieved by: (1) Protecting Conserved Lands from new or expanding nonnative, invasive plant species; (2) Detecting new invasive species and new invasions early on and controlling them before the plants have a chance to establish; and (3) Addressing invasive species using the response appropriate for the level of invasiveness (level 1 through 5) as defined in the Invasive Plant Strategic Plan (IPSP).*

### Current Condition Status

Since 2015, the Regional EDRR Program has surveyed, treated, and monitored nonnative, invasive plant species on Conserved Lands in western San Diego County. Data from the Regional EDRR Program (Dendra, Inc. 2014, 2015a-d, 2016a-d, 2017a-c, 2018a-d, 2019a-d, 2020a-d) informed the Invasive Nonnative Plants Indicator and metric condition, trends, and confidence levels.

The current overall condition of the Invasive Nonnative Plants Indicator is Concern, with an Improving Trend, based on consideration of the three metric conditions (table 24). As of 2020, there have been no nonnative, invasive plant species eradicated. While that is a concerning condition, it is improving. The program is getting closer to the goal of eradicating certain plant species (Metric 1) by eradicating individual nonnative, invasive plant species sites (Metric 2), and when all individual sites of an invasive plant species are eradicated, the species will be considered eradicated from Conserved Lands. However, even as the Regional EDRR Program increases the number of sites treated (Metric 3), there is the potential for new or existing nonnative, invasive plants to establish new occurrences. The confidence for each of the three metrics is High as there are ample data from the EDRR program; however, the overall confidence level is Moderate. This is due to the lack of data on invasive removal work conducted by individual land managers outside of the EDRR program. In the future, it is anticipated that there will be additional tracking of invasive, nonnative plant removal from Conserved Lands that are not part of the Regional EDRR Program. As more information becomes available, future reports will include additional metrics evaluating the threat from invasive, nonnative plants and management prioritization based on threat risk.

**Table 24.** Current overall condition status for the Invasive Nonnative Plants Indicator and period of baseline to current years of comparison for metric conditions, trends, and confidence levels.

| Indicator/metric (baseline – current years) | Condition | Trend | Confidence |
|---|---|---|---|
| Invasive nonnative plants overall condition status | Concern | Improving | Moderate |
| Metric 1: number of species eradicated (2015-2020) | Significant Concern | No Change | High |
| Metric 2: number of sites eradicated (2015-2020) | Concern | Improving | High |
| Metric 3: number of sites treated (2015-2020) | Caution | Improving | High |

Detailed information about the metrics in this section is available in Appendix 1. Information includes further explanation of why the indicator was selected, how the metrics were assessed, and why datasets were chosen. The appendix also includes a larger discussion on the condition, trend, and confidence of this indicator. More information about the Invasive Nonnative Plants Indicator metrics can be found in Appendix 1: Section Invasive Plants.

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# IV. Summary

## Status of the Regional Preserve System

This first report on the *State of the Regional Preserve System in Western San Diego County* details progress in preserve assembly for the four multiple species conservation plan areas (see Section II Status of the MSCP and MHCP Preserve System and Covered Species) and provides metrics for 19 indicators of preserve health for the regional preserve system (see Section III Regional Preserve System Indicators and Metrics). These indicators include four Vegetation Community Indicators, 11 Species Indicators (plant and animal species or species groups), and four Ecosystem Processes and Landscape-scale Threat Indicators. See Appendix 1 Table 1 for a list of all indicators and associated metrics.

### Preserve Assembly and Species Conservation

Preserve assembly is progressing in the completed plan areas, particularly for the MSCP. The MSCP has completed conservation goals for southern coastal bluff scrub, Torrey pine forest, and Tecate cypress forest (table 1). The plan is close to meeting conservation goals for chaparral communities, riparian woodland, and maritime succulent scrub. The MSCP is also making good progress in CSS and grassland conservation. In contrast, the MHCP, with only one subarea plan completed, is challenged to meet most conservation goals (see Section II, table 2). The other two planning areas (North and East County), which encompass the rest of San Diego County, do not have completed conservation plans. Currently, conservation in the North and East counties is primarily on lands owned and managed by the U.S. Forest Service, California State Parks, and Bureau of Land Management.

Combined efforts by land managers, Wildlife Agencies, USGS, and the SDMMP have led to surveying or monitoring the majority of species of conservation concern in the regional preserve system. Data have been collected on 85 (77 percent) of the 111 MSP species, 67 (79 percent) of the 85 MSCP Covered Species (table 4) and 45 (74 percent) of the 61 MHCP Covered Species (table 5). Species that are not monitored tend to be of low conservation concern (for example, Canada goose [*Branta canadensis*] and western bluebird [*Sialia mexicana*]), extremely rare in San Diego County and outside of their main range (for example, reddish egret [*Egretta rufescens*]), or are scheduled for future regional monitoring (for example, Otay manzanita [*Arctostaphylos otayensis*] and Gander's pitcher sage [*Lepechinia gander*]).

### Indicators and Metrics

Of the 19 indicators, the majority (12 of 19) have an overall condition of Concern or Significant Concern, indicating that the regional preserve system faces challenges (table 25). The overall condition of indicators was assessed by metrics that characterize the conservation status of species and vegetation communities; condition of vegetation communities and status of species occurrences; magnitude and pervasiveness of threats with some metrics of the effectiveness of threat management; and the impact of threats to species and vegetation communities.

To understand the implications of these overall rankings, it is important to consider the selection of indicators and the metrics upon which the overall indicator statuses are based. Species Indicators include some of the most at-risk species and those of high conservation concern. These at-risk species reflect limiting conditions in the preserve system, such as restrictive habitat requirements, small and declining populations, and high levels of threats. They are prioritized for monitoring and management because of concerns over their status and, therefore, have some of the highest quality monitoring datasets. A subset of potential Ecosystem

**Table 25.** Overall condition status metrics, trends, and confidence levels for 19 indicators of the health of the regional preserve system in western San Diego County. Categories of indicators include Vegetation Community, Species (Landscape, Rare and Specialist, and Vegetation Community Species), and Ecosystem Processes and Landscape-Scale Threats.

| Indicator | Indicator Category | Overall Condition | Trend | Confidence |
|---|---|---|---|---|
| Chaparral | Vegetation community | Caution | Unknown | Moderate |
| Coastal sage scrub | Vegetation community | Concern | Unknown | Moderate |
| Oak woodland | Vegetation community | Caution | Unknown | Moderate |
| Riparian forest and scrub | Vegetation community | Good | Unknown | Moderate |
| Bats | Species - Landscape | Caution | Unknown | Low |
| Mountain lion | Species - Landscape | Significant Concern | Unknown | High |
| Encinitas baccharis | Species - Rare and specialist | Caution | Unknown | Moderate |
| San Diego thornmint | Species - Rare and specialist | Caution | Improving | Moderate |
| Willowy monardella | Species - Rare and specialist | Concern | Unknown | Moderate |
| Hermes copper | Species - Rare and specialist | Significant Concern | Declining | High |
| Southwestern pond turtle | Species - Rare and specialist | Concern | Improving | Moderate |
| Coastal cactus wren | Species - CSS vegetation | Concern | No Change | High |
| Coastal California gnatcatcher | Species - CSS vegetation | Concern | Improving | High |
| Arroyo toad | Species - Riparian vegetation | Significant Concern | Declining | Moderate |
| Least Bell's vireo | Species - Riparian vegetation | Good | Improving | High |
| Hydrology | Ecosystem processes and landscape-scale threats | Concern | Unknown | Moderate |
| Connectivity | Ecosystem processes and landscape-scale threats | Significant Concern | Improving | Moderate |
| Fire | Ecosystem processes and landscape-scale threats | Significant Concern | Declining | High |
| Invasive nonnative plants | Ecosystem processes and landscape-scale threats | Concern | Improving | Moderate |

Processes and Landscape-scale Threat Indicators were chosen as they posed the greatest risk to native species and vegetation communities. This focus on selecting Species Indicators most at risk and threats causing the greatest harm to species and vegetation communities represents a relatively pessimistic view of the state of the regional preserve system. However, there are reasons to be optimistic with the continuing efforts in habitat conservation and monitoring and management activities.

### Conservation Status for Selected Vegetation Community and Species Indicators

There are four Vegetation Community Indicators and five Species Indicators with metrics evaluating conservation status (such as, number of occurrences conserved or percent of habitat or vegetation community conserved) within the regional preserve system in western San Diego County (table 26). The trend in these nine conservation status metrics is Improving as habitat is conserved through implementation of the conservation plans. It is anticipated that when the North and East County MSCP Plans are completed, there will be significantly higher levels of conservation than currently, and the condition thresholds will need to be re-evaluated to reflect the growing preserve system.

Based on our analysis, the Mountain Lion Species Indicator is one of the most imperiled when it comes to conservation levels with a ranking of Significant Concern (table 26). This is because the mountain lion requires large, contiguous blocks of habitat that are not fragmented by roads or development. To maintain a genetically healthy population of mountain lions will require concerted effort to conserve large blocks of habitat and improve connectivity between the Santa Ana Mountains, Peninsular Range, and Transverse Range in Orange, Riverside, San Diego, and San Bernardino counties (see mountain lion section in Appendix 1). There has been improvement in meeting this goal in San Diego County since 1995, as habitat has been conserved through implementation of the MSCP.

Southwestern Pond Turtle Species Indicator has a conservation status of Significant Concern as measured by a metric based on the number of Managed Occurrences on Conserved Lands (Metric 4; table 26). Currently, three of seven managed occurrences have young turtles surviving and recruiting into the breeding population (see southwestern pond turtle section in Appendix 1). This is an improvement from 2005 when there were no successfully reproducing pond turtle populations and no active management of pond turtles in the regional preserve system.

### Ecological Integrity and Occurrence Status Metrics

Metrics were developed to assess the status of vegetation communities and species occurrences (table 27). Ecological integrity metrics were developed to assess the health of four Vegetation Community Indicators (Wurtzebach and Schultz 2016). NDVI and lidar were used to calculate measures of ecological integrity using percent shrub cover for Chaparral and CSS Vegetation Community Indicators (Diffendorfer and others 2007; Lawson and Keeley 2019) and percent live trees for Riparian and Oak Woodland Vegetation Community Indicators. The

**Table 26.** Metrics evaluating conservation status for selected Vegetation Community and Species Indicators on Conserved Lands in western San Diego County.

| Indicator | Indicator category | Metric (M#) | Evaluation period | Condition | Trend | Confidence |
|---|---|---|---|---|---|---|
| Chaparral | Vegetation Community | M1: Percent conserved | 1995-2020 | Good | Improving | Moderate |
| Coastal sage scrub | Vegetation Community | M1: Percent conserved | 1995-2020 | Caution | Improving | Moderate |
| Oak woodland | Vegetation Community | M1: Percent conserved | 1995-2020 | Concern | Improving | Moderate |
| Riparian forest and scrub | Vegetation Community | M1: Percent conserved | 1995-2020 | Caution | Improving | Moderate |
| Mountain lion | Species – Landscape | M2: Conserved habitat | 1995-2020 | Significant Concern | Improving | High |
| Encinitas baccharis | Species – Rare and Specialist | M1: Conserved occurrences | 1996-2020 | Good | Improving | Moderate |
| San Diego thornmint | Species – Rare and Specialist | M1: Conserved occurrences | 1998-2020 | Good | Improving | Moderate |
| Willowy monardella | Species – Rare and Specialist | M1: Conserved occurrences | 1998-2020 | Caution | Improving | Moderate |
| Southwestern pond turtle | Species – Rare and Specialist | M4: Managed occurrences on Conserved Lands | 2000-2020 | Significant Concern | Improving | High |

baseline for these ecological integrity metrics is 2014, which coincides with an extreme drought year during a long-lasting period of drought (Robeson 2015). Since there is only one year of data available (2014) for ecological integrity, a trend is not currently available. However, it is possible to draw a few conclusions about what can be expected in future assessment periods.

For shrub-dominated habitats, ecological integrity of the Chaparral Indicator in 2014 ranked in the Concern condition, whereas the CSS Indicator fell into the Significant Concern condition, with very low ecological integrity (table 27). Multiple stressors affect CSS and, to a lesser extent, chaparral vegetation. These natural systems are affected by complex interactions between wildfire, climate change (drought and increasing temperatures), nitrogen deposition, and invasive species (Keeley and Brennan 2012; Kimball and others 2014). It is expected that CSS is currently doing somewhat better now than in 2014, one of the most extreme drought years on record (Robeson 2015). This is because CSS shrubs lose leaves during drought stress and can appear dead, resulting in lower percent live shrub cover. In the last 30 years, wildfires have increased in size and frequency as reflected in the metrics for the Fire Indicator that all rank as Significant Concern (table 28). CSS is especially impacted by increased fire frequency over the last 30 years (see CSS section in Appendix 1). This type of disturbance has opened CSS for invasion by nonnative grasses and forbs, causing habitat degradation that can be tracked through the ecological integrity metric (Diffendorfer and others 2007; Lawson and Keeley 2019). SDMMP is working on calculating ecological integrity metrics from the 1990s to analyze changes in CSS and chaparral over time in relation to fire, invasive nonnative species, and drought.

For tree-dominated habitats, Oak Woodland and Riparian Forest and Scrub Vegetation Community Indicators, ecological integrity was classified as Good in 2014. However, the 2012-2019 California drought has caused extensive riparian woodland mortality along the Santa Clara River in southern California (Kibler and others 2021). It is likely the long period of drought is affecting trees in San Diego County as well. Over the last decade, invasive beetles and fungal pathogens have caused substantial riparian and oak woodland tree mortality in areas of San Diego County (Lynch and others 2013; Boland 2016). Therefore, these two vegetation communities could show a decline in condition with inclusion of more recent assessments.

Occurrence status for the majority of the Species Indicators ranked as Concern or Significant Concern (8 of 13, table 27). Species Indicators falling into the Significant Concern condition represent the most-at-risk species (Mountain Lion, Encinitas Baccharis, Willowy Monardella, Hermes Copper, Southwestern Pond Turtle, Arroyo Toad), typically with small populations vulnerable to environmental and demographic stochasticity, loss of genetic diversity, and inbreeding.

The Coastal California Gnatcatcher Species Indicator, an obligate resident of coastal sage scrub habitats, has an occurrence status (that is, PAO) condition of Concern (table 27). Orange County has higher occupancy than San Diego County (0.36 versus 0.24), although San Diego traditionally supported more habitat and birds (see coastal California gnatcatcher section in Appendix 1; Kus and Houston 2021).

**Table 27.** Metrics evaluating ecological integrity for Vegetation Community Indicators and occurrence status[1] for Species Indicators on Conserved Lands in western San Diego County.

| Indicator | Indicator Category | Metric (M#) | Evaluation period | Condition | Trend | Confidence |
|---|---|---|---|---|---|---|
| Chaparral | Vegetation Community – Shrub Dominated | M2: Ecological integrity | 2014 | Concern | Unknown | Moderate |
| Coastal sage scrub | Vegetation Community – Shrub Dominated | M2: Ecological integrity | 2014 | Significant Concern | Unknown | Moderate |
| Oak woodland | Vegetation Community – Tree Dominated | M2: Ecological integrity | 2014 | Good | Unknown | Moderate |
| Riparian forest and scrub | Vegetation Community – Tree Dominated | M2: Ecological integrity | 2014 | Good | Unknown | Moderate |
| Bats | Species – Landscape | M1: Species richness | 2002-2019 | Good | Unknown | Low |
| Bats | Species – Landscape | M2: Pallid and Townsend's big-eared bat detections | 2002-2019 | Caution | Unknown | Low |
| Mountain lion | Species – Landscape | M1: Genetic diversity | 1992-2016 | Significant Concern | Unknown | High |
| Encinitas baccharis | Species – Rare and Specialist | M2: Occurrence status | 1995-2020 | Significant Concern | Unknown | Low |
| San Diego thornmint | Species – Rare and Specialist | M2: Occurrence status | 1986-2020 | Caution | No Change | Moderate |
| Willowy monardella | Species – Rare and Specialist | M2: Occurrence status | 1998-2020 | Significant Concern | Declining | High |
| Hermes copper | Species – Rare and Specialist | M1: Occupied sites | 2010-2020 | Significant Concern | Declining | High |
| Hermes copper | Species – Rare and Specialist | M3: Population status | 2010-2020 | Significant Concern | Declining | High |
| Southwestern pond turtle | Species – Rare and Specialist | M1: Presence of adult vs juvenile pond turtles | 2000-2020 | Significant Concern | Improving | High |

| Indicator | Indicator Category | Metric (M#) | Evaluation period | Condition | Trend | Confidence |
|---|---|---|---|---|---|---|
| Coastal cactus wren | Species – CSS Vegetation | M1: Occupied plots | 2009-2020 | Caution | No Change | High |
| Coastal California gnatcatcher | Species – CSS Vegetation | M1: Proportion area occupied | 2016-2020 | Concern | Unknown | High |
| Arroyo toad | Species – Riparian Vegetation | Number of sites occupied by young of the year | 2008-2020 | Significant Concern | Declining | Moderate |
| Least Bell's vireo | Species – Riparian Vegetation | M1: Occupied grid cells | 1984-2020 | Good | Improving | High |

[1] "Occurrence status" includes a variety of species-specific measurements – for example, species richness, genetic diversity, proportion area occupied, etc.

In contrast, the Least Bell's Vireo Species Indicator is an endangered species restricted to breeding in willow riparian habitats and has a Good occurrence status condition. Least Bell's vireos show a clear increase in occupied sites from 1984 to 2020 on the San Luis Rey River (see least Bell's vireo section in Appendix 1; Kus 2021). In the mid-1980s, they had disappeared from most of their range in California. However, habitat conservation and restoration, combined with management of brown-headed cowbirds, have caused a rebound in population size and even some recolonization in their former range (Kus 1998, 2002; Kus and Whitfield 2005).

### Ecosystem Processes and Landscape-scale Threats Metrics

Metrics evaluating Ecosystem Processes and Landscape-scale Threats Indicators confirm that there are large-scale threats affecting the health of the preserve system (table 28) and impacting the status of species and vegetation communities. Hydrology Indicator metrics primarily fall in the Concern condition, the single Connectivity Indicator metric is of Significant Concern, and the Fire Indicator metrics are of Significant Concern. The Invasive Nonnative Plants Indicator, despite intensive management to eradicate high priority species, has mixed effects with metric conditions ranging from Caution to Significant Concern.

Metrics related to Ecosystem and Landscape-scale Threats Indicators are also included to evaluate impacts to Vegetation Community and Species Indicators (table 29). For the metrics for Vegetation Community Indicators, fire frequency for Chaparral is ranked in the Caution condition with a declining trend and fire frequency in CSS is ranked in the Significant Concern condition. As mentioned above, CSS is especially impacted by increased fire frequency over the last 30 years (see CSS section in Appendix 1).

For the metrics for species, all seven Species Indicators (Encinitas Baccharis, San Diego Thornmint, Willowy Monardella, Southwestern Pond Turtle, Coastal Cactus Wren, Coastal California Gnatcatcher, and Arroyo Toad) include threat related metrics that are ranked in the Concern condition. Habitat loss and fragmentation have led to loss of connectivity for many species. Since the plans were adopted in the late 1990s and early 2000s, there have been additional major changes in environmental conditions resulting from human activities. The fire regime changed dramatically over the last 30 years, with more frequent large wildfires. The extremely large wildfires of 2003 and 2007 impacted extensive areas of chaparral and CSS, with large amounts of habitat burned twice. Increasing fire frequency has opened up the landscape and facilitated invasion of nonnative grasses and forbs. These invasive plants have increased in abundance and are impacting post-fire vegetation recovery. This can be seen in metrics for CSS, Chaparral, Coastal California Gnatcatcher, and Fire Indicators.

For example, a postfire recovery study in San Diego County shows that gnatcatcher populations have not fully recovered from 2003 and 2007 wildfires (table 29; Kus and Houston 2021). The loss of ecological integrity seen in CSS metrics is also reflected in gnatcatcher population status metrics (PAO). In 2020, burned habitats had 50 percent lower PAO than

**Table 28.** Metrics evaluating Ecosystem Processes and Landscape-scale Threat Indicators in the regional preserve system.

| Indicator | Metric (M#) | Evaluation period | Condition | Trend | Confidence |
|---|---|---|---|---|---|
| Hydrology | M1: Hydrologic impairment score | 2015-2020 | Caution | Unknown | High |
| Hydrology | M2: Watershed percent area burned | 1980-2020 | Concern | Declining | High |
| Hydrology | M3: Impervious surfaces score | 2015-2020 | Concern | Unknown | Moderate |
| Hydrology | M4: Native versus invasive aquatic species index | 2000-2020 | Concern | Unknown | High |
| Connectivity | M1: Percent of linkage area conserved | 1995-2020 | Significant Concern | Improving | Moderate |
| Fire | M1: Percent of Conserved Lands burned at least once | 1969-2019 | Significant Concern | Declining | High |
| Fire | M2: Percent of Conserved Lands burned 2 or more times | 1969-2019 | Significant Concern | Declining | High |
| Fire | M3: Percent of Conserved Lands burned 3 or more times | 1959-2019 | Significant Concern | Declining | High |
| Invasive Nonnative Plants | M1: Number of species eradicated | 2015-2020 | Significant Concern | No Change | High |
| Invasive Nonnative Plants | M2: Number of sites eradicated | 2015-2020 | Concern | Improving | High |
| Invasive Nonnative Plants | M3: Number of sites treated | 2015-2020 | Caution | Improving | High |

**Table 29.** Metrics evaluating the effects of Ecosystem Processes and Landscape-scale Threats Indicators on Vegetation Community and Species Indicators.

| Indicator | Indicator Category | Metric | Evaluation period | Condition | Trend | Confidence |
|---|---|---|---|---|---|---|
| Chaparral | Vegetation Community | M3: Fire frequency | 1965-2019 | Caution | Declining | Moderate |
| Coastal Sage Scrub | Vegetation Community | M3: Fire frequency | 1965-2019 | Significant Concern | Declining | Moderate |
| Encinitas Baccharis | Species - Rare and Specialist | M3: Threats to occurrences | 2016-2020 | Caution | Unknown | High |
| San Diego Thornmint | Species - Rare and Specialist | M3: Threats to occurrences | 2014-2020 | Concern | No Change | High |
| Willowy Monardella | Species - Rare and Specialist | M3: Threats to occurrences | 2014-2020 | Concern | No Change | High |
| Southwestern Pond Turtle | Species – Rare and Specialist | M2: Invasive aquatic species impact score | 2005-2020 | Concern | No Change | Moderate |
| Southwestern Pond Turtle | Species - Rare and Specialist | M3: Water availability score | 2015-2020 | Concern | Unknown | Moderate |
| Coastal Cactus Wren | Species - CSS Vegetation | M3: Habitat quality | 2015-2020 | Concern | No Change | High |
| Coastal California Gnatcatcher | Species - CSS Vegetation | M2: Recovery from fire | 2015-2020 | Concern | Improving | High |
| Arroyo Toad | Species - Riparian Vegetation | M2: Water availability score | 2008-2020 | Concern | Unknown | High |
| Arroyo Toad | Species - Riparian Vegetation | M3: Invasive aquatic species impact score | 2000-2020 | Concern | No Change | Moderate |

unburned habitats as there were more invasive, nonnative grasses and lower shrub cover, particularly for shrub species preferred by gnatcatchers, in the burned areas. One hopeful note is that there is a slow but upwards trajectory in gnatcatcher PAO in burned habitats, indicating some improvement over time.

Similarly, climate change is contributing to more frequent, intense, and prolonged droughts. This is associated with rapid decline of some most-at-risk Species Indicators such as Arroyo Toad and Hermes Copper, and both species also face other threats simultaneously. In addition to drought, arroyo toads are impacted by altered hydrology and invasive aquatic animals (see arroyo toad section in Appendix 1; Brown and others 2020), whereas Hermes copper has been hit hard by fire and loss of connectivity (see Hermes copper section in Appendix 1; Marschalek and Deutschman 2008; Marschalek 2020).

Multiple, interacting, and large-scale threats are a challenge to land managers, who hope that management can be effective and lead to recovery of vegetation communities and species of conservation concern. Progress is illustrated by improving trends for post-fire recovery of coastal California gnatcatchers, recovery of least Bell's vireo populations through habitat restoration and management of brown-headed cowbirds, conservation of linkages, and control of high priority invasive, nonnative plant species.

# V. Conclusion

## Lessons Learned

Selecting indicators and preparing metrics for this first State of the Regional Preserve System report has been informative. By deconstructing the regional preserve system into different components (that is indicators of Vegetation Communities, Species, and Ecosystem Processes and Landscape-scale Threats) and preparing metrics exploring the status of these indicators, SDMMP was able to obtain a better understanding of the health of the regional preserve system and learned things about the regional preserve system that were unexpected. There are commonalities between indicators, such as different species responding in a similar manner to the same suite of threats. Even more striking was an overall pattern of multiple, often interacting landscape-scale threats negatively impacting species and vegetation communities.

SDMMP found that while there is progress in land conservation and preserve assembly, this progress is overwhelmed by the impacts from multiple, large-scale threats largely caused by human activities. Natural ecosystem processes and services have been altered by humans and have become threats (such as climate, fire, and hydrology). The magnitude, frequency, and interaction of these threats was not anticipated when the early conservation plans were prepared and adopted. Most of these threats exploded in frequency, scale, and intensity over the last 2 decades, beyond levels previously documented in the regional preserve system. These landscape-scale threats often interact in a positive feedback loop to have greater impact on multiple species and vegetation communities. For instance, drought intensified by climate change can kill trees and shrubs, thereby increasing fire frequency, intensity, and size, which opens up space for invasive annual plants that can act as flashy fuels and can increase fire activity favoring annual nonnative grasses over native shrubs. Drought can further reduce germination and survival of native plant species, contributing to the conversion of native shrublands to nonnative annual grasslands that do not support many priority MSP species. Fire, drought, and invasive nonnative plants are interacting to negatively impact vegetation communities and species such as CSS, chaparral, San Diego thornmint, Hermes copper butterfly, coastal cactus wren, and coastal California gnatcatcher.

This issue of emerging threats emphasizes the need for regional monitoring to evaluate the status of species and vegetation communities and measure ecosystem processes and threats to inform management to mitigate threat levels. Landscape-scale threats present great challenges to land managers, but also opportunities to collaborate in regional monitoring and management. The SDMMP coordinates implementation of regional monitoring and management actions that would not be possible without partner collaboration and leverage of resources. This collaboration with many partners achieves a greater scale of monitoring, research, and management that benefits land managers at the preserve level and is also advantageous for the larger preserve system.

Sound science is critical in driving the development and implementation of the regional monitoring and management program. Information based upon monitoring, research, and management studies is used to prioritize monitoring and management goals and objectives in the MSP Roadmap. Selecting indicators and developing metrics based on data collected from scientific studies informs ongoing and future monitoring and management. To determine metric condition, thresholds were created given knowledge of the system. Developing these indicators and metrics on a periodic basis (such as every 5 years) allows a pause to evaluate and prioritize next steps. The selected indicators and associated metrics measure how well goals and objectives are being met over time and leads to refinement and improvement of strategies as more information is gathered. This approach can allow for greater management effectiveness and lead to a healthier regional preserve system. Metrics are likely to become a better gauge of the preserve system with more information and better documentation of changes over time. Results from this State of the Regional Preserve System report have been used to update the 2022-2026 monitoring and management objectives in the MSP Roadmap.

In this first State of the Regional Preserve System report, the focus is on a subset of the Indicator Species selected to represent the status of the regional preserve system. Selected species largely meet the following criteria: they are of high conservation importance, have certain habitat requirements representing conditions for a range of other species, are most at risk because of small, isolated populations, or face high levels of threats. These species are closely monitored to track their status and prioritize the greatest management needs. Species were chosen with different habitat requirements and varying sensitivities to different threats to represent a range of conditions found in the regional preserve system. It is important to note that many of the Indicator Species were rare, threatened, and endangered when the MSCP and MHCP were developed with the intent of conserving them. By selecting species of highest conservation concern, the evaluation of the preserve system is biased toward species that may require significant management to ensure persistence. As a result of concerted management, the expectation is that many of the most at-risk species will improve in status over time. In the future, Indicator Species will include more at-risk species reflecting additional aspects of preserve system health. Future reports will also include species at lower risk or with less restrictive habitat requirements, reflecting general conditions for more abundant and widespread species

Without conservation planning and acquisition of large areas of interconnected natural habitats for protection in a regional preserve system, impacts to species and vegetation communities in western San Diego County could be far worse. The lands are being conserved in adopted plan areas, and the focus is shifting to management and developing techniques that can apply to large-scale threats. Progress is evident by improving trends for post-fire recovery of California gnatcatchers; recovery of least Bell's vireo populations through habitat restoration and management of brown-headed cowbirds; conservation of linkages; and control of high priority invasive, nonnative plant species. Information learned from indicator metrics can be used to infer how the regional preserve system may be functioning for other species. For example, one of the mountain lion metrics shows that loss of genetic diversity can lead to inbreeding and highlights the importance of improving connectivity for large-roaming species in an increasingly fragmented landscape.

Finally, without the wealth of research and monitoring data collected over the last 20 years, it would not be possible to develop these metrics which provide valuable insight into potential future management and monitoring priorities.

To view the SDMMP Metrics Dashboard visit: https://sdmmp.com/metrics/

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# Appendix 1: State of the Regional Preserve System in Western San Diego County: Detailed Methods and Descriptions of Indicators and Metrics

This appendix includes detailed information and methods that were used to assess the condition, trend, and confidence for the indicators and metrics included in the main body of this report: *Status of the Regional Preserve System in Western San Diego County.* This appendix is meant to stand alone and includes information from the main body of the report. Appendix table 1 provides indicator and metric condition status, trends and confidence and can be used to navigate to different sections within this appendix.

The appendix is organized following the report sections: Vegetation Community Indicators, Species Indicators, and Ecosystem Processes and Landscape-scale Threat Indicators. Each indicator section includes information about why the indicator was chosen, stressors affecting the indicator, the desired condition, the current overall condition status with an explanation of how the overall condition was determined, and a table summarizing the overall condition and individual metric conditions.

Each metric is then described in detail with an overview of the metric, baseline values, target values, and detailed information about the condition, trend, and confidence. Tables and figures support information provided, and original sources of data are cited. References cited are provided by indicator. For further information on the indicators chosen and the organization of sections, see the section Regional Preserve System Indicators and Metrics Introduction. Following are brief descriptions of the indicator categories in this appendix.

## Vegetation Community Indicators

Vegetation Community Indicators in this report are Chaparral, Coastal Sage Scrub (CSS), Oak Woodland, and Riparian Forest and Scrub. All indicators in this section include a metric evaluating the percent conserved by habitat in the regional preserve system. These metrics use the 1995 vegetation map (City of San Diego and others 1995; CalFire 2015) and the 2020 Conserved Lands (SDMMP 2020) layer. There is also a metric for each of these indicators measuring ecological integrity or the health of the vegetation community. Chaparral and CSS have additional metrics to describe the impacts of fire.

## Species Indicators

Species Indicators are split into three types: Landscape Species, Rare and Specialist Species, and Vegetation Community Species. Landscape Species roam over large areas and require connected habitat throughout the County. Rare and Specialist Species have restrictive habitat requirements. Vegetation Community Species are primarily found in a particular type of vegetation community. A limited number of species are evaluated here. As more data become available, more species and metrics will be added.

Landscape Species Indicators are Bats and Mountain Lion. Rare and Specialist Species Indicators are Encinitas Baccharis, San Diego Thornmint, Willowy Monardella, Hermes Copper, and Southwestern Pond Turtle. Vegetation Community Species Indicators for CSS are Coastal Cactus Wren and Coastal California Gnatcatcher. Vegetation Community Species Indicators for riparian habitat are Arroyo Toad and Least Bell's Vireo.

### Landscape Species

Landscape Species roam widely across western San Diego County and inhabit a variety of vegetation communities. They often make long distance movements, and these movements can be constrained by habitat loss and fragmentation from urban development. Habitat fragmentation and separation of a habitat patch from other habitat patches can limit movement by species traveling both on the ground and in the air, such as bats moving between roosting and foraging areas. Connectivity can be further constrained by freeways and highways and by human activities. Maintaining connectivity for Landscape Species by conserving and restoring natural habitat linkages and improving road crossing infrastructure can facilitate movement by other species in the regional preserve system.

### Rare and Specialist Species

This category includes species with specialized habitat requirements that are more restrictive than an association with a particular vegetation community. Rare and Specialist Species require a limited range of specific environmental conditions or, for insects, require a specific host plant species in their life cycle. This category also includes species that are naturally rare or are endemic to the Management and Monitoring Strategic Plan Roadmap Area (MSPA). Plants in this category generally have specific soil requirements, are rare in occurrence, or are endemic to San Diego County, bordering counties, and northern Baja California, Mexico.

### Vegetation Community Species

This category includes species which may be broadly distributed but which typically inhabit specific vegetation communities, such as CSS, chaparral, grassland, riparian, oak woodland, salt marsh, dunes and coastal strands, and vernal pools. These species are indicators of the health of these vegetation communities for other ecologically similar species. This report focuses on species inhabiting CSS and riparian habitats.

## Ecosystem Processes and Landscape-Scale Threat Indicators

Large and interconnecting natural processes and threats affect San Diego's native species and vegetation communities. Some of these natural processes essential to San Diego County's ecosystems, such as wildfires, have become altered by human activities and now pose a threat to natural communities. Similarly, natural hydrological processes have been altered by urbanization and water infrastructure projects causing threats to many aquatic species. Understanding the change of natural processes and threats over time is essential to adaptive management of the natural system. This report covers four Ecosystem Processes and Landscape-scale Threat Indicators in San Diego County: hydrology, connectivity, fire regime, and invasive plants. Other Ecosystem Processes and Landscape-scale Threats Indicators will be included in future reports. Climate change will be covered more explicitly in the future, but as it is likely to amplify the impacts of many of the existing threats (for example, fire, hydrology, and invasive plants), it is covered indirectly in this report. Management and Monitoring Strategic Plan (MSP) species face cumulative effects from threats, often with one threat worsening the impacts from another threat (for example, invasive plants creating flashy fuels for fire and fire disturbing the landscape, making it easier for invasive plants to establish). The impacts from threats often account for major changes in the habitat quality and biodiversity.

**Table 1.** Indicators with overall condition status and metrics with condition, trend, and confidence. This table can be used to navigate to different sections within this appendix.

| Indicator/Metric | Condition | Trend | Confidence | Appendix Page Number |
|---|---|---|---|---|
| **Vegetation Community Indicators** | | | | |
| ***Chaparral*** | | | | 8 |
| Overall condition status | Caution | Unknown | Moderate | 10 |
| Metric 1: percent conserved (1995-2020) | Good | Improving | Moderate | 10 |
| Metric 2: ecological Integrity (2014) | Concern | Unknown | Moderate | 14 |
| Metric 3: fire frequency (1965-2019) | Caution | Declining | Moderate | 19 |
| ***CSS*** | | | | 26 |
| Overall condition status | Concern | Unknown | Moderate | 28 |
| Metric 1: percent conserved (1995-2020) | Caution | Improving | Moderate | 28 |
| Metric 2: ecological integrity (2014) | Significant Concern | Unknown | Moderate | 32 |
| Metric 3: fire frequency (1965-2019) | Significant Concern | Declining | Moderate | 37 |
| ***Oak Woodland*** | | | | 44 |
| Overall condition status | Caution | Unknown | Moderate | 46 |
| Metric 1: percent conserved (1995-2020) | Concern | Improving | Moderate | 46 |
| Metric 2: ecological integrity (2014) | Good | Unknown | Moderate | 50 |
| ***Riparian Forest and Scrub*** | | | | 57 |
| Overall condition status | Good | Unknown | Moderate | 59 |
| Metric 1: percent conserved (1995-2020) | Caution | Improving | Moderate | 60 |
| Metric 2: ecological integrity (2014) | Good | Unknown | Moderate | 63 |

| Indicator/Metric | Condition | Trend | Confidence | Appendix Page Number |
|---|---|---|---|---|
| **Species Indicators (Landscape Species)** | | | | |
| ***Bats*** | | | | 70 |
| Overall condition status | Caution | Unknown | Low | 72 |
| Metric 1: species richness (2002-2019) | Good | Unknown | Low | 73 |
| Metric 2: percent of sites with pallid bat and/or Townsend's big-eared bat detections (2002-2019) | Caution | Unknown | Low | 74 |
| ***Mountain Lion*** | | | | 79 |
| Overall condition status | Significant Concern | Unknown | High | 81 |
| Metric 1: genetic diversity (1992-2016) | Significant Concern | Unknown | High | 83 |
| Metric 2: conserved habitat (1995-2020) | Significant Concern | Improving | High | 86 |
| **Species Indicators (Rare and Specialist Species)** | | | | |
| ***Encinitas Baccharis*** | | | | 93 |
| Overall condition status | Caution | Unknown | Moderate | 95 |
| Metric 1: conserved occurrences (1996-2020) | Good | Improving | Moderate | 96 |
| Metric 2: occurrence status (1995-2020) | Significant Concern | Unknown | Low | 99 |
| Metric 3: threats to occurrences (2016-2020) | Caution | Unknown | High | 102 |
| ***San Diego Thornmint*** | | | | 107 |
| Overall condition status | Caution | Improving | Moderate | 109 |
| Metric 1: conserved occurrences (1998-2020) | Good | Improving | Moderate | 109 |
| Metric 2: occurrence status (1986-2020) | Caution | No Change | Moderate | 112 |
| Metric 3: threats to occurrences (2014-2020) | Concern | No Change | High | 115 |
| ***Willowy Monardella*** | | | | 120 |
| Overall condition status | Concern | Unknown | Moderate | 122 |
| Metric 1: conserved occurrences (1998-2020) | Caution | Improving | Moderate | 122 |
| Metric 2: population status (1998-2020) | Significant Concern | Declining | High | 125 |
| Metric 3: threats to occurrences (2014-2020) | Concern | No Change | High | 128 |

| Indicator/Metric | Condition | Trend | Confidence | Appendix Page Number |
|---|---|---|---|---|
| **Species Indicators (Rare and Specialist Species)** | | | | |
| ***Hermes Copper*** | | | | 133 |
| Overall condition status | Significant Concern | Declining | High | 134 |
| Metric 1: occupied sites (2010-2020) | Significant Concern | Declining | High | 135 |
| Metric 2: population status (2010-2020) | Significant Concern | Declining | High | 138 |
| ***Southwestern Pond Turtle*** | | | | 142 |
| Overall condition status | Concern | Improving | Moderate | 144 |
| Metric 1: presence of adult versus juvenile pond turtles | Significant Concern | Improving | High | 146 |
| Metric 2: invasive aquatic species index (2000-2020) | Concern | No Change | Moderate | 151 |
| Metric 3: water availability (2000-2020) | Concern | Unknown | Moderate | 154 |
| Metric 4. number of conserved restored populations (2000- | Significant Concern | Improving | High | 157 |
| **Species Indicators (Vegetation Community Species)** | | | | |
| ***Coastal Cactus Wren*** | | | | 163 |
| Overall condition status | Concern | No Change | High | 165 |
| Metric 1: occupied plots (2009-2020) | Caution | No Change | High | 166 |
| Metric 2: habitat quality (2015-2020) | Concern | No Change | High | 171 |
| ***Coastal California Gnatcatcher*** | | | | 178 |
| Overall condition status | Concern | Improving | High | 180 |
| Metric 1: proportion area occupied (2016-2020) | Concern | Unknown | High | 181 |
| Metric 2: recovery from fire (2015-2020) | Concern | Improving | High | 184 |
| ***Arroyo Toad*** | | | | 191 |
| Overall condition status | Significant Concern | Declining | Moderate | 192 |
| Metric 1: number of sites occupied by young of the year | Significant Concern | Declining | Moderate | 193 |
| Metric 2: water availability score (2008-2020) | Concern | Unknown | High | 197 |
| Metric 3: invasive aquatic species impact score (2000-2020) | Concern | No Change | Moderate | 201 |

| Indicator/Metric | Condition | Trend | Confidence | Appendix Page Number |
|---|---|---|---|---|
| ***Least Bell's Vireo*** | | | | 207 |
| Overall condition status | Good | Improving | High | 208 |
| Metric 1: occupied grid cells (1984-2020) | Good | Improving | High | 209 |
| **Ecosystem Processes and Landscape-scale Threat Indicators** | | | | |
| ***Hydrology*** | | | | 220 |
| Overall condition status | Concern | Unknown | Moderate | 221 |
| Metric 1: hydrologic impairment (2015-2020) | Caution | Unknown | High | 222 |
| Metric 2: watershed percent area burned (1980-2020) | Concern | Declining | High | 226 |
| Metric 3: impervious surfaces (2015-2020) | Concern | Unknown | Moderate | 230 |
| Metric 4: native versus invasive aquatic species index (2000- | Concern | Unknown | Moderate | 233 |
| ***Connectivity*** | | | | 240 |
| Overall condition status | Significant Concern | Improving | Moderate | 241 |
| Metric 1: percent of linkage area conserved (1995-2020) | Significant Concern | Improving | Moderate | 242 |
| ***Fire*** | | | | 248 |
| Overall condition status | Significant Concern | Declining | High | 250 |
| Metric 1: percent of Conserved Lands burned at least once | Significant Concern | Declining | High | 251 |
| Metric 2: percent of Conserved Lands burned two or more | Significant Concern | Declining | High | 255 |
| Metric 3: percent of Conserved Lands burned three or more | Significant Concern | Declining | High | 259 |
| ***Invasive Nonnative Plants*** | | | | 265 |
| Overall Status | Concern | Improving | Moderate | 267 |
| Metric 1: number of species eradicated (2015-2020) | Significant Concern | No Change | High | 259 |
| Metric 2: number of sites eradicated (2015-2020) | Concern | Improving | High | 271 |
| Metric 3: number of sites treated (2015-2020) | Caution | Improving | High | 275 |

# Chaparral - Vegetation Community Indicator

# (Shrub-dominated Habitat)


### Why Is This Indicator Included?

Chaparral is the most extensive vegetation community in San Diego County, with a baseline of 705,181 acres mapped in 1995 (City of San Diego and others 1995; CalFire 2015). Chaparral habitat supports a rich diversity of plant and animal species, some of which are found only in chaparral and others that use a variety of vegetation types. There are 50 MSP Species (13 animals and 37 plants) that inhabit or use chaparral (SDMMP and TNC 2017). Species such as Rainbow manzanita (*Arctostaphylos rainbowensis*), Del Mar manzanita (*Arctostaphylos glandulosa* ssp. *crassifolia*), and Lakeside ceanothus (*Ceanothus cyaneus*) are found only in chaparral vegetation communities.

Chaparral was selected as an indicator because it provides important habitat to many species, including species of conservation concern, and the health of chaparral is a critical element to the health of the regional preserve system.

### Stressors

Habitat loss and fragmentation threaten chaparral communities. Human population growth and activities threaten chaparral ecosystem functions and plant and animal biodiversity (Keeley 2018; Jennings 2018). Repeated fires and nonnative grass invasions have reduced density of chaparral shrubs in some areas and threaten those areas with vegetation type conversion to nonnative grassland (Keeley and Brennan 2012; Lawson and Keeley 2019). California's climate is projected to become warmer and drier with more frequent, intense, and prolonged droughts (Diffenbaugh and others 2015). Extensive chaparral shrub mortality has been attributed to extreme drought (Kelly and Goulden 2008; Keeley and others 2009). This in turn can increase fire frequency and intensity (Jin and others 2014) and has contributed to the extremely large wildfires in San Diego County during 2003 and 2007 (Keeley and Zedler 2009).

- **Fire and Invasive Nonnative Grasses**: An altered fire regime, with a shortened fire return interval of less than thirty years (Keeley and others 2011) can threaten chaparral through vegetation type conversion from chaparral to nonnative annual grassland (Keeley and Brennan 2012).
- **Climate Vulnerability**: Chaparral shrubs can have considerable mortality during intense and prolonged droughts (Kelly and Goulden 2008; Keeley and others 2009). Elevational shifts in chaparral shrub species in the Santa Rosa Mountains of southern California have been attributed to regional changes in climate (Kelly and Goulden 2008).
- **Urbanization**: Urban development in the MSPA contributes to loss of chaparral vegetation. Chaparral near urban development may be disturbed through habitat alteration, as well as other disturbances, such as the creation of roads and trails (Sauvajot and others 1998). Brush management along roadsides and the Wildland Urban Interface (WUI) may also degrade and reduce chaparral habitat. The creation of fuel and fire breaks crushes vegetation, clears strips of land of shrub cover (Green 1977) and can alter soil chemistry substantially (Busse and others 2014). The disturbed areas from fuel breaks are often colonized by nonnative, invasive plants, which act as sources for further invasion into adjacent areas (Zink and others 1995; Keeley and others 2005; Merriam and others 2006; Mayberry 2011; Syphard and others 2014).

Chaparral is comprised of evergreen drought-and fire-tolerant shrubs 1-4 m tall with thick leaves to resist water loss (Quinn and Keeley 2006). Shrubs are adapted to long, hot, dry summers and unpredictable winter rainfall of the Mediterranean climate region in San Diego County. Chaparral grows on steep, rocky, dry slopes. The vegetation is dense with an understory of small shrubs, forbs, and openings with bare soil.

Fire is a natural process in chaparral ecosystems and required for germination of some shrub species while others recover by stump sprouting.

## Desired Condition

MSP Roadmap Goal (SDMMP and TNC 2017):

*Maintain, enhance, and restore chaparral on Conserved Lands in the MSPA that supports or has the potential to support MSP species and to incidentally benefit a diverse array of other species so that the vegetation community has high ecological integrity, and these species are resilient to environmental stochasticity, catastrophic disturbances, and threats, such as very large wildfires and prolonged droughts, and will be likely to persist over the long term (>100 years).*

### Current Condition Status

According to baseline acreages calculated from the 1995 vegetation map (City of San Diego and others 1995; CalFire 2015), 58 percent of the 705,181 acres of chaparral in San Diego County is currently conserved in the regional preserve system through the Multiple Species Conservation Program (MSCP), Multiple Habitat Conservation Program (MHCP), and other mechanisms. An increase in the fire return interval (that is, fire frequency), coupled with nonnative grass invasions, have reduced the density of shrubs in some chaparral stands and threatens type conversion to nonnative grasslands. Based on the 2020 vegetation map (County of San Diego 2021; AECOM 2014), a total of 231,697 of the 411,300 acres (56 percent) of conserved chaparral burned at least once in the last 30 years and 51,781 acres (12.5 percent) burned two or more times (calculated using: County of San Diego 2021; CalFire 2019; SDMMP 2020). This is a large increase in the percent of conserved chaparral affected by fire since 1995, when only 139,448 (40 percent) of 350,604 acres (conserved in 1995) was recovering from fires during the previous 30 years.

Overall, the Chaparral Vegetation Community Indicator was given a condition of Caution in the MSPA because, while conservation of chaparral is meeting targets (Metric 1), ecological integrity (Metric 2) and fire frequency (Metric 3) have not reached target conditions (table CHAP0.1). High levels of repeat fire and other threats have degraded the shrub cover and increased nonnative grasses. These threats are also likely to continue without additional management. As more information becomes available, additional metrics on the composition of native and nonnative plants and the acreage restored or enhanced will be added.

**Table CHAP0.1**. Current overall condition status for the Chaparral Vegetation Community Indicator and baseline to current years comparison, metric conditions, trends, and confidence levels.

| Indicator/metric (baseline – current years) | Condition | Trend | Confidence |
|---|---|---|---|
| Chaparral overall condition status | Caution | Unknown | Moderate |
| Metric 1: percent conserved (1995-2020) | Good | Improving | Moderate |
| Metric 2: ecological Integrity (2014) | Concern | Unknown | Moderate |
| Metric 3: fire frequency (1965-2019) | Caution | Declining | Moderate |

## Metric 1: Percent Conserved

**Overview:** As recognized by the MSCP and MHCP, conservation is an essential first step to maintaining healthy chaparral habitat. The MSCP Plan targeted conservation of 49 percent of all chaparral communities mapped in 1995 (City of San Diego 1998), and the MHCP Plan aims for 70 percent conservation (AMEC and others 2003). Two other conservation plan areas (North and East County) in San Diego County do not have completed plans, so conservation targets are unknown. Thresholds in this report for the regional preserve system may change in future versions to reflect new targets once the North and East County plans are complete. These thresholds are not intended to supersede conservation plan targets.

The table below (table CHAP1.1) breaks down the conservation targets and their current statuses by plan area (MSCP and MHCP), other non-plan areas (Other), and the total conserved in the regional preserve system within the MSPA (Total). Acres across the table for MSCP, MHCP, and Other make up the Total. These acreages differ from the "Preserve Assembly" section of the report because of differences in the categorization. The values in this metric should not be used to track the compliance of the MSCP or MHCP. Instead, they are provided here to give detail on the location breakdown of conservation and reasoning for the metric thresholds.

While conservation is important, it does not guarantee that the land continues to function as chaparral habitat into the future due to type conversion and other threats. The functioning of conserved chaparral is not captured in this metric. Metric 1 simply measures the first step required for management, which is legal protection from development. Metrics 2 and 3 address the quality of the habitat after conservation, assessing ecological integrity and identifying a key threat (fire frequency). Metric 1 only uses 1995 baseline mapping as vegetation categorization differs between the 1995 and 2020 vegetation maps. This metric does not include a measure of chaparral lost to development or type conversion to another vegetation type as a direct comparison cannot be made between the 1995 and 2020 maps.

**Metric Evaluation Period:** 1995-2020 (Baseline: 1995; Current: 2020)

**Baseline**: In 1995, a comprehensive vegetation map was created for San Diego County that identified 705,181 acres of chaparral mapped in the MSPA (City of San Diego and others 1995; CalFire 2015). At that time, 350,604 acres (50 percent) was conserved (SDMMP 2020).

**2027 Progress Toward Desired Condition:** There is no short-term project milestone in progress towards the desired condition, as this is dependent on each plan's requirements and timeline.

**Table CHAP1.1**. Chaparral conservation acreages and percentages by plan area within the MSPA from 1995 baseline vegetation mapping.

| Conservation level | MSCP | MHCP | Other[1] | Total |
|---|---|---|---|---|
| Conservation target | 52,473 acres (49 percent) | 7,287 acres (70 percent) | NA | NA |
| Baseline conserved 1995 | 26,965 acres | 2,443 acres | 321,196 acres | 350,604 acres |
| Current conserved 2020 | 61,737 acres | 5,559 acres | 345,034 acres | 412,330 acres |
| Total chaparral in plan area | 107,088 acres | 10,410 acres | 587,683 acres | 705,181 acres |
| Percent of chaparral conserved | 58 percent | 53 percent | 59 percent | 58 percent |
| Difference | 9 percent > goal | 17 percent < goal | NA | NA |

[1] Other refers to areas within the MSPA but not within an approved plan. This includes lands that will be included into the North County Plan and East County Plan. Targets are not yet set for these areas.

### Condition Thresholds:

Condition thresholds are based on known targets in the local conservation plans. While approved plans differ in targets and some plans are not yet approved, a Good condition would indicate meeting the baseline goal for the regional preserve system. These values will be refined as plans are adopted.

- **Good**: ≥50 percent of chaparral conserved in the MSPA using 1995 baseline acreage.
- **Caution**: 30-49 percent of chaparral conserved in the MSPA using 1995 baseline acreage.
- **Concern**: 15-29 percent of chaparral conserved in the MSPA using 1995 baseline acreage.
- **Significant Concern**: <15 percent of chaparral conserved in the MSPA using 1995 baseline acreage.

### Current Condition: Good

Currently, there are 412,330 acres (58 percent) of baseline chaparral conserved in the regional preserve system in San Diego County (fig. CHAP1.1).

### Trend (1995-2020): Improving

In 1995, there was a total of 705,181 acres of chaparral, with 350,604 acres (50 percent) conserved in the MSPA. Using the baseline 1995 vegetation map, 61,726 acres of chaparral have been added to the regional preserve system (fig. CHAP1.2) for a total of 412,330 acres conserved (58 percent of baseline chaparral).

### Confidence: Moderate

Vegetation mapping was done using several different methods and periods of time and is not consistent across the County.

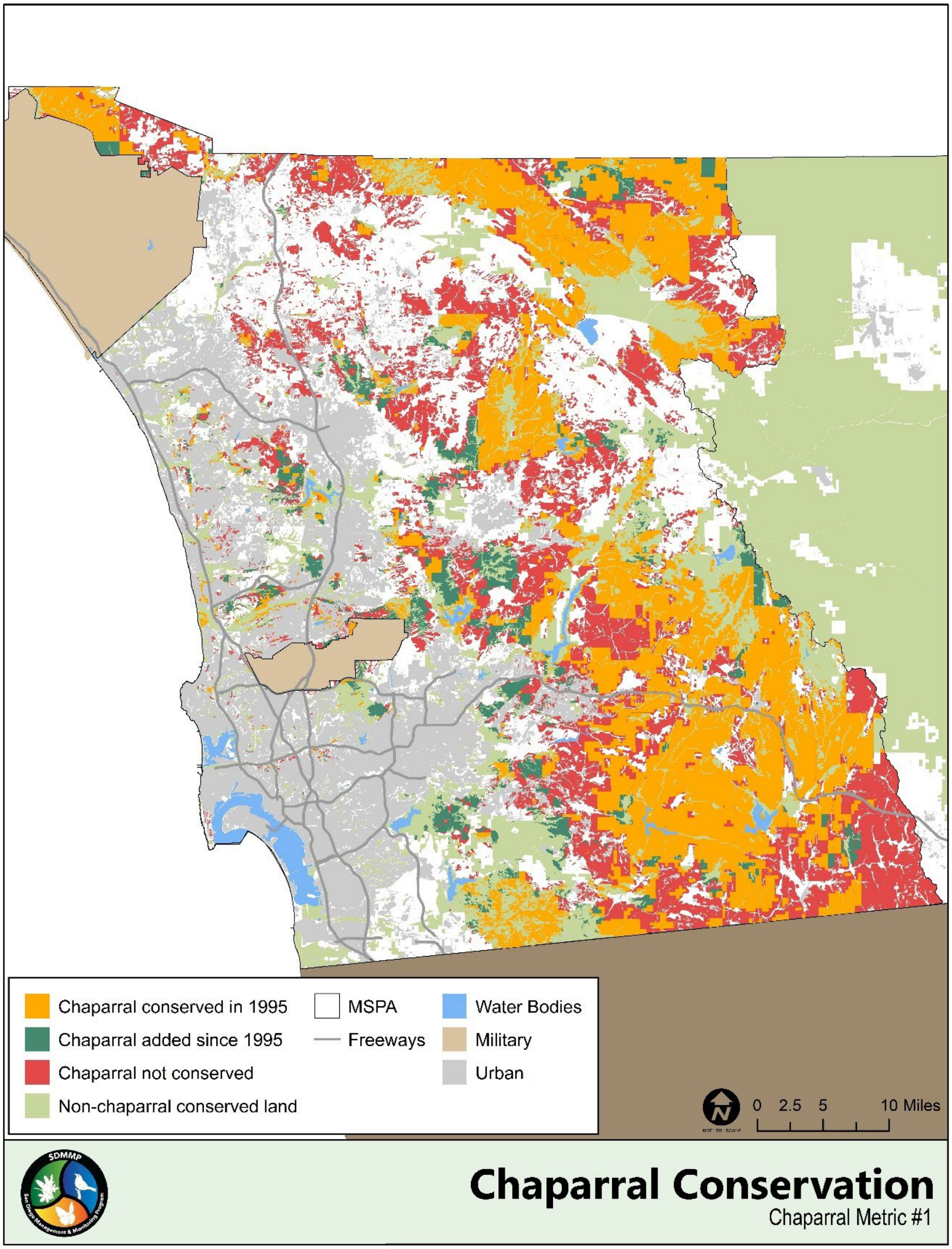


**Figure CHAP1.1.** Chaparral conserved in the MSPA in 1995, conserved since 1995, and not conserved (City of San Diego and others 1995; CalFire 2015; SDMMP 2020).
This map of the MSPA depicts areas mapped as chaparral conserved in 1995 (orange), conserved between 1995 and 2020 (green), and not conserved (red).

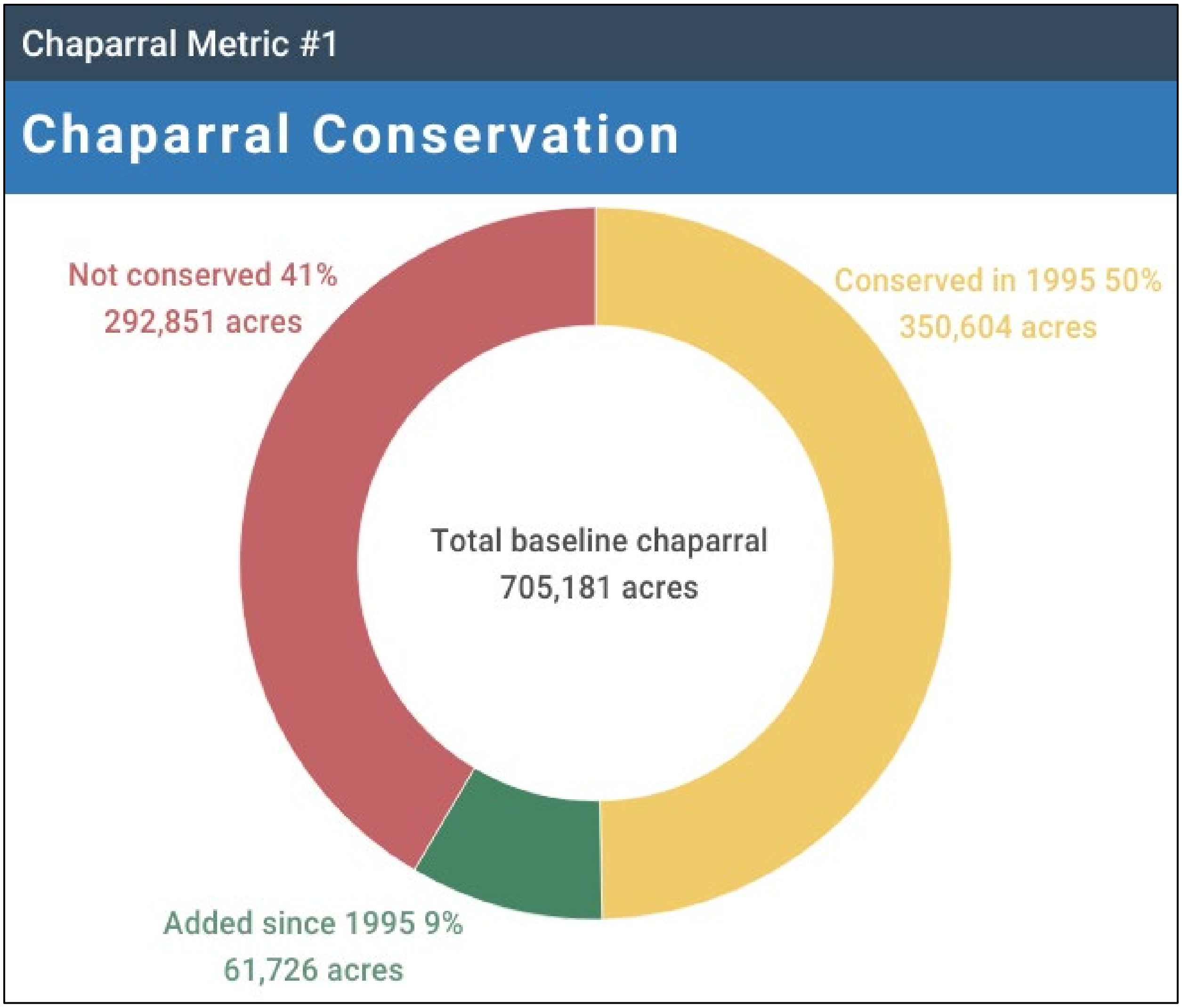


**Figure CHAP1.2.** Percent of chaparral conserved by time period in the MSPA.
This pie graph shows the total acreage of chaparral mapped in 1995 (705,181 acres) with the percent conserved at that time (yellow), the percent added between 1995 and 2020 (green), and the percent not conserved (red).

## Metric 2: Ecological Integrity

**Overview**: For this metric, ecological integrity is defined as the extent to which a habitat's structure, composition, and function operate within the bounds of historical variation (Lawson and Keeley 2019). Percent cover of functional groups reflects fire and annual nonnative grass disturbance and is easily understood and measured by managers and scientists (Diffendorfer and others 2004; Diffendorfer and others 2007; Lawson and Keeley 2019).

Invasive, nonnative grasses frequently follow fire and expand in an area as fire frequency increases (Keeley and Brennan 2012). Nonnative grass cover is an indicator of vegetation type conversion from shrubland to nonnative grassland (Diffendorfer and others 2004; Diffendorfer and others 2007; Lawson and Keeley 2019). Shrub cover is negatively correlated with invasive, nonnative grass cover and can be used to measure shrub loss or gain (Westman and O'Leary 1986). Here, shrub cover within chaparral is used as an indicator of ecological integrity.

Cutoff values for high, moderate, and low integrity are based on analyses by Lawson and Keeley (2019). High integrity sites have at least 80 percent shrub cover. Moderate integrity sites have between 30 and 80 percent, and low integrity sites have less than 30 percent shrub cover. These cutoffs are a working framework developed to monitor shrublands in southern California and are based on literature review and expert opinion. Values and cutoffs may change with additional analyses of species biodiversity data. Details of the process can be found in Lawson and Keeley 2019 (supplemental table S2).

For chaparral habitat, ecological integrity is measured as the percent of shrub cover. We used two remote sensing products: light detection and ranging data (lidar) (OCM Partners 2015; 2016) and the Normalized Difference Vegetation Index (NDVI) (United States Department of Agriculture 2015; Perkins 2022). Lidar data were used to determine the vegetation height above the natural surface within open space areas (limited to the MSPA) with 1-meter (m) resolution. Areas with a height between 0.5m and 3m were classified as a potential shrub. Percent shrub cover was calculated on a 30-m grid. These data were used to determine percent shrub cover. Areas considered to have high ecological integrity had at least 80 percent shrub cover.

NDVI was used to distinguish between healthy and live shrubs (>0.1 NDVI), moisture stressed shrubs (0-0.1 NDVI), and dead shrubs (≤0 NDVI). Moisture stressed shrubs were considered relevant to ecological integrity because the analysis was done in 2014 during an extreme drought. Visual analysis of imagery from later years confirmed that moisture stressed shrubs were greener in wetter years and therefore were not dead in the 2014 image. These shrubs might be particularly susceptible to extended droughts in the future so, while this metric only measures the total percent shrub cover, a map of the stressed shrubs is also provided. NDVI data are presented here for additional context; they were not used to determine percent shrub cover.

**Metric Evaluation Period:** 2014 (Baseline: 2014; Current: 2014)

**Baseline**: In 2014, 25 percent of chaparral on Conserved Lands in the MSPA fell into the high integrity category (at least 80 percent shrub cover), 58 percent in moderate (between 30 and 80 percent shrub cover), and 16 percent in the low (less than 30 percent shrub cover). Many areas with low shrub cover were burned between 2005 and 2014 (fig. CHAP2.1). Moisture stress values were derived from May 2014 National Agriculture Inventory Program (NAIP) imagery using the NDVI. This information is not explicitly tracked in this metric, but these are places where shrub die-off could be prevalent in future years' analyses (fig. CHAP2.2).

**2027 Progress Toward Desired Condition**: There is no short-term project milestone in progress towards the desired condition.

### Condition Thresholds:

Condition thresholds were determined based on estimates for meaningful targets of ecological integrity. These will be further refined with additional analysis.

- **Good**: ≥50 percent of chaparral on Conserved Lands in the MSPA is ranked in the high ecological integrity class (at least 80 percent shrub cover).
- **Caution**: 35-49 percent of chaparral on Conserved Lands in the MSPA is ranked in the high ecological integrity class.
- **Concern**: 25-34 percent of chaparral on Conserved Lands in the MSPA is ranked in high ecological integrity class.
- **Significant Concern**: <25 percent of chaparral on Conserved Lands in the MSPA is ranked in high ecological integrity class.

### Current Condition: Concern

In 2014, 25 percent of chaparral on Conserved Lands in the MSPA fell into the high integrity category, 58 percent in moderate integrity, and 16 percent in the low integrity.

### Trend (2014): Unknown

The trend of this metric is currently Unknown because data are not available for another time period. Future reports will identify a trend by repeating these analyses with additional years of data.

### Confidence: Moderate

Mapping of shrub cover was based on lidar-derived height values and NDVI distinguished live shrubs from dead and moisture stressed shrubs. This does not account for species composition.

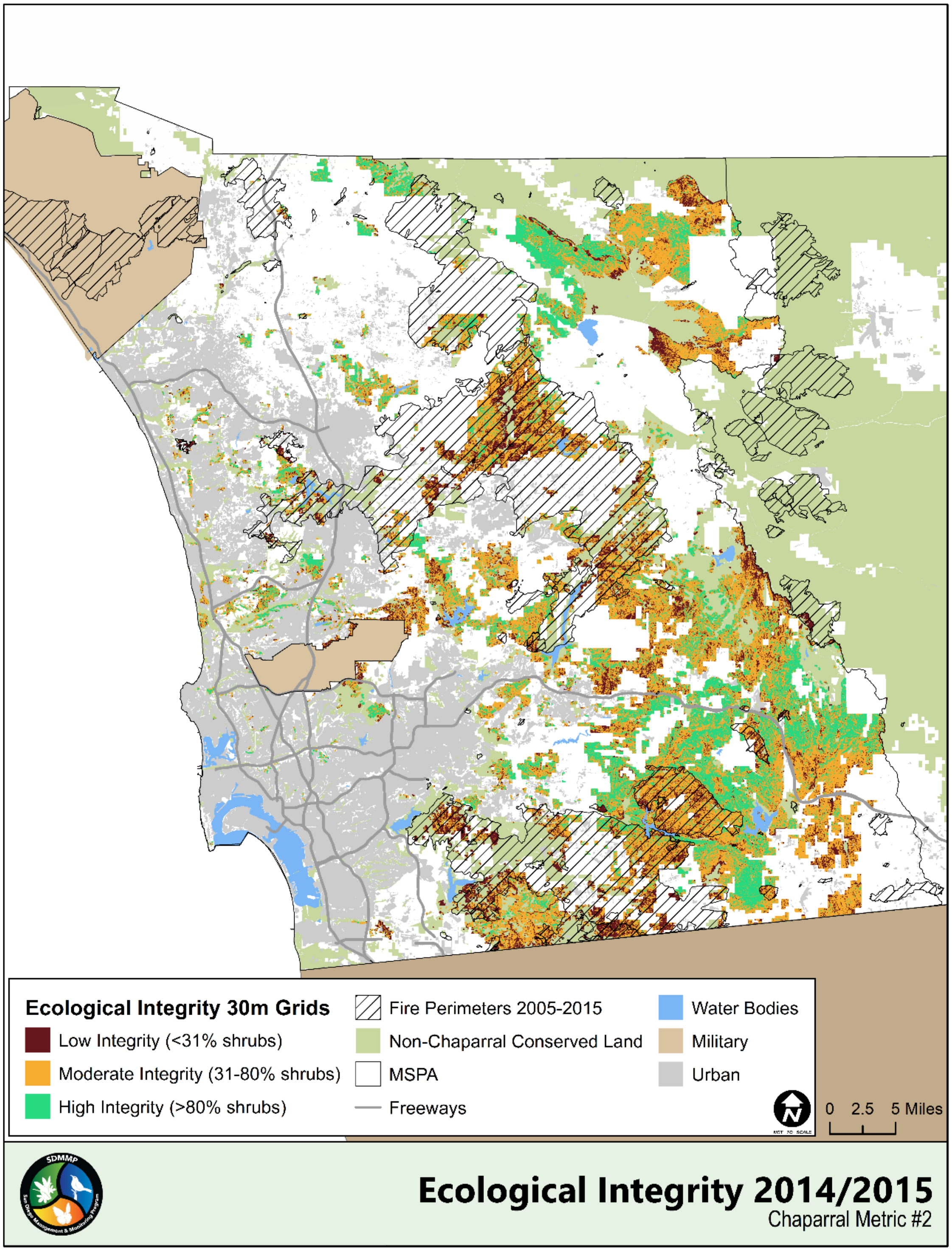


**Figure CHAP2.1.** Ecological integrity of chaparral on Conserved Lands in the MSPA.
Ecological integrity was calculated as percent shrub cover within 30-m grid cells. High integrity is defined as more than 80 percent shrub cover (green). Moderate integrity is 31-80 percent (orange) and low integrity is less than 31 percent (red). Grid areas were restricted to chaparral mapped in 2020 (County of San Diego 2021).

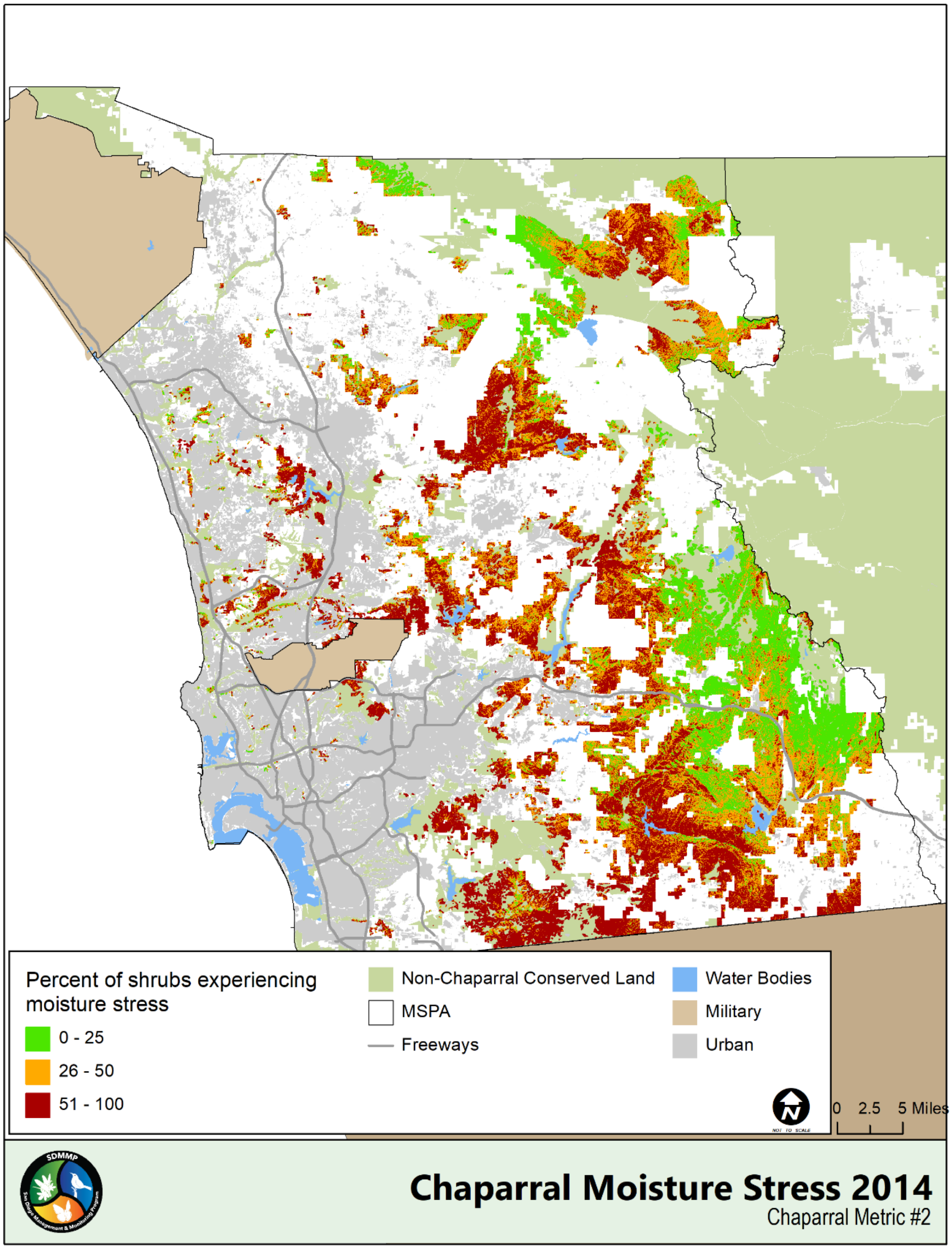


**Figure CHAP2.2.** Percent of chaparral shrubs moisture stressed in 2014 due to drought or other stressors.

Shrubs with low NDVI values (red) had a high level of moisture stress during the 2014 drought. This map shows the percent of shrubs in the MSPA with moisture stress at a 30-m grid in areas mapped as chaparral in 2020 (County of San Diego 2021).

## Metric 3: Fire Frequency

**Overview**: Chaparral vegetation communities are adapted to fire when the fire return interval is 30 years or greater (Keeley and Syphard 2018). When the fire return interval is short, nonsprouting shrubs are eliminated, and sprouting shrub species may gain an advantage over long periods of time (Keeley and Zedler 1978). Northern mixed chaparral and chamise chaparral can withstand repeated fires as many species respond by stump sprouting. A dense cover of annual herbs is common in the first growing season after a fire, followed in later years by perennial herbs, short-lived shrubs, and reestablishment of original dominant shrub species. Scrub oak chaparral can recover faster due to more mesic (moist) soils (Oberbauer and others 2008). Fire appears necessary in southern maritime chaparral for continued reproduction of many characteristic species. The coastal sage-chaparral transition is usually a post-fire successional community.

An altered fire regime, with a shortened fire return interval of less than 30 years (for example, 5-10 years) (Keeley and others 2011) can threaten chaparral through vegetation type conversion to nonnative annual grassland (Keeley and Brennan 2012). Extremely large, human-caused Santa Ana wind-driven wildfires occurred in the MSPA in late October 2003 and 2007. In 2003, four fires burned simultaneously for a combined total of 369,619 acres and, again in 2007, eight fires burned concurrently over 314,508 acres. Across the MSPA, 95,076 acres (26 percent) of land burned in 2003 also burned in 2007. Compared with historical fire frequency, much of the County has burned more frequently since 2000, especially inland valleys and foothills. Areas burned less frequently than the historical record include higher mountain slopes at the east edge of the MSPA.

**Metric Evaluation Period:** 1965-2019 (Baseline: 1965-1995; Current: 1989-2019)

**Baseline**: The baseline for burn history of chaparral in the MSPA was taken from 1965-1995, using the 1995 vegetation map. A 30-year period was determined to be a useful measure of fire history for chaparral because areas that have burned two or more times in 30 years could be more susceptible to type conversion (Keeley and others 2011; Keeley and Brennan 2012). This metric is dependent on vegetation mapping data, so 30-year periods prior to the 1995 vegetation map are compared with current times (2020; County of San Diego 2021). See the Fire Indicator section in the Ecosystem and Landscape-scale Threats section for more explanation of this baseline period. An analysis of total acres burned (not limited to chaparral) in 30-year periods from 1909 to 2019 indicated that total acres burned at least once from 1965-1995 (359,579 acres) is within the historical range (historical average is 331,569 acres). Therefore, the 1965-1995 time period can be considered representative of the longer-term (1909-1969) fire history. From 1965-1995, just over 2.5 percent (8,852 acres) of mapped conserved chaparral burned two or more times.

**2027 Progress Towards Desired Condition**: There is no short-term project milestone in progress towards the desired condition, as this is dependent on each plan's requirements and timeline.

### Condition Thresholds:

Condition thresholds were based on the percentage of conserved chaparral that burned two or more times in the regional preserve system at baseline fire frequencies. The baseline time period was 1965-1995. A Good condition indicates that most chaparral burned in the last 30 years (1989-2019) at baseline (1965-1995) frequencies of 2.5 percent conserved chaparral.

- **Good**: ≤2.5 percent of chaparral on Conserved Lands in the MSPA burned ≥2 times in the last 30 years.
- **Caution**: 2.6-15 percent of chaparral on Conserved Lands in the MSPA burned ≥2 times in the last 30 years.
- **Concern**: 16-25 percent of chaparral on Conserved Lands in the MSPA burned ≥2 times in the last 30 years.
- **Significant Concern**: >25 percent of chaparral on Conserved Lands in the MSPA burned ≥2 in the last 30 years.

### Current Condition: Caution

From 1989-2019, 12.5 percent (42,577 acres) of most recently mapped conserved chaparral burned two or more times (fig. CHAP3.1; County of San Diego 2021; SDMMP 2020).

### Trend (1965-2019): Declining

In the baseline period (1965-1995), 2.5 percent (8,852 acres) of chaparral on Conserved Lands in the MSPA had burned two or more times, whereas from 1989-2019 this increased to 12.5 percent (51,781 acres) (fig. CHAP3.2). This increase in fire frequency represents a decline in condition compared to the historic fire regime and can adversely affect chaparral vegetation.

### Confidence: Moderate

Vegetation mapping of chaparral is outdated in some portions of the County. While the latest mapping took place in 2020 (County of San Diego 2021), it did not include all areas in the County. As a result, data from previous years (including the 1990s) was used to fill in gaps. The values for vegetation acreages may be inaccurate in some areas of the County, and this would affect the accuracy of the percentages calculated.

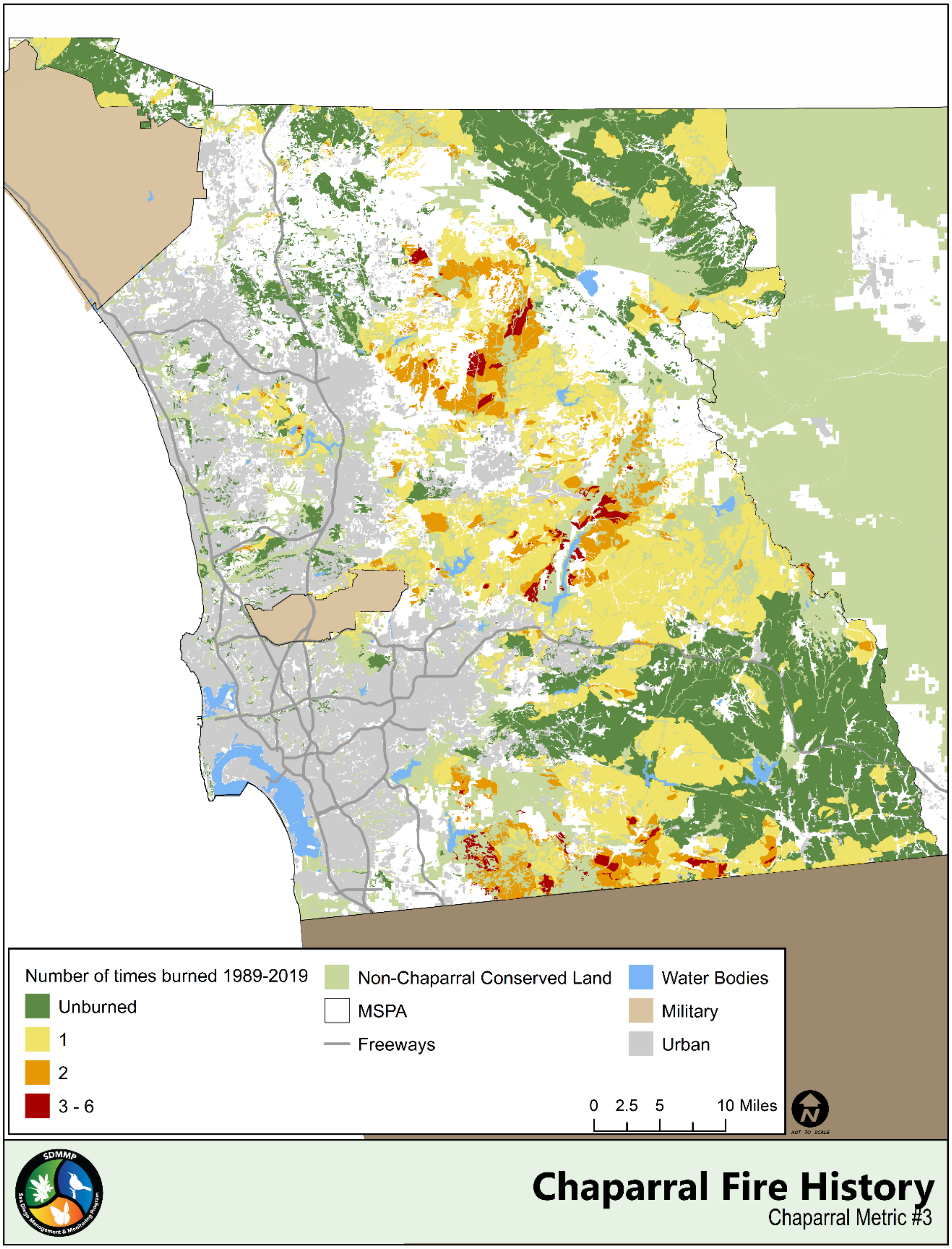


**Figure CHAP3.1.** Chaparral fire frequency (1989-2019) on Conserved Lands in the MSPA.
This map shows the number of times chaparral burned in the current cycle (1989 to 2019), with areas that burned three or more times shown in red, two times in orange, one time in yellow, and unburned in green (County of San Diego 2021; CalFire 2019).

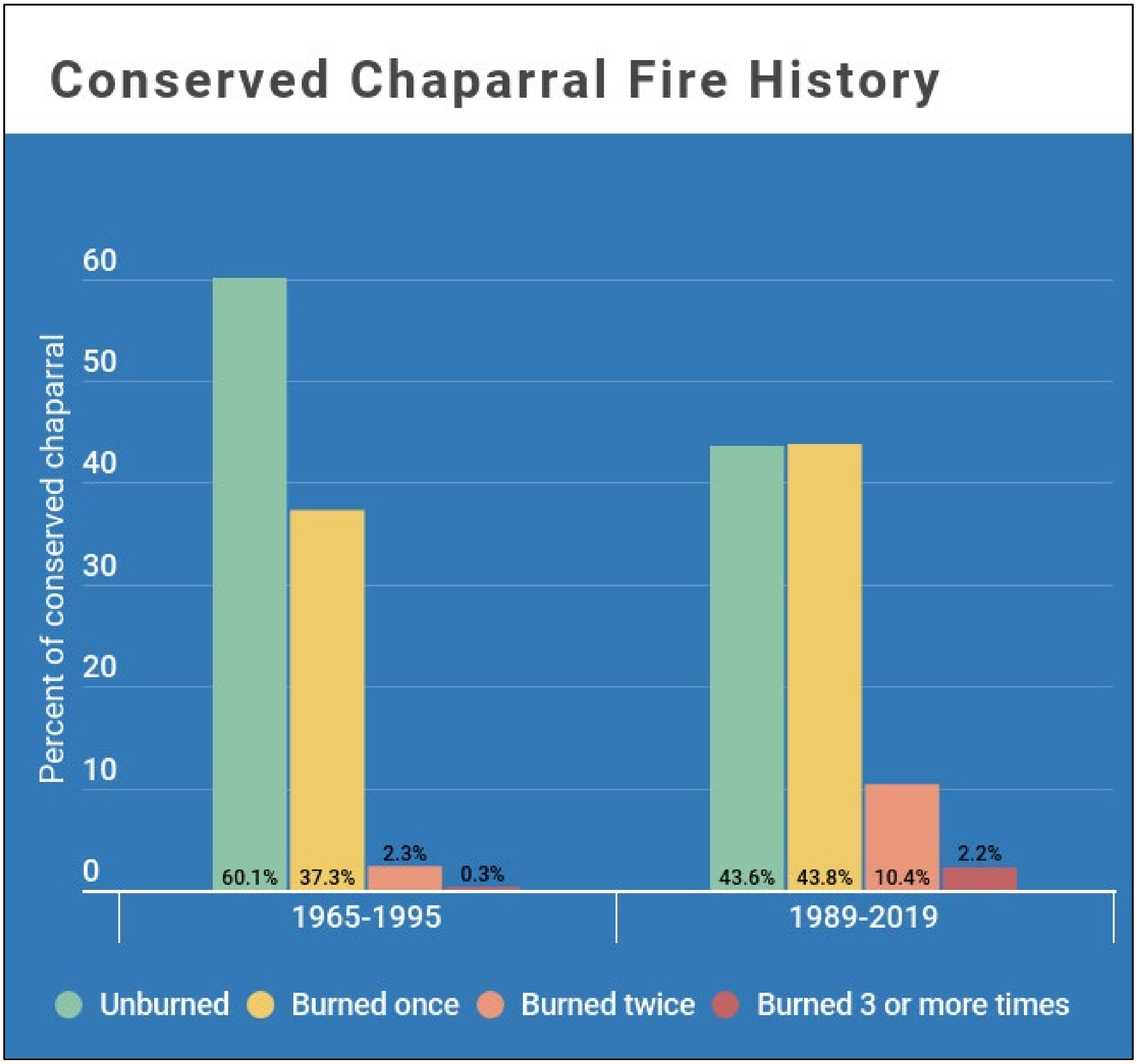


**Figure CHAP3.2.** Chaparral fire frequency trends over time on Conserved Lands in the MSPA.
This graph shows change in the number of times conserved chaparral burned in the MSPA between baseline (1965-1995) and current (1989-2019) time periods. Chaparral mapped in 1995 was used to calculate the percentages unburned and those burned one, two, or three or more times in baseline period. A current vegetation map (County of San Diego 2021) was used to calculate number of times burned in the current time period.

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## Coastal Sage Scrub - Vegetation Community Indicator (Shrub-dominated Habitat)

Photo: Sarah McCutcheon, USGS

### Why Is This Indicator Included?

CSS is the second most extensive vegetation community in San Diego County with a baseline of 189,303 acres mapped in 1995 (CalFire 2015; County of San Diego 2021). CSS habitat supports a large variety of species, including 39 MSP Species (14 animals and 25 plants) that inhabit only CSS or use CSS as well as other vegetation types (SDMMP and TNC 2017). A couple of obligate CSS species are coastal cactus wren (*Campylorhynchus brunneicapillus sandiegensis*) and coastal California gnatcatcher (*Polioptila californica californica*). The health of CSS is an essential element to the health of the overall system.

CSS and the coastal California gnatcatcher are major foci of the MSCP and MHCP. CSS is considered a fragile and rapidly declining habitat, and habitat loss and fragmentation are among the largest threats to this community (Westman 1981b; Minnich and Dezzani 1998). Connectivity between remaining patches is crucial to regional biodiversity. Interconnected preserve areas can support California gnatcatchers and coastal cactus wrens and allow a full spectrum of native species to move between natural areas.

CSS was selected as an indicator because it provides important habitat for many species, including species of high conservation priority, and the health of CSS is a critical element to the health of the regional preserve system.

### Stressors

Conserved CSS faces significant, large-scale threats to habitat quality and persistence. Fire, drought, and nitrogen deposition acting alone and in concert are threatening large-scale type conversion of CSS to annual nonnative grassland in the MSPA. Conservation of CSS could benefit from management actions that help maintain or improve vegetation composition, structure, and integrity to promote higher regional biodiversity and persistence of species within an area.

- **Climate Vulnerability**: CSS shrubs are adapted to semi-arid conditions, although there can be considerable shrub mortality during intensive and prolonged droughts (Minnich and Dezzani 1998; Keeley and others 2009; Kimball and others 2014).
- **Urbanization**: Loss, fragmentation, and degradation due to urban and agricultural development is a threat to CSS (Westman 1981a; Minnich and Dezzani 1998). Brush management in the WUI and along roadsides has also reduced and degraded CSS (Green 1977).
- **Fire and Invasive Nonnative Grasses**: Repeated fires can degrade CSS vegetation through a loss of native shrubs and increasing cover of nonnative grasses (D'Antonio and Vitousek 1992; Minnich and Dezzani 1998). An altered fire regime, with a shortened fire return interval of less than 10–15 years (Keeley and others 2011) can result in vegetation type conversion from CSS to nonnative annual grassland (Keeley and Brennan 2012). The 2003 Cedar Fire (270,686 total acres burned) (CalFire 2019) and 2007 Witch Creek and Harris Fires (162,071 and 90,728 total acres burned, respectively) (CalFire 2019) degraded CSS vegetation through shrub mortality and an invasion of nonnative grasses.

CSS is composed of drought-deciduous, soft-leaved subshrubs typically ≤1 m tall (Kirkpatrick and Hutchinson 1977; Westman 1981a). The shrubs are adapted to long, hot, dry summers, and unpredictable winter rainfall in the Mediterranean climate region of southern California. CSS occurs from sea level to 1,000 m in elevation along the California coast (Kirkpatrick and Hutchison 1977; Sproul and others 2011). CSS often grows on southwest-facing slopes with sandy loam soils (Sawyer and others 2009; Sproul and others 2011).

Fire is a natural process in CSS ecosystems. Many shrub and understory plants depend on fire for seed germination (Keeley 1986).

### Desired Condition

MSP Roadmap Goal (SDMMP and TNC 2017):

*Maintain, enhance, and restore CSS on Conserved Lands in the MSPA that supports or has the potential to support MSP species and to incidentally benefit a diverse array of other species so that the vegetation community has high ecological integrity, and these species are resilient to environmental stochasticity, catastrophic disturbances and threats, such as very large wildfires, invasive plants, and prolonged drought, and will be likely to persist over the long term (>100 years).*

### Current Condition Status

Nearly 47 percent (88,172 of 189,303 acres) of CSS identified on the 1995 baseline vegetation map has been conserved in the MSPA. The MSCP and MHCP plans have conservation goals of 62 percent of baseline acreage in the MHPA and FPA respectively (City of San Diego 1998; AMEC and others 2003). While the acreage of conserved CSS has grown over the last 25 years, so too have the threats. Nonnative annual grasses have invaded many areas, reducing the amount of open ground and shrub cover and increasing competition for resources like water and sunlight (D'Antonio and Vitousek 1992; Minnich and Dezzani 1998; Keeley and Brennan 2012). In some cases, these nonnative grasses grow over shrubs. This invasion has reduced the ability of native grasses, forbs, and shrub seedlings to germinate and grow in openings and can lead to vegetation type conversion from CSS to nonnative grassland (Keeley and Brennan 2012). This conversion to nonnative grasses is an indicator of poor health and functioning of the shrubland habitat (Diffendorfer and others 2007; Lawson and Keeley 2019). Type conversion is facilitated by nitrogen deposition and high fire frequency (Talluto and Suding 2008; Cox and others 2014).

The overall condition status for the CSS Vegetation Community Indicator in the regional preserve system is Concern (table CSS0.1). Conservation targets (Metric 1: percent conserved) have not been reached, and areas that are conserved are often of lower ecological integrity (Metric 2) with a significant reduction in shrub cover and increase in nonnative grasses, and a large increase in repeat fire events (Metric 3: fire frequency). Urbanization has fragmented this habitat, leaving little opportunity for linkages as well as threatening species of conservation concern and the overall biodiversity of CSS species. As more information becomes available, additional metrics on the composition of native and nonnative plants and the acreage restored or enhanced will be added.

**Table CSS0.1**. Current overall condition status for the CSS Vegetation Community Indicator and period of baseline to current years comparison, metric conditions, trends, and confidence levels.

| Indicator/metric (baseline – current year) | Condition | Trend | Confidence |
|---|---|---|---|
| CSS overall condition status | Concern | Unknown | Moderate |
| Metric 1: percent conserved (1995-2020) | Caution | Improving | Moderate |
| Metric 2: ecological integrity (2014) | Significant Concern | Unknown | Moderate |
| Metric 3: fire frequency (1965-2019) | Significant Concern | Declining | Moderate |

## Metric 1: Percent Conserved

**Overview:** Regional plans identified conservation as an essential first step to maintaining healthy CSS habitat. The MSCP Plan targeted 62 percent of the 1995 mapped CSS and maritime succulent scrub in the MHPA for conservation (City of San Diego, 1998), and the MHCP Plan has a conservation goal of 62 percent in the FPA (AMEC and others 2003). The two other conservation plan areas (North and East County) in San Diego County have uncompleted plans, so conservation targets are unknown. Thresholds in this report for the regional preserve system may change in future versions to reflect new targets once the North and East County plans are complete. These thresholds are not intended to supersede conservation plan targets.

The table below (table CSS1.1) breaks down the conservation targets and their current statuses by plan area (MSCP and MHCP), other non-plan areas (Other), and the total conserved in the regional preserve system within the MSPA (Total). Acres across the table for MSCP, MHCP, and Other make up the Total. These acreages differ from the “Preserve Assembly” section of the report because of differences in the categorization. The values in this metric should not be used to track the compliance of the MSCP or MHCP. Instead, they are provided here to give detail on the location breakdown of conservation and reasoning for the metric thresholds.

While conservation is important, it does not guarantee that the land continues to function as CSS habitat into the future due to type conversion and other threats. The functioning of conserved CSS is not captured in this metric. This metric simply measures the first step required for management, which is legal protection from development. Metrics 2 and 3 address the quality of the habitat after conservation, assessing ecological integrity and the key threat of fire. Metric 1 only uses 1995 baseline mapping and does not compare the 1995 vegetation map to the 2020 map. Vegetation categorization differs between the 1995 and 2020 map, so a direct comparison between the two is not meaningful to understand how much CSS has been converted to urban or another vegetation type.

**Metric Evaluation Period:** 1995-2020 (Baseline: 1995; Current: 2020)

**Baseline:** In 1995, a comprehensive vegetation map was created for San Diego County that identified 189,303 acres of CSS (City of San Diego and others 1995; CalFire 2015). At that time, 41,416 (22 percent) of the CSS habitat was conserved in the MSPA (SDMMP 2020).

**2027 Progress Towards Desired Condition**: There is no short-term project milestone in progress towards the desired condition, as this is dependent on each plan’s requirements and timeline.

**Table CSS1.1.** Coastal sage scrub conservation acreages and percentages by plan area within the MSPA.

| Conservation level | MSCP | MHCP | Other[1] | Total |
|---|---|---|---|---|
| Conservation target | 70,702 acres (62 percent) | 6,193 acres (62 percent) | NA | NA |
| Baseline conserved (1995) | 22,341 acres | 1,865 acres | 17,210 acres | 41,416 acres |
| Current conserved (2020) | 62,070 acres | 3,830 acres | 22,272 acres | 88,172 acres |
| Total CSS in plan area | 114,035 acres | 9,989 acres | 65,279 acres | 189,303 acres |
| Percent of CSS conserved | 54 percent | 38 percent | 34 percent | 47 percent |
| Difference | 8 percent < goal | 24 percent < goal | NA | NA |

[1] Other refers to areas within the MSPA but not within an approved plan. This includes lands that will be included in the North County Plan and East County Plan. Targets are not yet set for these areas.

### Condition Thresholds:

While the North and East County MSCPs are being developed, general conservation thresholds were set based on the previously adopted MSCP and MHCP plans. These thresholds are likely to change once the new plans are adopted and are not intended to supersede plan conservation targets.

- **Good**: ≥50 percent of CSS conserved in the MSPA using 1995 baseline acreages.
- **Caution**: 30-49 percent of CSS conserved in the MSPA using 1995 baseline acreages.
- **Concern**: 15-29 percent of CSS conserved in the MSPA using 1995 baseline acreages.
- **Significant Concern**: <15 percent of CSS conserved in the MSPA using 1995 baseline acreage.

### Condition: Caution

Currently, there are 88,172 acres (47 percent) of CSS conserved in the regional preserve system in the MSPA (fig. CSS1.1).

### Trend (1995-2020): Improving

In 1995, there was a total of 189,303 acres of CSS, with 41,416 acres (22 percent) conserved in the MSPA. Using the baseline vegetation map, 46,756 acres of CSS have been added to the regional preserve system for a total of 88,172 acres conserved (47 percent of baseline CSS).

### Confidence: Moderate

Vegetation mapping was done using several different methods and at different times; it is not consistent across the County.

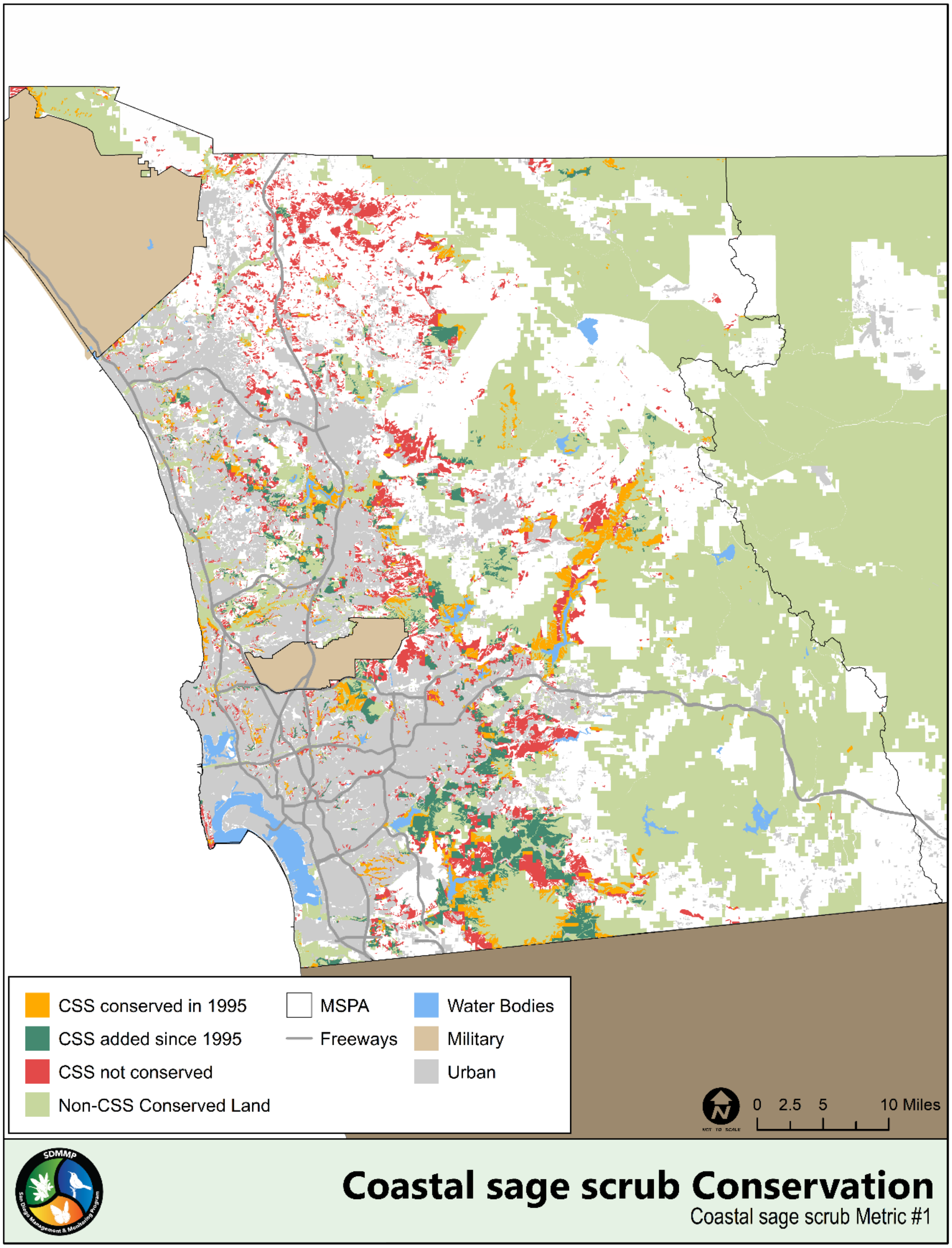


**Figure CSS1.1.** CSS conserved in the MSPA since 1995.
This map of the MSPA depicts areas of CSS conserved in 1995 (orange), conserved between 1995 and 2020 (green), and not conserved (red).

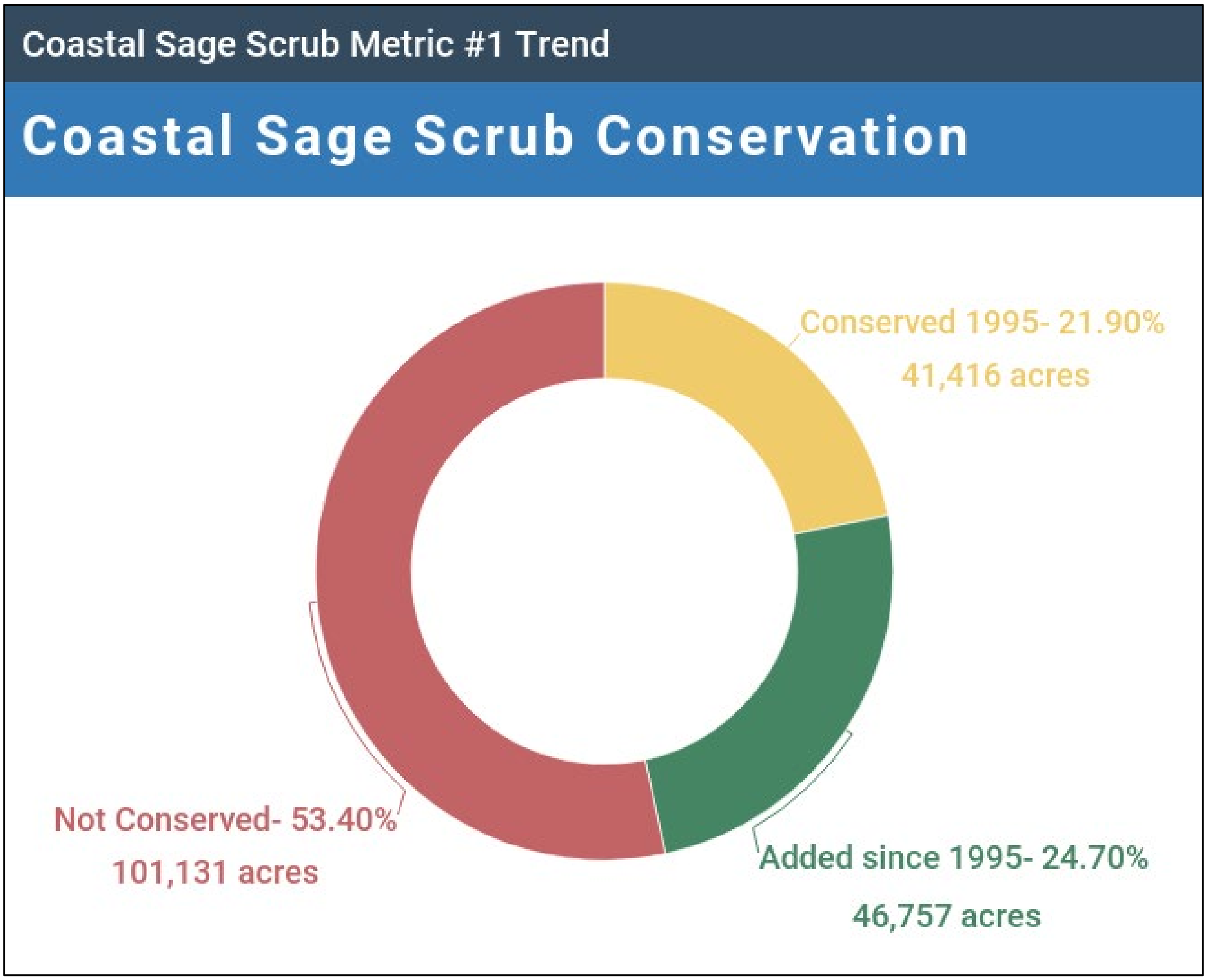


**Figure CSS1.2.** Percent of CSS conserved by time period in the MSPA.
This pie graph shows total acreage of CSS mapped in 1995 (189,303 acres) with the percent conserved at that time (yellow), the percent added between 1995 and 2020 (green), and the percent not conserved (red).

## Metric 2: Ecological Integrity

**Overview**: For this metric, ecological integrity is defined as the degree to which a habitat's structure, composition, and function operate within the bounds of historical variation (Lawson and Keeley 2019). Percent cover of functional groups reflects fire and annual nonnative grass disturbance, and it is easily understood and measured by managers and scientists (Diffendorfer and others 2004, 2007; Lawson and Keeley 2019).

Nonnative grass cover is one indicator of vegetation type conversion from CSS to nonnative grassland that can occur after frequent fire and other disturbances (Diffendorfer and others 2004, 2007; Lawson and Keeley 2019). Invasive, nonnative grasses frequently follow fire and expand in areas as repeat fires burn more frequently. Shrub cover is negatively correlated with nonnative grass cover and can also be used to measure shrub loss or gain (Westman and O'Leary 1986). Here, shrub cover within CSS is used as an indicator of ecological integrity in the regional preserve system. CSS areas were determined by using vegetation mapping from 2020 (County of San Diego 2021). This map was based on the vegetation categorization from the Vegetation Classification Manual for Western San Diego County (Sproul and others 2011).

Cutoff values for high, moderate, and low integrity continue to be refined. For the purposes of this report, high integrity sites have at least 65 percent CSS shrub cover (Lawson and Keeley 2019), moderate integrity sites have between 30 and 64 percent shrub cover, and low integrity sites have less than 30 percent. These cutoffs are a working framework developed to monitor shrublands in southern California and are based on a literature review and expert opinion. Values and cutoffs may change with additional analysis of species biodiversity data. Details of the process can be found in Lawson and Keeley (2019; supplemental table S1).

For CSS habitat, ecological integrity is measured as the percent of shrub cover. We used two remote sensing products: light detection and ranging data (lidar) (OCM Partners 2015; 2016) and the Normalized Difference Vegetation Index (NDVI; United States Department of Agriculture 2015; Perkins 2022). Lidar data were used to determine the vegetation height above the natural surface within open space areas (limited to the MSPA) with 1-m resolution. Areas with a height between 0.5m and 3m were classified as a potential shrub. Percent shrub cover was calculated on a 30-m grid. These data were used to determine percent shrub cover. Areas considered to have high ecological integrity had at least 65 percent shrub cover.

NDVI was used to distinguish between healthy and live shrubs (>0.1 NDVI), moisture stressed shrubs (0-0.1 NDVI), and dead shrubs (≤0 NDVI). Moisture stressed shrubs were considered relevant to ecological integrity because the analysis was done in 2014 during an extreme drought. Visual analysis of imagery from later years confirmed that moisture stressed shrubs got greener in wetter years and therefore were not dead in the 2014 image. These shrubs might be particularly susceptible to extended droughts in the future so, while this metric only measures the total percent shrub cover, a map of the stressed shrubs is also provided. NDVI data are presented here for additional context; they were not used to determine percent shrub cover.

**Metric Evaluation Period:** 2014 (Baseline: 2014; Current: 2014)

**Baseline**: In 2014, 9 percent of CSS in the regional preserve system fell into the high integrity category (at least 65 percent shrub cover), 30 percent in moderate integrity (30-64 percent shrub cover), and 61 percent in low integrity (less than 30 percent shrub cover). Many areas with low shrub cover were recently burned (2005-2014; fig. CSS2.1). In response to extreme drought, shrubs were highly stressed or dead, adding to lower shrub cover in some areas (fig. CSS2.2). Moisture stress values were derived from May 2014 NAIP imagery using the NDVI. This information is not explicitly tracked in this metric, but these are places where shrub die-off could be prevalent in future years' analyses.

**2027 Progress Towards Desired Condition**: There is no short-term project milestone in progress towards the desired condition, as this is dependent on each plan's requirements and timeline.

### Condition Thresholds:

Condition thresholds were determined based on estimates for meaningful targets of ecological integrity. These will be further refined with additional analysis.

- **Good**: ≥50 percent of CSS on Conserved Lands in the MSPA is ranked in the high ecological integrity class (at least 65 percent shrub cover).
- **Caution**: 35-49 percent of CSS on Conserved Lands in the MSPA is ranked in the high ecological integrity class.
- **Concern**: 25-34 percent of CSS on Conserved Lands in the MSPA is ranked in the high ecological integrity class.
- **Significant Concern**: <25 percent of CSS on Conserved Lands in the MSPA is ranked in the high ecological integrity class.

### Current Condition: Significant Concern

In 2014, 9 percent of CSS on Conserved Lands in the MSPA fell into the high integrity category, 30 percent in the moderate category, and 61 percent in the low category.

### Trend (2014): Unknown

The trend of this metric is currently Unknown because data are not available for another time period. Future reports will identify a trend by repeating these analyses with additional years of data.

### Confidence: Moderate

Mapping of shrubs was based on lidar-derived height values, and NDVI distinguished live shrubs from dead and moisture stressed shrubs. This does not account for species composition.

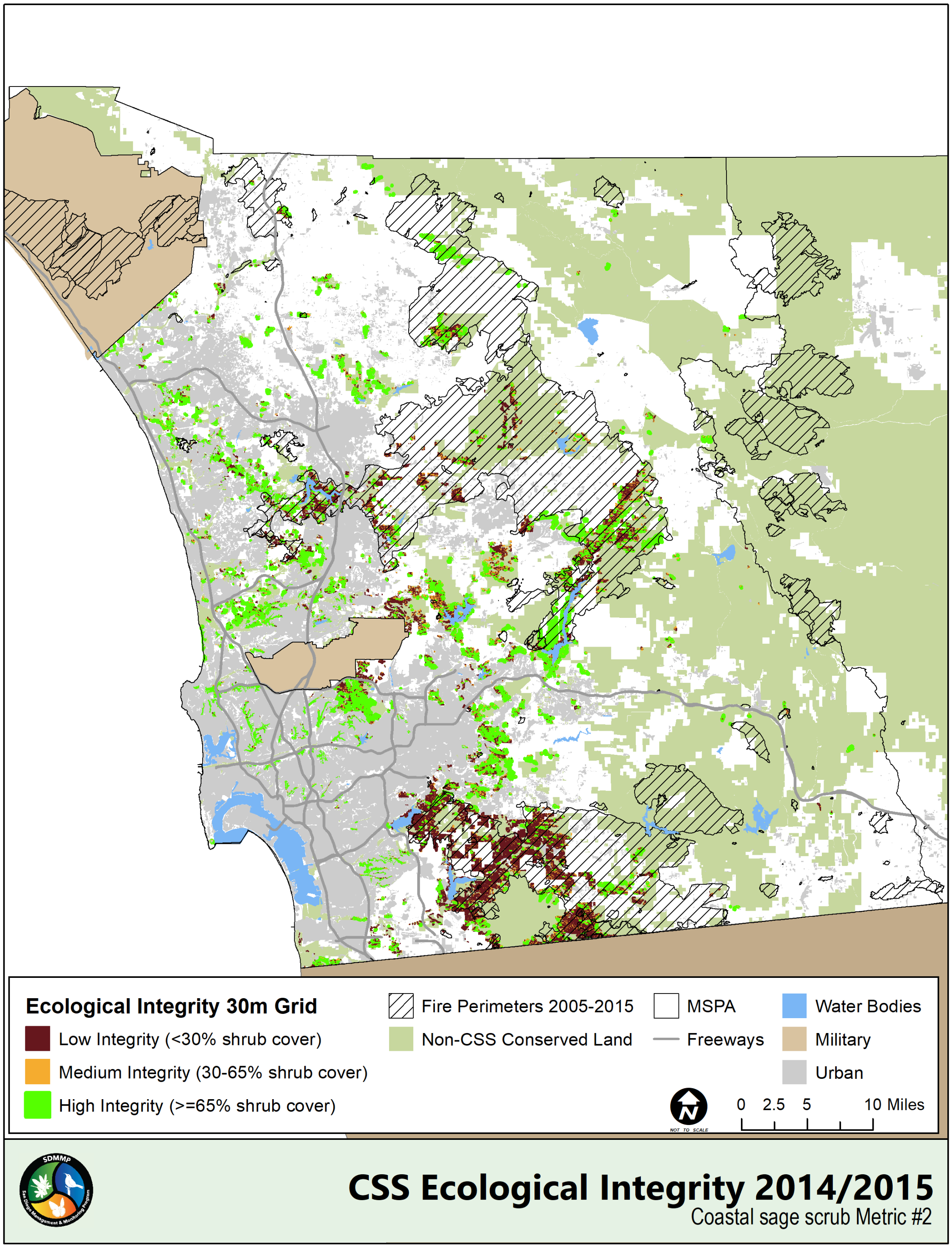


**Figure CSS2.1:** Ecological integrity of CSS on Conserved Lands in the MSPA.
Ecological integrity was calculated as percent shrub cover within 30-m grids. High integrity (green) is defined as grids with at least 65 percent shrub cover. Moderate integrity (orange) is 30-64 percent shrub cover. Low integrity (red) is less than 30 percent shrub cover. Grid area was restricted to areas mapped as CSS in 2012.

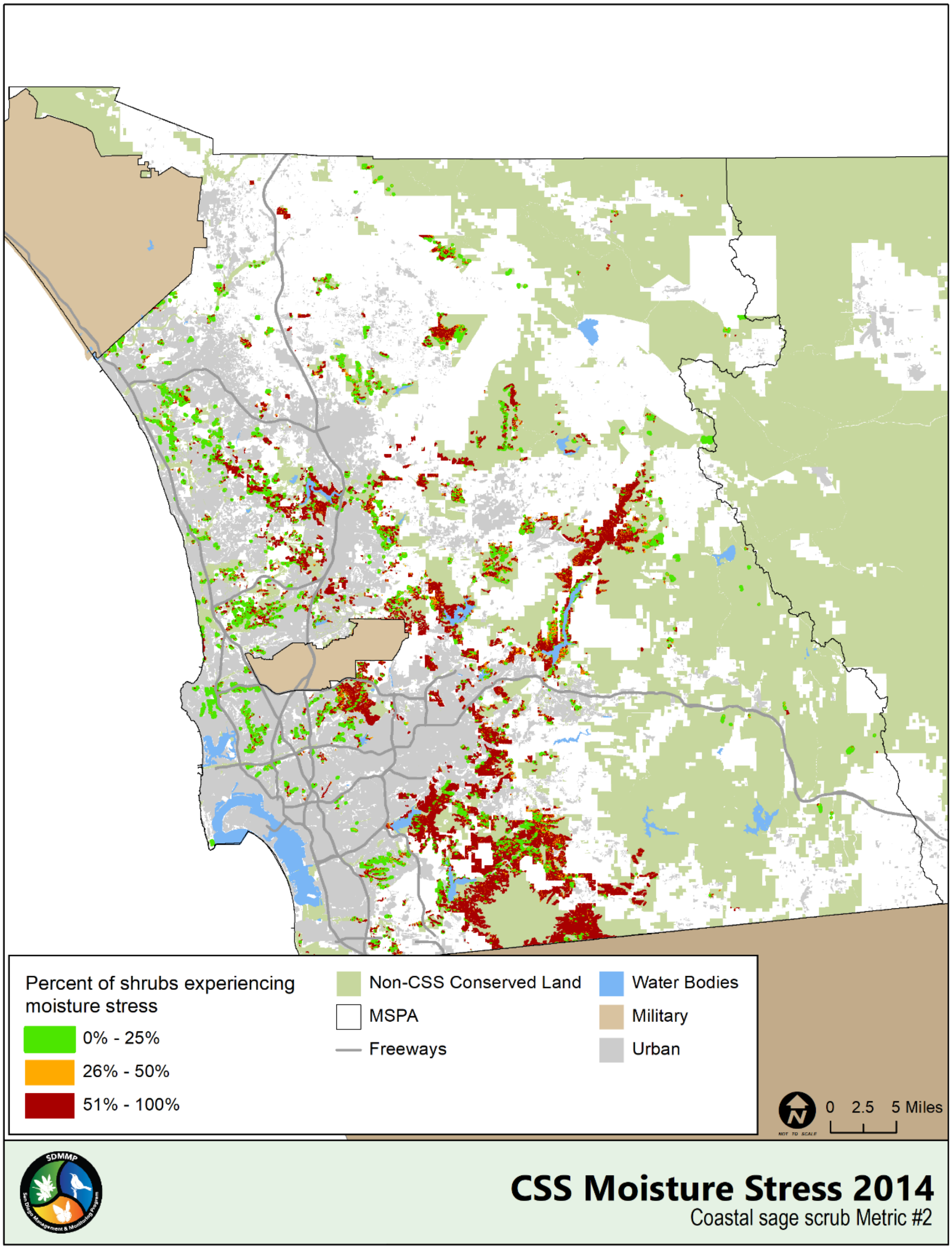


**Figure CSS2.2.** Percent of CSS shrubs moisture stressed in 2014 due to drought or other stressors. Shrubs with low NDVI values (red) had a high level of moisture stress during the 2014 drought. This map shows the percent of shrubs in the MSPA with moisture stress at a 30-m grid in areas mapped as CSS.

## Metric 3: Fire Frequency

**Overview**: Fire is a natural process in CSS ecosystems, with many shrub and herbaceous understory plants dependent on fire for seed germination and recruitment (Keeley 1986). An altered fire regime, with a shortened fire return interval of less than 10–15 years (Keeley and others 2011), can result in vegetation type conversion from CSS to nonnative annual grassland (Keeley and Brennan 2012). This conversion process is partially the result of an altered fire regime with frequent fire (Keeley and others 2005; Keeley and Brennan 2012). There were extremely large, human-caused Santa Ana wind-driven wildfires in the MSPA in late October 2003 and 2007. These fires degraded CSS vegetation, with a loss of native shrubs and increase in nonnative grasses. More discussion on fires is included in the Fire Indicator section in Ecosystem Processes and Landscape-scale Threats.

**Metric Evaluation Period:** 1965-2019 (Baseline: 1965-1995; Current: 1989-2019)

**Baseline**: The baseline for burn history of CSS in the MSPA was taken from 1965-1995, using the 1995 vegetation map (City of San Diego and others 1995). A 30-year period was determined to be a useful measure of fire history for CSS, because areas that have burned two or more times in 30 years could be more susceptible to type conversion (Keeley and others 2011; Keeley and Brennan 2012). This metric is dependent on vegetation mapping data, so it compared the 30-year periods prior to the 1995 vegetation map and current time (2019). See the Fire Indicator in the Ecosystem and Landscape-scale Threats section for more explanation of the selection of this baseline period. An analysis of total acres burned (not limited to CSS) in 30-year periods from 1909 to 2019 indicated that total acres burned at least once from 1965-1995 (359,579 acres) is within the historical range (historical average is 331,569 acres). Therefore, the 1965-1995 time period can be considered representative of the longer-term (1909-1969) fire history. In 1995, just over 7 percent (2,947 acres) of mapped conserved coastal sage scrub had burned two or more times in the burn period 1965-1995.

**2027 Progress Towards Desired Condition**: There is no short-term project milestone in progress towards the desired condition, as this is dependent on each plan's requirements and timeline.

### Condition Thresholds:

Condition thresholds were based on the percentage of CSS that burned two or more times in the regional preserve system at baseline fire frequencies. The baseline time period was 1965-1995. A Good condition indicates that most CSS burned two or more times in the current time period (1989-2019) at baseline (1965-1995) frequencies of 7 percent of conserved CSS.

- **Good:** ≤7 percent of CSS on Conserved Lands in the MSPA burned ≥2 times in the last 30 years.
- **Caution:** 8-15 percent of CSS on Conserved Lands in the MSPA burned ≥2 times in the last 30 years.

- **Concern:** 16-25 percent of CSS on Conserved Lands in the MSPA burned ≥2 times in the last 30 years.
- **Significant Concern:** >25 percent of CSS on Conserved Lands in the MSPA burned ≥2 times in the last 30 years.

#### Current Condition: Significant Concern

During the current 30-year period (1989-2019), 32,470 acres of 88,172 acres (37 percent) of conserved CSS mapped in 2012 burned two or more times (fig. CSS3.1; SDMMP 2020; County of San Diego 2021; CalFire 2019).

#### Trend (1965-2019): Declining

Between 1965 to 1995), 2,947 acres (7 percent) of conserved CSS burned two or more times compared to 32,470 acres (37 percent) from 1989-2019 (fig. CSS3.2; City of San Diego and others 1995; CalFire 2015; SDMMP 2020).

#### Confidence: Moderate

Vegetation mapping of CSS is outdated in some portions of the County. While the latest mapping took place in 2012, it did not include all areas in the County. As a result, data from previous years (including the 1990s) was used to fill in gaps. The values for vegetation acreages may be inaccurate in some areas of the County, and this would affect the accuracy of the percentages calculated.

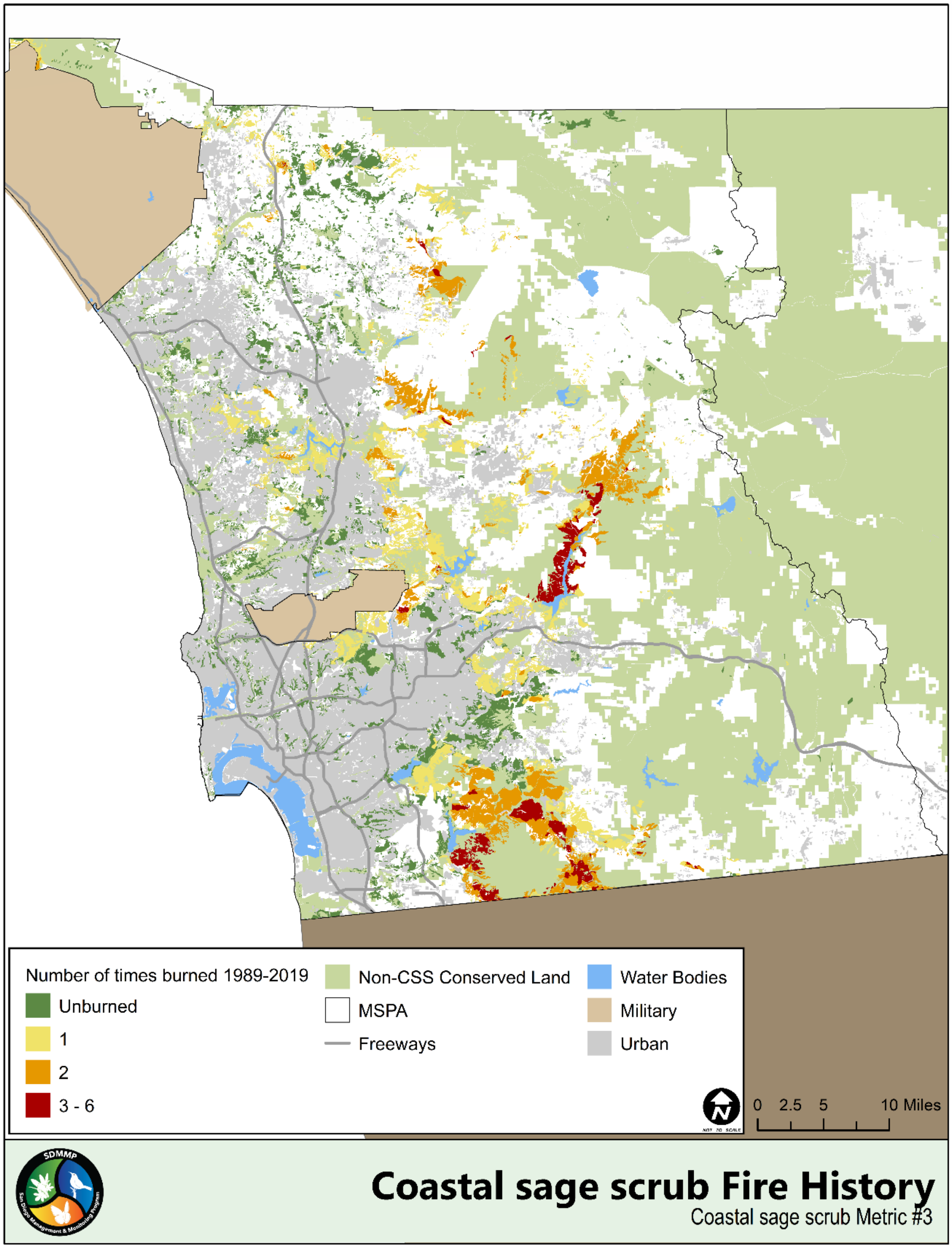


**Figure CSS3.1.** CSS fire frequency (1989-2019) on Conserved Lands in the MSPA.
This map shows the number of times CSS burned in the current time period (1989-2019) with areas that burned three or more times shown in red, two times in orange, one time in yellow, and unburned in green.

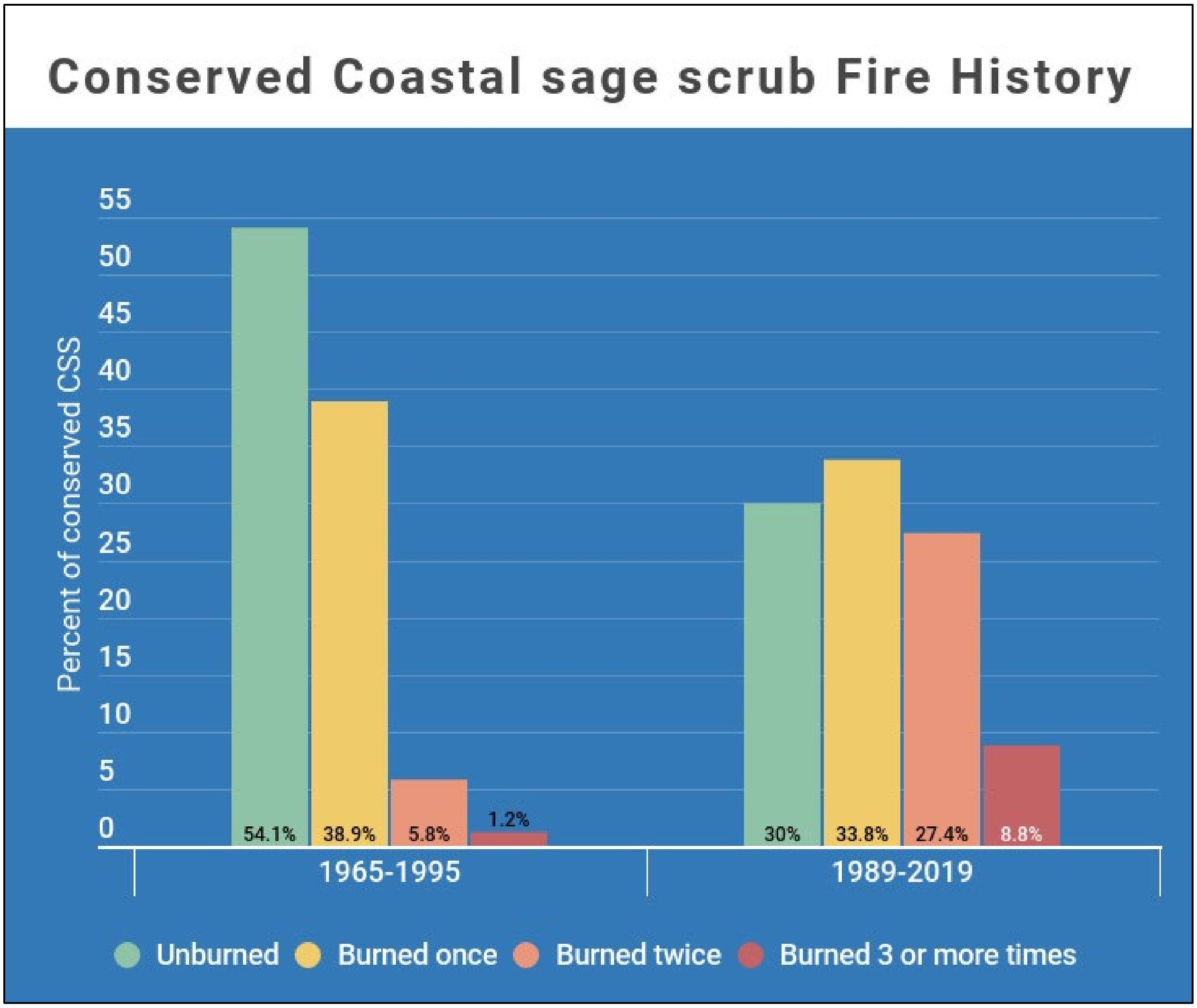


**Figure CSS3.2:** CSS fire frequency trends over time on Conserved Lands in the MSPA.

This graph shows change in the number of times conserved CSS burned in the MSPA between baseline (1965-1995) and current (1989-2019) time periods. CSS mapped in 1995 was used to calculate the percentages unburned and those burned one, two, or three or more times in the 30 years prior (1965-1995). A current vegetation maps were used to calculate number of times burned in the current time period.

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## Oak Woodland – Vegetation Community Indicator (Tree-dominated Habitat)


**Why Is This Indicator Included?**

Oak woodland is the fourth largest vegetation community in the MSPA, covering 125,556 acres when mapped in 1995 (City of San Diego and others 1995; County of San Diego 2021). Sixteen MSP species are associated with oak woodlands (SDMMP and TNC 2017). Engelmann oak (*Quercus engelmannii*) is a rare endemic species that defines an important type of oak woodland of high conservation priority (City of San Diego and others 1998; AMEC and others 2003).

The plans identify conservation of oak woodland habitat as a goal. The MSCP targeted for conservation 47 percent of oak woodlands mapped in the MHPA in 1995 (City of San Diego 1998), while the MHCP had a goal of 83 percent conserved in the FPA (AMEC and others 2003). The other two conservation planning areas (North County and East County) with the most oak woodlands have not yet established conservation targets.

Oak woodland was selected as an indicator because it provides important habitat to many species, including rare and sensitive species, and the health of oak woodland is a critical element to the health of the regional preserve system.

## Stressors

There are numerous threats, some of which can be partially mitigated by management actions, impacting oak woodland in San Diego County. Those threats are: habitat loss and degradation, an altered fire regime, intense and prolonged drought, and invasive, nonnative beetles and fungal pathogens (Tyler and others 2006; Coleman and Seybold 2008; Coleman and others 2011; Lynch and others 2013a,b).

- **Fire**: Fire is the primary natural process affecting upland stands of oak woodland, and short fire return intervals can eliminate coast live oak woodland stands (Sproul and others 2011). Engelmann oak stands with grassy understories are typically resilient to fire, while stands with shrub understories can be top-killed. Trees may recover by resprouting (Sproul and others 2011).
- **Climate Vulnerability**: Multiple years of drought are interacting with other threats such as fire, nonnative pests, and fungal pathogens to increase mortality (Coleman and Seybold 2011; Lynch and others 2013a).
- **Invasive Animals**: The invasive, nonnative goldspotted oak borer (*Agrilus auroguttatus*; GSOB) is spreading in distribution in southern California, weakening and killing trees (Coleman and Seybold 2008; Coleman and others 2011).
- **Disease**: Novel fungal pathogens have invaded live oaks in southern California and caused extensive disease and mortality (Lynch and others 2013a).

Engelmann oak woodland is restricted to southern California in the foothills of the Peninsular Range in San Diego County and the Santa Ana Mountains of San Diego and Riverside counties. It often occupies the ecotone between grassland and surrounding shrublands (Oberbauer and others 2008). Engelmann oaks occur at relatively moist sites with fine-textured soils on gentle slopes and valley bottoms (Sproul and others 2011).

Coast live oak (*Quercus agrifolia*) woodlands are distributed west of the Sierra Nevada from Mendocino County, California, south to northwest Baja California, Mexico. In southern California, they are distributed along the South Coast Ranges and coastal slopes of theTransverse and Peninsular Ranges (Oberbauer and others 2008). These woodlands typically occur on north-facing slopes and in shaded areas (Oberbauer and others 2008). Stands may be found in mesic uplands where the canopy is open to continuous (Sproul and others 2011). Coast live oaks can live for more than 200–300 years.

## Desired Condition

MSP Roadmap Goal (SDMMP and TNC 2017):

*Maintain, enhance, and restore oak woodlands on Conserved Lands in the MSPA that support or have the potential to support MSP species and coast live oak woodlands that incidentally benefit a diverse array of other MSP species so that the vegetation communities have high ecological integrity, and these species are resilient to invasive pests and disease pathogens, environmental* *stochasticity, threats, and catastrophic disturbances, such as very large wildfires and intense and prolonged drought, and will be likely to persist over the long term (>100 years).*

### Current Condition Status

The overall condition of the Oak Woodland Vegetation Community Indicator was evaluated as Caution (table OAK0.1). While conservation targets have not yet been reached (Metric 1: percent conserved), the health of oak woodlands is in Good condition (Metric 2: ecological integrity). Ecological integrity was measured as the percent of healthy (living) trees and showed clusters of die-offs that may be early indicators of the start of decline in ecological integrity. Large-scale changes are likely to have occurred since 2014 with the increase in intensity and duration of drought and spread of fungal pathogens and invasive, nonnative pests. Additional analyses over multiple years are required to understand the exact impacts of many of the newly emerging and ongoing threats. As more information becomes available, additional metrics on the composition of native and nonnative plants and the acreage restored or enhanced will be added.

**Table OAK0.1**. Current overall condition status for the Oak Woodland Vegetation Community Indicator and period of baseline to current years comparison, metric conditions, trends, and confidence levels.

| Indicator/metric (baseline – current year) | Condition | Trend | Confidence |
|---|---|---|---|
| Oak woodland overall condition status | Caution | Unknown | Moderate |
| Metric 1: percent conserved (1995-2020) | Concern | Improving | Moderate |
| Metric 2: ecological integrity (2014) | Good | Unknown | Moderate |

## Metric 1: Percent Conserved

**Overview:** The plans identify conservation as an essential first step to maintaining healthy oak woodlands habitat. The MSCP Plan targeted for conservation 47 percent of oak woodlands mapped in the MHPA in 1995 (City of San Diego 1998). The MHCP Plan had a goal of 83 percent conservation in the FPA (AMEC and others 2003). The other two conservation planning areas (North and East County), with the majority of oak woodlands, have not yet established conservation targets.

**Metric Evaluation Period:** 1995-2020 (Baseline: 1995; Current: 2020)

**Baseline:** In 1995, a comprehensive vegetation map was created for San Diego County with 125,556 acres of oak woodland mapped in the MSPA (City of San Diego and others 1995; CalFire 2015). At that time, 32,179 acres (26 percent) of oak woodland was conserved (SDMMP 2020). A breakdown of conservation acreage and current status by plan area (MSCP and MHCP), other non-plan areas (Other), and the total in the MSPA (Total) is provided in table OAK1.1. Acres across the table for MSCP, MHCP, and Other make up the Total. These values differ slightly from the "Preserve Assembly" section of this report because of differing vegetation categorization.

**2027 Progress Towards Desired Condition:** There is no short-term project milestone in progress towards the desired condition, as this is dependent on each plan's requirements and timeline.

**Table OAK1.1**. Oak woodland conservation acreages and percentages by plan area in the MSPA.

| Conservation Level | MSCP | MHCP | Other[1] | Total |
|---|---|---|---|---|
| Conservation target | 5,116 acres (47 percent) | 1,015 acres (83 percent) | NA | Unknown |
| Baseline conserved (1995) | 1,133 acres | 516 acres | 30,530 acres | 32,179 acres |
| Current conserved (2020) | 3,973 acres | 849 acres | 38,779 acres | 43,600 acres |
| Total oak woodlands in plan area | 10,884 acres | 1,223 acres | 113,449 acres | 125,556 acres |
| Percent of plan area conserved | 37 percent | 69 percent | 34 percent | 35 percent |
| Difference | 10.5 percent < target | 13.6 percent < target | NA | NA |

[1] Other refers to areas within the MSPA but not within an approved plan. This includes lands that will be included into the North County Plan and East County Plan. Targets are not yet set for these areas.

### Condition Thresholds:

While additional local multiple species conservation plans are being developed, general conservation thresholds were set. These will change as plans are adopted and are not intended to supersede plan targets.

- **Good:** ≥75 percent of oak woodland conserved in the MSPA using 1995 baseline acreages.
- **Caution:** 50-74 percent of oak woodland conserved in the MSPA using 1995 baseline acreages.
- **Concern:** 25-49 percent of oak woodland conserved in the MSPA using 1995 baseline acreages.
- **Significant Concern:** <25 percent of oak woodland conserved in the MSPA using 1995 baseline acreages.

### Current Condition: Concern

Currently, there are 43,600 acres (35 percent) of baseline oak woodland conserved in the MSPA (fig. OAK1.1).

### Trend (1995-2020): Improving

In the baseline period (1995), there was a total of 125,556 acres of oak woodland with 32,179 acres (26 percent) conserved in the MSPA. In the current period (2020), using the baseline vegetation map, 11,421 acres of oak woodland have been added to the regional preserve system, increasing the amount conserved to 43,600 acres (35 percent; fig. OAK1.2).

### Confidence: Moderate

Vegetation mapping methods and categorization definitions changed from 1995 to 2012, and these differences are likely responsible for some of the apparent changes. Some areas of the County have not been mapped since the 1990s. Vegetation on many Conserved Lands was last mapped in 2012.

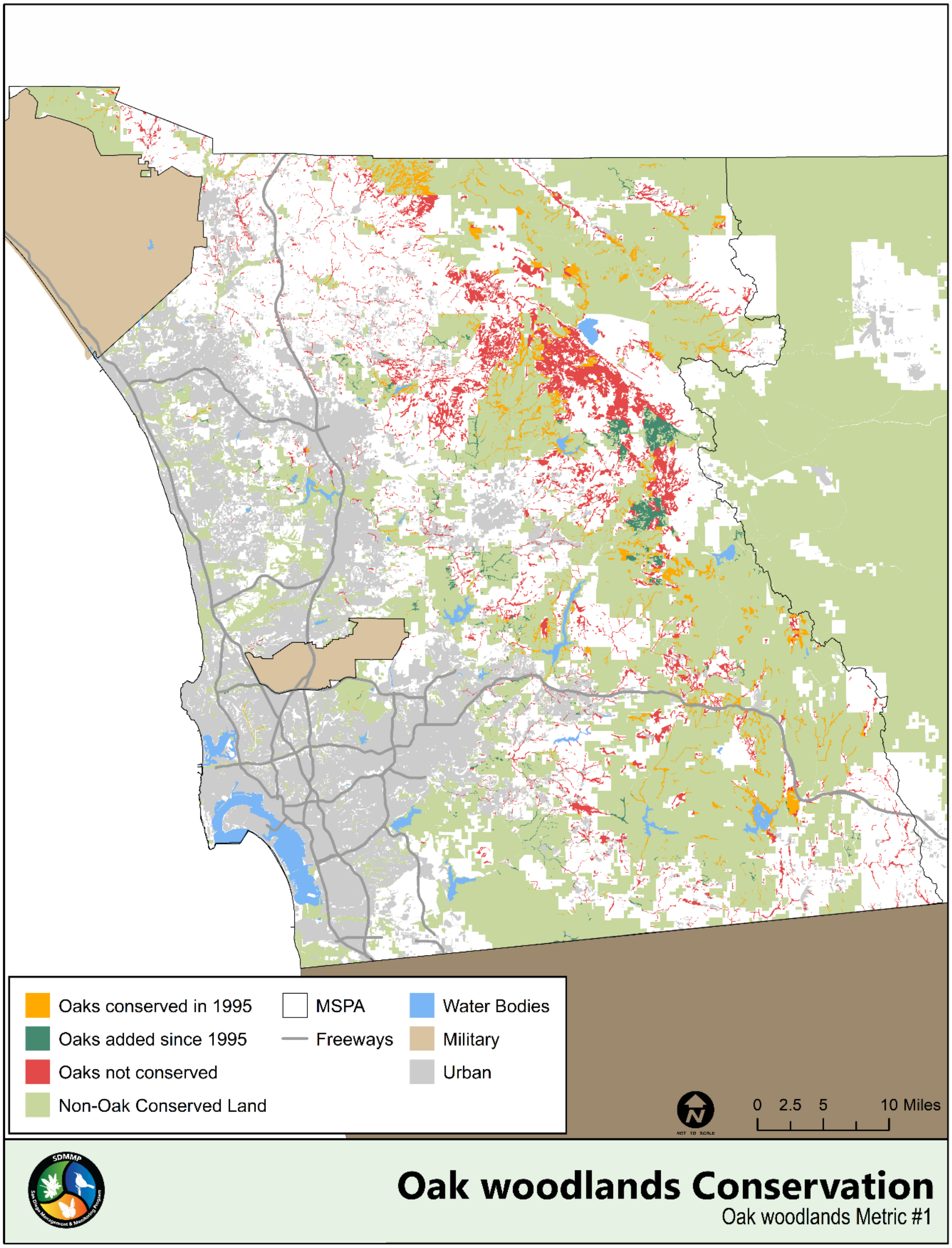


**Figure OAK1.1.** Oak woodland conserved in the MSPA since 1995.
This map of the MSPA depicts areas mapped as oak woodland conserved in 1995 (orange), conserved between 1995 and 2020 (green), and not conserved (red).

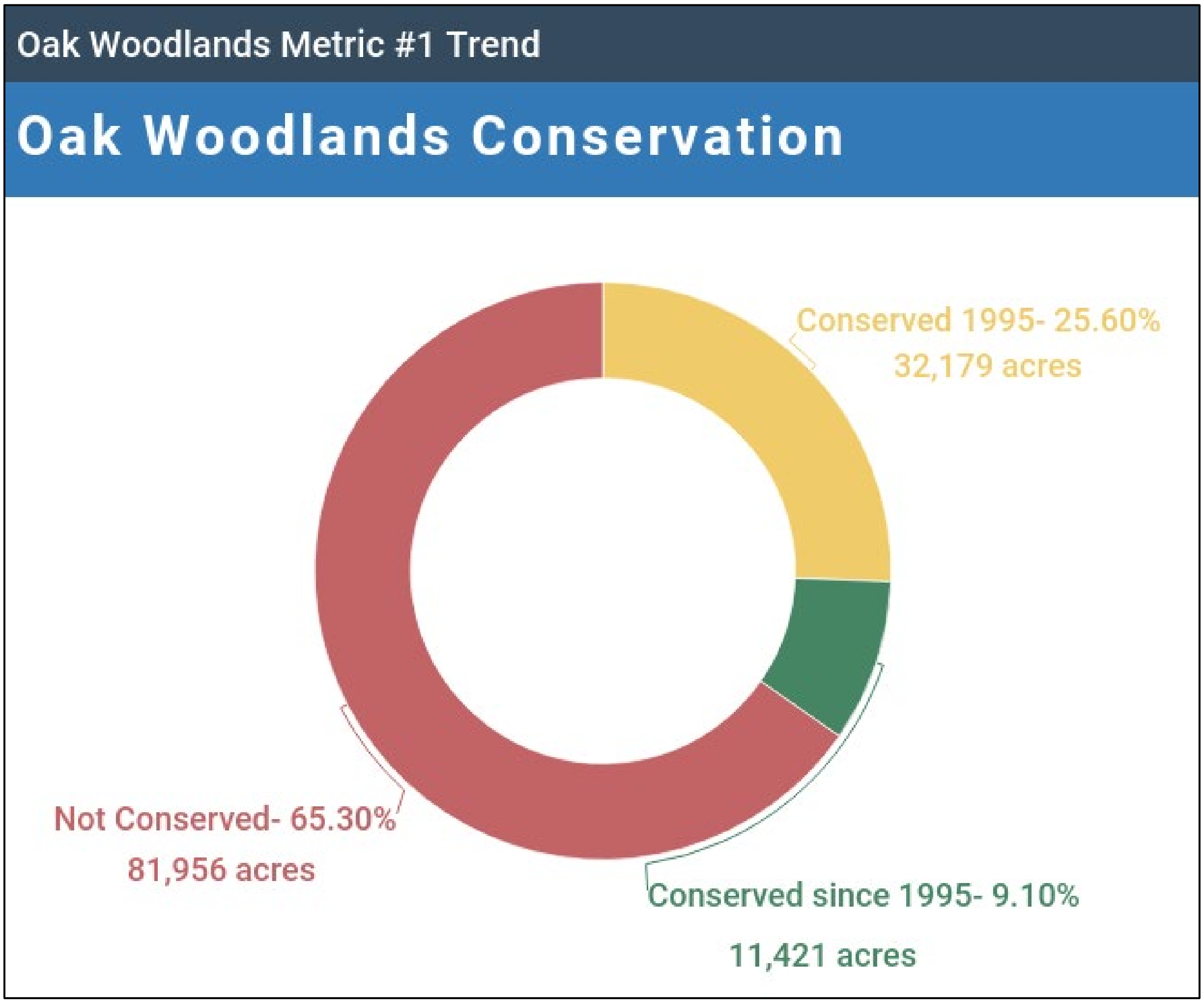


**Figure OAK1.2.** Percent of oak woodland conserved by time period in the MSPA.
This graph shows total acreage of oak woodland mapped in 1995 (125,556 acres) with percent conserved at that time (yellow), the percent added between 1995 and 2020 (green), and the percent not conserved (red).

## Metric 2: Ecological Integrity

**Overview:** Oaks are undergoing a high level of mortality due to a combination of drought, fire, the GSOB, and fungal pathogens (Coleman and Seybold 2008; Coleman and others 2011; Lynch and others 2013a,b). These threats compound to result in tree mortality from multiple causes.

Tree mortality can be estimated using remote sensing images and calculating NDVI. In 2014 and 2015, lidar data were collected in San Diego County (OCM Partners 2015; 2016). San Diego Management and Monitoring Program (SDMMP) used multiple return lidar values to determine the height of natural vegetation in the western two-thirds of the County (Perkins and Kus 2022). Tree locations (based on height) were mapped at 1-m resolution, and oaks were identified using the 2019 vegetation map.

For each pixel identified as a tree (based on height >3m), May 2014 NDVI was calculated (USDA 2015). Lower NDVI values indicate death or extreme stress for the tree. Higher values (closer to 1) indicate a healthy (live and actively growing) tree. The percentage of healthy trees was calculated as a percentage of total tree cover with NDVI >0.1 for a 30-m grid cell in oak-mapped areas. We considered low integrity to be 33 percent or less healthy trees in a 30-m grid cell, moderate integrity to be 34-66 percent healthy trees, and high integrity to be over 66 percent healthy trees. For the condition thresholds, the percent of conserved 30-m oak woodland grid cells across the MSPA that were high integrity (>66 percent healthy trees) was calculated. For example, a Good condition would be >80 percent of 30-m oak woodland grid cells categorized as high integrity.

**Metric Evaluation Period:** 2014 (Baseline: 2014; Current: 2014)

**Baseline:** In 2014, 85 percent of the 30-m grid cells mapped in conserved oak woodland in the regional preserve system was considered to have high integrity (>66 percent healthy trees with NDVI >0.1) (fig. OAK2.1). Although oak woodlands were considered in Good condition, many GSOB infestations had already been detected in 2014 (fig. OAK2.2). Future editions of this report will include additional analysis to understand the baseline before this change.

**2027 Progress Towards Desired Condition:** There is no short-term project milestone in progress towards the desired condition, as this is dependent on each plan's requirements and timeline.

### Condition Thresholds:

Condition thresholds were chosen as general indicators of health. These values will be refined with additional analysis.

- **Good:** >80 percent of 30-m grid cells mapped in conserved oak woodlands in the MSPA are high ecological integrity (>66 percent healthy trees).
- **Caution:** 61-79 percent of 30-m grid cells mapped in conserved oak woodlands in the MSPA are high ecological integrity (>66 percent healthy trees).
- **Concern:** 40-60 percent of 30-m grid cells mapped in conserved oak woodlands in the MSPA are high ecological integrity (>66 percent healthy trees).
- **Significant Concern:** <40 percent of 30-m grid cells mapped in conserved oak woodlands in the MSPA are high ecological integrity (>66 percent healthy trees).

### Current Condition: Good

Currently, only a single year of data is available for this metric (2014). The baseline and the current conditions both use data from this year. In 2014, the condition is Good. 85 percent of the area mapped as conserved oak woodlands in the MSPA are considered to have high integrity, as determined by a >66 percentage of healthy trees (high NDVI).

### Trend (2014): Unknown

The trend of this metric is currently Unknown because data are not available for another time period. Future reports will identify a trend by repeating these analyses with additional years of data.

### Confidence: Moderate

Mapping techniques do not account for tree or plant species. Tree values are based on height in 2014 and 2015.

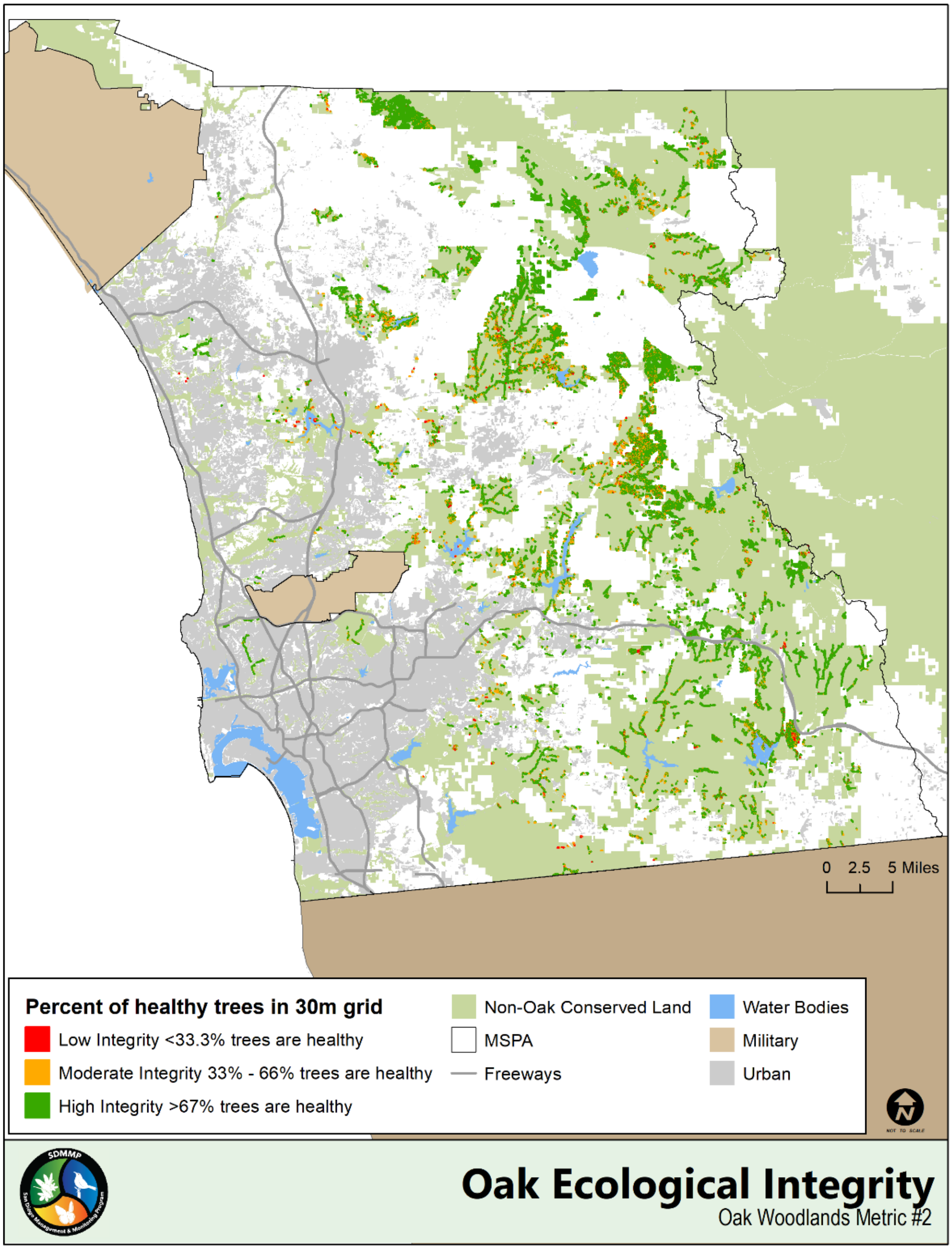


**Figure OAK2.1.** Ecological integrity of conserved oak woodland in the MSPA.

Ecological integrity was calculated as percent of healthy trees in mapped oak woodlands in a 30-m grid. Low integrity is 33 percent or less healthy trees (red). Moderate is 34-66 percent healthy trees (orange). High integrity is over 66 percent healthy trees (dark green).

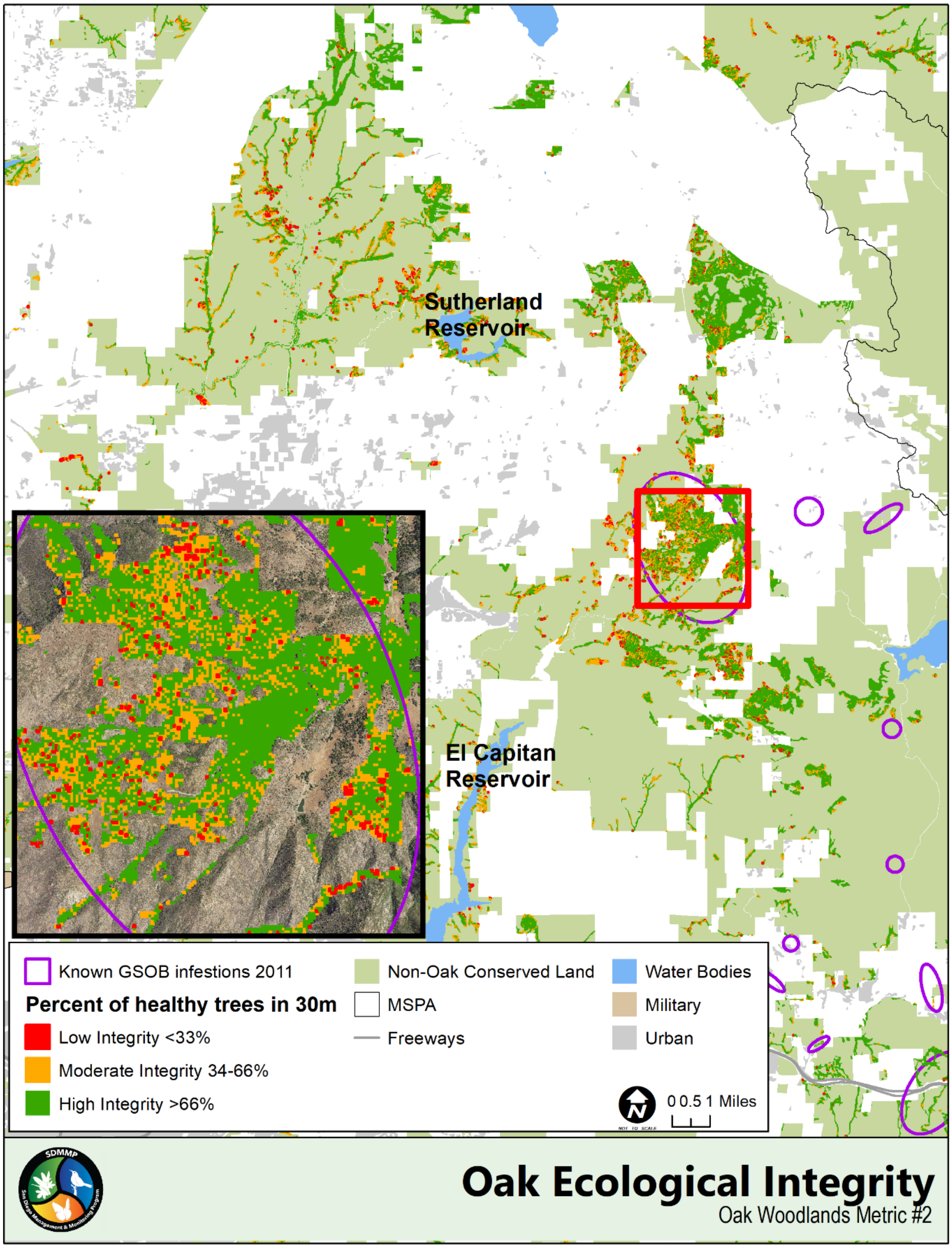


**Figure OAK2.2.** Ecological integrity of oak woodland in Pine Hills and surrounding areas with known GSOB infestations.

Areas with known GSOB infestations in 2011 are indicated with circles in purple. Oak Woodland ecological integrity is indicated as a percent of healthy trees (NDVI >0.1) within a 30-m grid.

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# Riparian Forest and Scrub - Vegetation Community Indicator (Tree-dominated Habitat)


### Why Is This Indicator Included?

Riparian forest and scrub comprise the fifth largest vegetation community in the MSPA, covering 23,822 acres when mapped in 1995 (City of San Diego and others 1995; County of San Diego 2021). It supports 15 MSP Species (one fish, two amphibians, two reptiles, four birds, two mammals, and four plants) (SDMMP and TNC 2017). These species inhabit riparian vegetation exclusively or use riparian as well as other vegetation types. Two species restricted to riparian vegetation are least Bell's vireo (*Vireo bellii pusillus*) and southwestern willow flycatcher (*Empidonax traillii extimus*). Other MSP species will benefit incidentally from riparian vegetation management (SDMMP and TNC 2017). Riparian vegetation not only provides important habitat for MSP and other species; it also provides carbon storage (Dybala and others 2018), holds unique soils and vegetation, and retains nutrients.

Riparian forest and scrub was selected as an indicator because it provides important habitat to many species, including species of high conservation priority, and the health of riparian vegetation is a critical element to the health of the regional preserve system.

### Stressors

There are multiple threats facing riparian vegetation communities. Significant die-offs of willows and other riparian vegetation have occurred in San Diego County because of invasive, nonnative polyphagous/Kurashio shot hole borer beetles (*Euwallacea* sp.) and their symbiotic *Fusarium* fungal pathogen (Eskalen and others 2013; Boland 2016; Boland and Woodward 2019). Another large-scale threat to riparian systems is invasive, nonnative plants (Mullin and others 2000) as evidenced by the prevalence of Arundo/giant reed (*Arundo donax)* and Tamarisk (*Tamarix* sp.) within the MSPA. Riparian vegetation is modified by altered hydrology from water management and urbanization (White and Greer 2006).

Riparian vegetation is found throughout California, growing in floodplains, canyon bottoms, and along streams. The hydrologic cycle is very important in determining the composition and structure of riparian communities through surface flows, ground water, nutrient cycling, sedimentation, erosion, and water quality (Stromberg 1993; Stohlgren and others 1998; White and Greer 2002).

Many riparian plant species regenerate from seed following flood events (Griggs 2009; Sproul and others 2011). Alluvial soils are nutrient-rich and fertile growing areas (Griggs 2009). Riparian forest is dominated by willows, sycamores, and oaks. Riparian scrub is shrub-dominated and dense.

- **Hydrology:** Human-made structures such as dams and flood control channels and increased impervious surfaces resulting from urban development have altered hydrology in natural riparian systems. Altered flows harm native species and can benefit invasive species (White and Greer 2006; Brown and others 2020). This change in flow regime can affect species composition and seed regeneration and more easily allow invasive plants to establish from high water and nutrient levels (Stromberg 1993; White and Greer 2006).
- **Climate Vulnerability:** Prolonged and extended drought can weaken trees to other stressors (McDowell and others 2008).
- **Invasive Animals:** Invasive pests and fungal pathogens, like shot hole borers and the *Fusarium* complex weaken and kill trees and large shrubs (Eskalen and others 2013). Aquatic predators and competitors prey upon native species and can cause reductions in their populations, with negative impacts to rare and listed species (Miller and others 2012).
- **Invasive Plants:** Invasive plants like Arundo, Tamarisk species, and castor bean (*Ricinus communis*) crowd out native plants and alter hydrology and geomorphology in riparian systems (Catford 2017).
- **Fire:** Repeated wildfires can degrade riparian communities by opening the landscape for the expansion of invasive, nonnative plants (Pettit and Naiman 2007). Large fires in watersheds can cause erosion and debris flows, impacting vegetation and geomorphology, and can carry pollutants and toxic chemicals (Burke and others 2013).
- **Urbanization:** Upstream urbanization increases water flows, even in the dry season, and has resulted in eroded deep cut channels rather than broad, braided channels (Stohlgren and others 1998; White and Greer 2006; Taniguchi and Biggs 2015). These perennial flows affect riparian vegetation and native species in different ways. In some cases, perennial flows support more extensive and lusher riparian vegetation, and this provides higher quality

habitat for some native species, including those listed or of high conservation concern. In other cases, these perennial flows allow invasion and proliferation of nonnative aquatic animal and plant species that adversely affect native species, including rare and listed species.

### Desired Condition

MSP Roadmap Goal (SDMMP and TNC 2017):

*Maintain, enhance, and restore riparian forest and scrub on Conserved Lands in the MSPA that supports or has the potential to support MSP species and to incidentally benefit a diverse array of other species so that the vegetation community has high ecological integrity, and these species are resilient to invasive pests and disease pathogens, environmental stochasticity, threats and catastrophic disturbances, such as very large wildfires and intense and prolonged drought, and will be likely to persist over the long term (>100 years).*

### Current Condition Status

Currently, 50 percent (11,878 acres) of the 1995 baseline riparian habitat is conserved in the regional preserve system (City of San Diego and others 1995; SDMMP 2020). This is an improvement from the 35 percent (8,404 acres) of baseline riparian habitat conserved in 1995. The invasion of shot hole borer beetles into the Tijuana River Valley has led to extensive willow mortality and invasion of nonnative plants (Boland 2016; Boland and Woodward 2019). This beetle is also in other major drainages in the County (UCANR 2021). Invasive plants and animals are a problem throughout the major watersheds and require intensive management efforts (Mission RCD 2013; Mission RCD 2018). Most watersheds have altered hydrology that impact natural riverine processes (Brown and others 2020).

Overall, the Riparian Forest and Scrub Vegetation Community Indicator was evaluated to have a condition of Good (table RIPARIAN0.1). While the conservation targets (Metric 1: percent conserved) have not been fully met, progress on conservation is improving. The health of trees in the riparian area (Metric 2: ecological integrity) is in the Good category, with specific areas having high rates of die-off. It is important to note that the health of trees was evaluated using 2014 data. Significant mortality may have occurred since 2014 due to the shot hole borers and fungal pathogens. Additional analyses are needed to understand the changes. As additional information becomes available, new metrics evaluating the native and nonnative species richness and the acres of restored or enhanced riparian habitat will be added.

**Table RIPARIAN0.1.** Current overall condition status for the Riparian Forest and Scrub Vegetation Community Indicator and period of baseline to current years comparison, metric conditions, trends, and confidence levels.

| Indicator/metric (baseline-current years) | Condition | Trend | Confidence |
|---|---|---|---|
| Riparian forest and scrub overall condition status | Good | Unknown | Moderate |
| Metric 1: percent conserved (1995-2020) | Caution | Improving | Moderate |
| Metric 2: ecological integrity (2014) | Good | Unknown | Moderate |

## Metric 1: Percent Conserved

**Overview:** The plans identify conservation as an essential goal for riparian forest and scrub habitat. The MSCP Plan targeted 80-81 percent of the mapped riparian forest (81 percent target) and scrub (80 percent target) mapped in the MHPA in 1995 for conservation (City of San Diego 1998). The MHCP Plan goal is to conserve 75 percent in the FPA (AMEC and others 2003). The other two conservation planning areas (North and East County) have not yet established conservation targets.

**Metric Evaluation Period:** 1995-2020 (Baseline: 1995; Current: 2020)

**Baseline:** In 1995, a comprehensive vegetation map was created for San Diego County that identified 23,822 acres of riparian forest and scrub (City of San Diego and others 1995; CalFire 2015). At that time, 8,404 acres (35 percent) of the habitat were conserved (SDMMP 2020). A breakdown of conservation acreage by plan area and current status by plan area (MSCP and MHCP), other non-plan areas (Other), and the total in the MSPA (Total) is provided in table RIPARIAN1.1. Acres across the table for MSCP, MHCP, and Other make up the Total. These values differ slightly from the "Preserve Assembly" section of this report because of differing vegetation categories.

**Table RIPARIAN1.1**. Riparian vegetation conservation acreages and percentages by plan area within the MSPA.

| Conservation level | MSCP | MHCP | Other[1] | Total |
|---|---|---|---|---|
| Conservation target | 5,893 acres (81 percent) | 2,001 acres (75 percent) | NA | Unknown |
| Baseline conserved (1995) | 2,390 acres | 1,024 acres | 4,990 acres | 8,404 acres |
| Current conserved (2020) | 4,517 acres | 1,452 acres | 5,909 acres | 11,878 acres |
| Total riparian in plan area | 7,275 acres | 2,668 acres | 13,879 acres | 23,822 acres |
| Percent of plan area conserved | 62 percent | 54 percent | 43 percent | 50 percent |
| Difference | 18.9 percent < target | 20.6 percent < target | NA | NA |

[1] Other refers to areas within the MSPA but not within an approved plan. This includes lands that will be included into the North County Plan and East County Plan. Targets are not yet set for these areas.

**2027 Progress Towards Desired Condition:** There is no short-term project milestone in progress towards the desired condition, as this is dependent on each plan's requirements and timeline.

**Condition Thresholds:**

Condition thresholds are based on known targets in the local conservation plans. While approved plans differ in targets and some plans are not yet approved, a Good condition would indicate meeting the baseline goal for the regional preserve system. These values will be refined as plans are adopted are not intended to supersede plan targets.

- **Good:** ≥75 percent of riparian forest and scrub are conserved in the MSPA using 1995 baseline acreages.
- **Caution:** 50-74 percent of riparian forest and scrub are conserved in the MSPA using 1995 baseline acreages.
- **Concern:** 25-49 percent of riparian forest and scrub are conserved in the MSPA using 1995 baseline acreages.
- **Significant Concern:** <25 percent of riparian forest and scrub are conserved in the MSPA using 1995 baseline acreages.

### Current Condition: Caution

Currently, 11,878 acres (50 percent) of 1995 baseline riparian forest and scrub have been conserved in the MSPA (fig. RIPARIAN1.1).

### Trend (1995-2020): Improving

In the baseline period (1995), there were 23,822 acres of riparian forest and scrub with 8,404 acres (35 percent) conserved in the MSPA. In the current period (2020), using baseline 1995 acreage, the amount of conserved habitat increased to 11,878 acres (50 percent; fig. RIPARIAN1.2).

### Confidence: Moderate

Vegetation mapping was not consistent across in the entire MSPA in methods or dates.

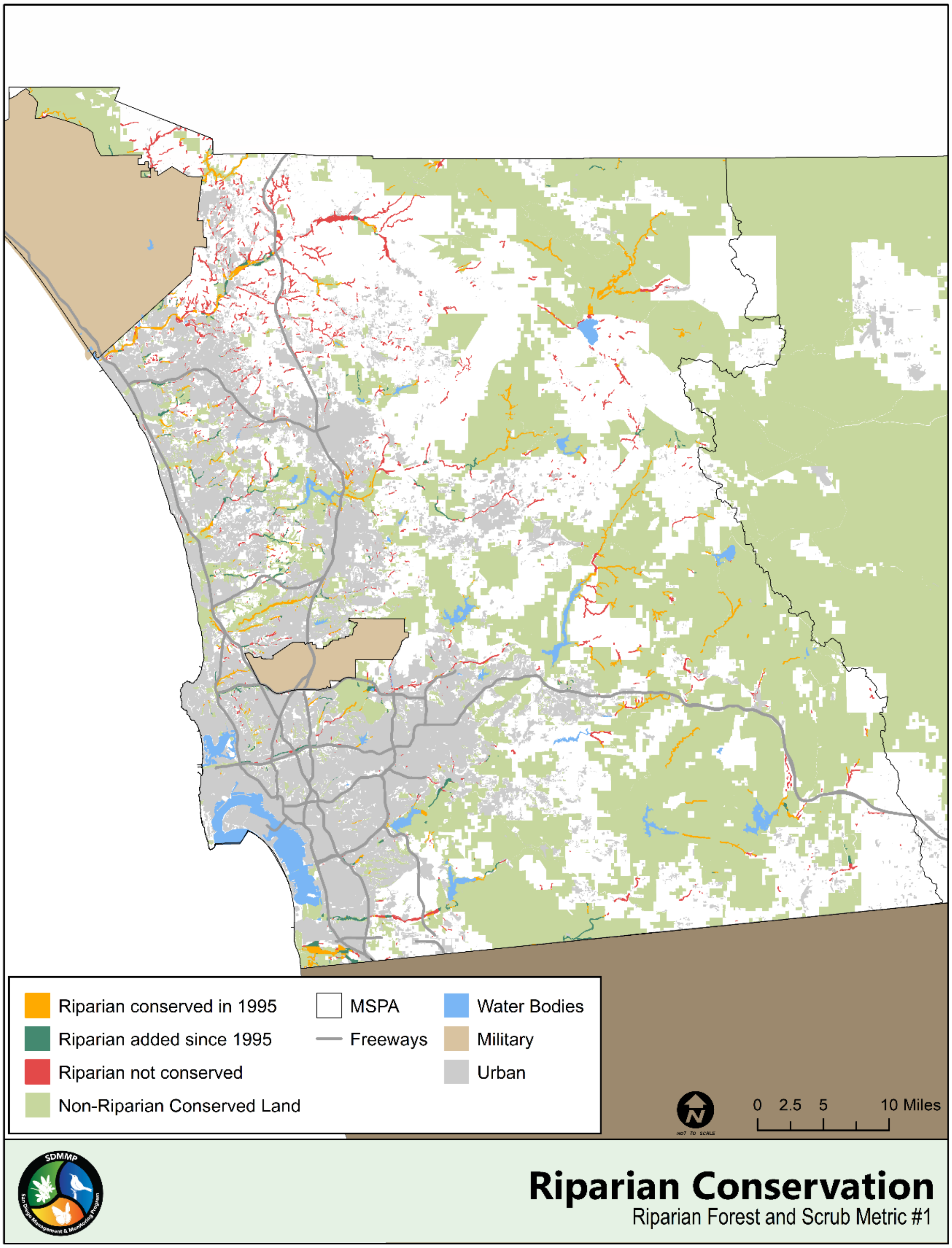


**Figure RIPARIAN1.1.** Riparian forest and scrub conserved by time period in the MSPA.
This map of the MSPA depicts areas mapped as riparian forest and scrub conserved in 1995 (orange), conserved between 1995 and 2020 (green), and not conserved (red).

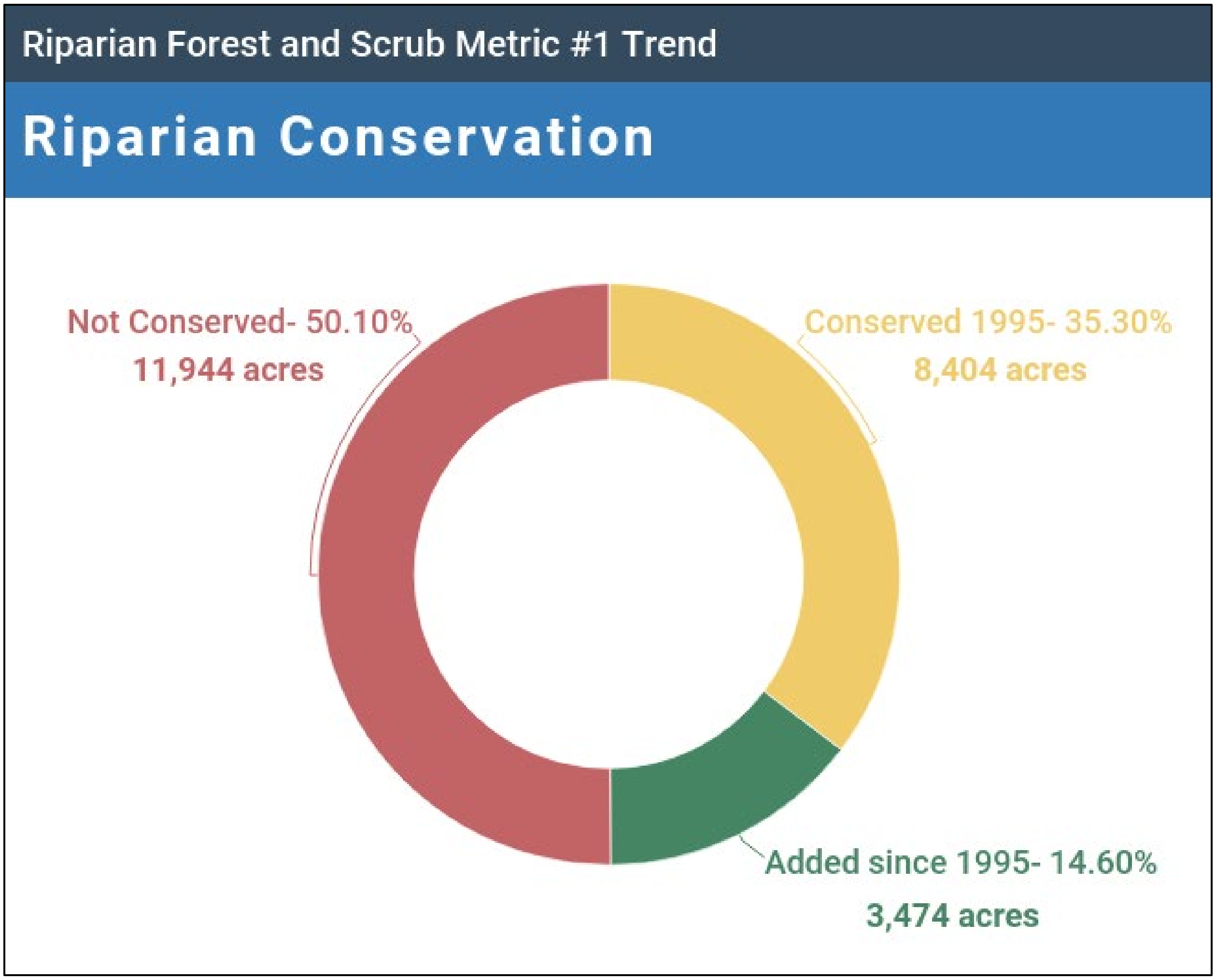


**Figure RIPARIAN1.2.** Percent of riparian forest and scrub conserved by time period in the MSPA. This graph shows total acreage of riparian habitat mapped in 1995 (23,822 acres) with percent conserved at that time (yellow), the percent added between 1995 and 2020 (green), and the percent not conserved (red).

## Metric 2: Ecological Integrity

**Overview:** Riparian trees are undergoing a high level of mortality resulting from drought and two invasive shot-hole borers with a symbiotic fungal pathogen that kills trees. Tree mortality may also be caused by a combination of fire and drought.

Tree mortality can be estimated using remote sensing images and calculating the NDVI. In 2014 and 2015, lidar data were collected in San Diego County (OCM Partners 2015; 2016). The San Diego Management and Monitoring Program (SDMMP) used multiple return lidar values to determine the height above the ground of natural vegetation in the western two-thirds of the County (Perkins and Kus 2022). Tree locations were mapped, and riparian was distinguished using the 2019 vegetation map. For each pixel identified as a tree (based on height >3m), May 2014 NDVI was calculated (USDA 2015). Lower NDVI values indicate death or extreme stress on the tree. Higher values (closer to 1) indicate a healthy (live and actively growing) tree. The percentage of healthy trees was calculated as a percentage of total tree cover with NDVI >0.1 for a 30-m grid cell in riparian-mapped areas. We considered low integrity to be 33 percent or less healthy trees in a 30-m grid cell, moderate integrity to be 34-66 percent healthy trees, and high integrity to be over 66 percent healthy trees. The condition thresholds consider the percent of conserved 30-m riparian grid cells across the MSPA that were high integrity (>66 percent healthy trees). For example, a Good condition would be >80 percent of conserved 30-m riparian grid cells categorized as high integrity.

**Metric Evaluation Period:** 2014 (Baseline 2014; Current: 2014)

**Baseline:** In 2014, 87 percent of the 30-m grid cells in conserved mapped riparian trees were considered to have high integrity (high NDVI; fig. RIPARIAN2.1).

**2027 Progress Towards Desired Condition:** There is no short-term project milestone in progress towards the desired condition, as this is dependent on each plan's requirements and timeline.

### Condition Thresholds:

Condition thresholds were chosen as general indicators of health. These values will be refined with additional analysis.

- **Good:** >80 percent of 30-m grid cells mapped in conserved riparian habitats in the MSPA are high ecological integrity (>66 percent healthy trees).
- **Caution:** 61- 80 percent of 30-m grid cells mapped in conserved riparian habitats in the MSPA are high ecological integrity (>66 percent healthy trees).
- **Concern:** 40- 60 percent of 30-m grid cells mapped in conserved riparian habitats in the MSPA are high ecological integrity (>66 percent healthy trees).
- **Significant Concern:** <40 percent of 30-m grid cells mapped in conserved riparian habitats in the MSPA are high ecological integrity (>66 percent healthy trees).

### Current Condition: Good

Currently, a single year of data is available for this metric (2014). The baseline and the current conditions both use this value. In 2014, 87 percent of the area mapped as trees in conserved riparian forest and scrub in the MSPA was considered to have high integrity, as determined by the percentage of healthy trees (high NDVI). While this condition meets the long-term goal, a high level of threat and additional mortality has taken place since 2014 as a result of shot hole borer infestations.

### Trend (2014): Unknown

The trend of this metric is currently Unknown because data are not available for another time period. Future reports will identify a trend by repeating these analyses with additional years of data

**Confidence: Moderate**

Mapping techniques do not account for tree or plant species. Tree values are based on height (>3 m) in 2014 and 2015. Large changes may have occurred since 2014 and additional years are required to understand this change.

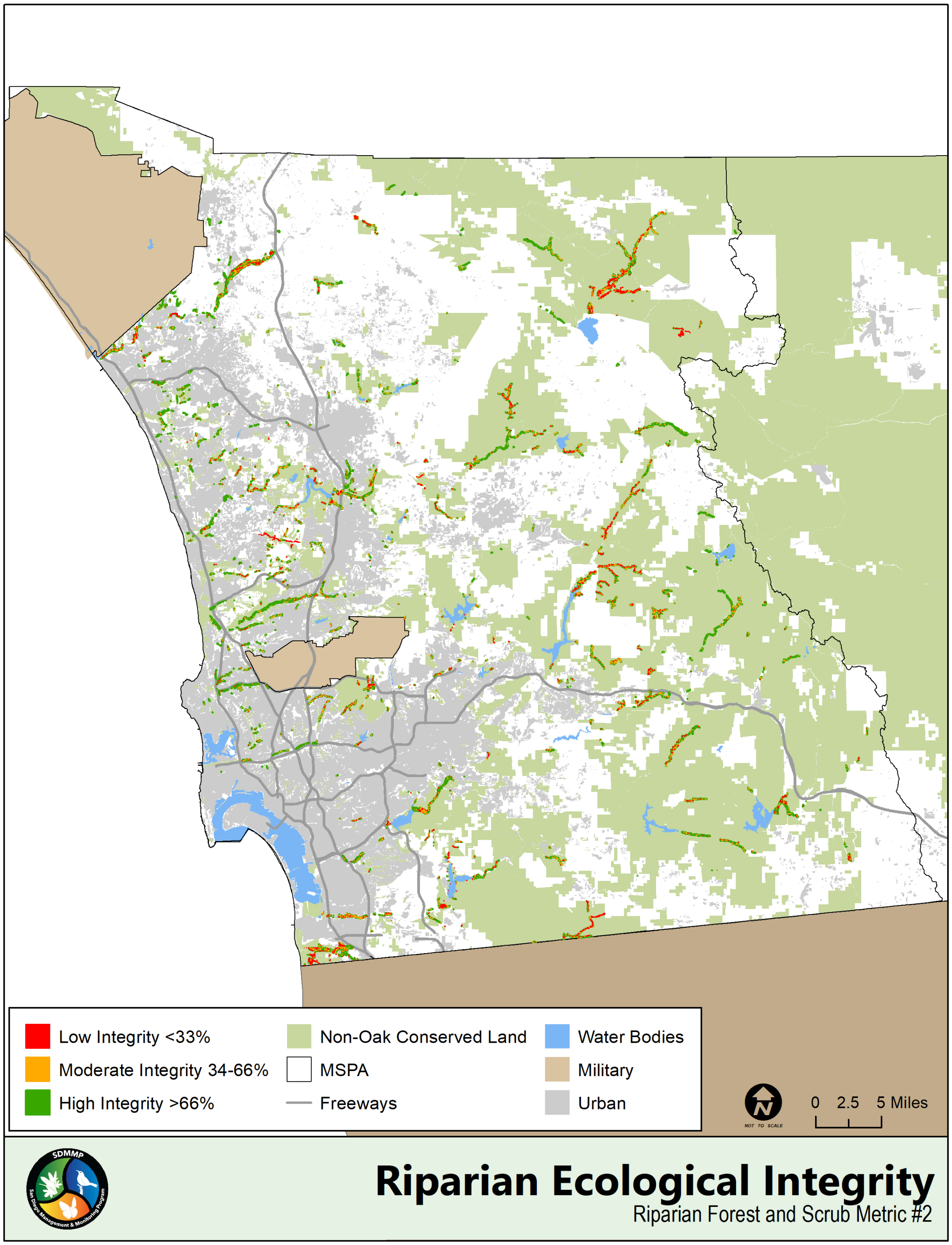


**Figure RIPARIAN 2.1.** Ecological integrity of conserved riparian forest and scrub in the MSPA. Ecological integrity was calculated as percent of healthy trees (live trees with NDVI ≥0.1) in a 30-m grid cell in areas mapped as riparian. Low integrity (red) is 33 percent or less healthy trees. Moderate integrity (orange) is 34-66 percent healthy trees. High integrity is over 66 percent healthy (dark green).

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## Bats – Species Indicator (Landscape Species)


### Why Is This Indicator Included?

> Bats are a diverse group and play an important role in ecosystems globally (Torquetti and others 2021). They help to control insect populations, such as mosquitos (Wray and others 2018) and agricultural insect pests, and serve as pollinators and seed dispersers (O'Shea and Bogan 2003; Torquetti and others 2021).

Bats were selected as an indicator of landscape connectivity as they use many areas across a landscape (Ball 2002; Rainho and Palmeirim 2011) and can be sensitive to habitat fragmentation from urban and agricultural development (Ball 2002; Miner and Stokes 2005; Frey-Ehrenbold and others 2013).

The loss of bats from the urban-wildland interface can indicate fragmentation and degradation of foraging habitats, such as riparian forest and scrub and oak woodlands (Miner and Stokes 2005; Fenton 2003). Bats use ecological neighborhoods that include different parts of the landscape for foraging and roosting (Ball 2002). The ecological neighborhoods used by bats include day and night roosting habitats and maternity colonies (caves, mines, bridges, rocky crevices, boulder fields, trees) and foraging habitat, especially open water and riparian areas (Ball 2002). Bats move among these resources, and it is important to consider landscape connectivity for the entire neighborhood when developing a management strategy and prioritizing management actions (Ball 2002; Rainho and Palmeirim 2011).

San Diego County is a biodiversity hot spot for bats with 22 species documented, many of conservation concern (Stokes and others 2005; SDNHM 2018). Of particular concern in San

Diego County are pallid bat (*Antrozus pallidus*) and Townsend's big-eared bat (*Corynorhinus townsendii*).

Pallid bats were once very abundant in southern California (Krutzcsh 1948) and have undergone a steep decline associated with the expansion of urban development (Miner and Stokes 2005). They roost in crevices and man-made structures and forage by gleaning prey from the ground and vegetation in grasslands and open scrub. Pallid bats forage for large-bodied arthropods, particularly grasshoppers and beetles (Lenhart and others 2010).

The Townsend's big-eared bat is of conservation concern due to a large decline in maternity colonies surveyed 1987-1991 (Bonham 2013). Townsend's big-eared bats roost in caves, buildings, bridges, and water diversion structures and tend to be sedentary (Pierson and Rainey 1998). They use riparian and wooded landscapes, where they specialize in foraging on Lepidoptera, especially medium sized moths (Brown and others 1994; Fellers and Pierson 2002; Bonham 2013).

### Stressors

Bats face threats such as habitat loss, fragmentation and degradation, human disturbance at roosting sites, climate change and increasing drought, invasive plant species, and pesticides (Miner and Stokes 2005; Adams and Hayes 2008; Fenton 2003; Torquotti and others 2021). Bats generally are good indicators of the integrity of environmental systems because of their global distribution, size, mobility, longevity, variety of trophic roles (Fenton 2003; Jones and others 2009), and population responses to pesticides and contaminants in natural ecosystems (Fenton 2003; Frick and others 2007; Jones and others 2009; Torquotti and others 2021).

- **Climate Vulnerability:** Changing climate may increase frequency, intensity, and duration of drought and negatively affect bat populations by reducing insect availability and open water for drinking (Jones and others 2009; Adams 2010; Sherwin and others 2012). Lack of water is of special concern for lactating females (Adams and Hayes 2008; Sherwin and others 2012). Insect abundance in semi-arid regions may be reduced during drought, which can affect bat productivity and survival and adversely impact populations (Adams 2010; Sherwin and others 2012).
- **Human Use:** A growing human population results in more human disturbance in roosting habitat. Bats are particularly sensitive to human activity and may abandon roosts (Miner and Stokes 2005; Stokes and others 2005; Bonham 2013). Humans can also exclude bats purposefully from roost structures, which are often in short supply. Humans may modify features near cave entrances that can affect cave microclimates, including humidity, temperature, and air flow, making the cave uninhabitable (Shaw and others 1992).
- **Connectivity**: Habitat fragmentation can affect bat neighborhoods, isolating roosting and foraging habitats, including water sources (Ball 2002).

- **Urbanization:** Loss of habitat may reduce bat diversity in urban areas (Miner and Stokes 2005; Jones and others 2009). Pesticides can reduce insect food supply and may also be toxic to bats (Jones and others 2009, Torquotti and others 2021). For some bat species, artificial lighting may attract insects and provide greater food availability, whereas for other species it is detrimental to their foraging (Azam and others 2015; Seewagon and Adams 2021).
- **Invasive Plants:** Invasive, nonnative plants may affect insect communities and interfere with foraging (Bateman and others 2008). Arundo/giant reed may alter insect availability in riparian habitats (Bateman and others 2008).

### Desired Condition

MSP Roadmap Goal (SDMMP and TNC 2017):

*Maintain a diverse bat community and enhance pallid and Townsend's big-eared bat populations by protecting diurnal, nocturnal, and maternity roosts from destruction and human disturbance and enhancing foraging habitat within traveling distance of roosts to increase resilience to environmental and demographic stochasticity, maintain genetic diversity, and improve chances of persistence over the long-term (>100 years).*

### Current Condition Status

From 2002 to 2019, bat communities were surveyed at 157 locations on Conserved Lands in San Diego County (Stokes and others 2005; SDNHM 2018; Myers and others, in preparation). Survey methods included mist netting, passive ANABAT detectors that record calls, audible detections by biologists, day roost surveys and exit counts, and night roost surveys. During surveys, threats to foraging and roosting habitat were noted. A total of 19 species were detected during these surveys, eight of conservation concern (Stokes and others 2005; SDNHM 2018).

The current overall condition status of the Bats Indicator is Caution with an Unknown trend based on the two metric condition values evaluated. More high-quality data is needed to determine trends (table BATS0.1). Based on historic categorizations of abundance and more recent survey results, pallid and Townsend's big-eared bat populations are declining. More surveys are needed to confirm this trend and to determine if there is a trend in bat species richness. As more information becomes available, future analyses will include additional metrics evaluating threats to bat foraging and roosting habitats.

**Table BATS0.1**. Current overall condition status for the Bats Species Indicator and period of baseline to current years comparison, metric conditions, trends, and confidence levels.

| Indicator /metric (baseline – current years) | Condition | Trend | Confidence |
|---|---|---|---|
| Bats overall condition status | Caution | Unknown | Low |
| Metric 1: species richness* (2002-2019) | Good | Unknown | Low |
| Metric 2: percent of sites with pallid bat and/or Townsend's big-eared bat detections (2002-2019) | Caution | Unknown | Low |

*number of species

Confidence is low for the current condition of the Bats Indicator and for metric conditions because older data sources are not comprehensive or consistent in methods, and recent data were collected during a long sampling period with unequal survey effort. It is anticipated that data quality will improve as future surveys include comprehensive and consistent monitoring protocols conducted over shorter sampling periods.

## Metric 1: Species Richness

**Overview:** From 2002 to 2019, bat surveys were conducted at 157 sites on Conserved Lands in western San Diego County (Stokes and others 2005; SDNHM 2018; Myers and others, in preparation). The number of species detected at each site equals the species richness score.

**Metric Evaluation Period:** 2002-2019 (Baseline: 2002-2019; Current: 2002-2019)

**Baseline:** From 2002 to 2019, species richness scores averaged 6.6 ± 4.0 and ranged from 0 to 15 at the 157 sites (Myers and others, in preparation). Eighty-one sites (52 percent) had a species richness score of ≥7.0, which is above the current average score and will be used as baseline for future comparisons (fig. BATS1.1).

**2027 Progress Towards Desired Condition:** To manage threats to species richness at ≥5 sites with species richness score ≥7.0 (associated with 2022-2026 MSP goals and objectives [SDMMP and TNC 2017]).

### Condition Thresholds:

- **Good:** ≥50 percent of sites have a species richness score ≥7.0.
- **Caution:** 40-49 percent of sites have a species richness score ≥7.0.
- **Concern:** 30-39 percent of sites have a species richness score ≥7.0.
- **Significant Concern:** <30 percent of sites have a species richness score ≥7.0.

### Current Condition: Good

There is only one sampling period for this metric (2002-2019), so current condition is also the baseline condition. Species richness scores averaged 6.6 ± 4.0 and ranged from 0 to 15 at the 157 sites (Myers and others, in preparation; fig. BATS1.1). Eighty-one sites (52 percent) had species richness scores ≥7.0.

### Trend (2002-2019): Unknown

For most sites, only one round of data collection within the 2002-2019 sampling period is available. Repeated bat monitoring during at least two more sampling periods would be needed to determine trends in bat species richness scores.

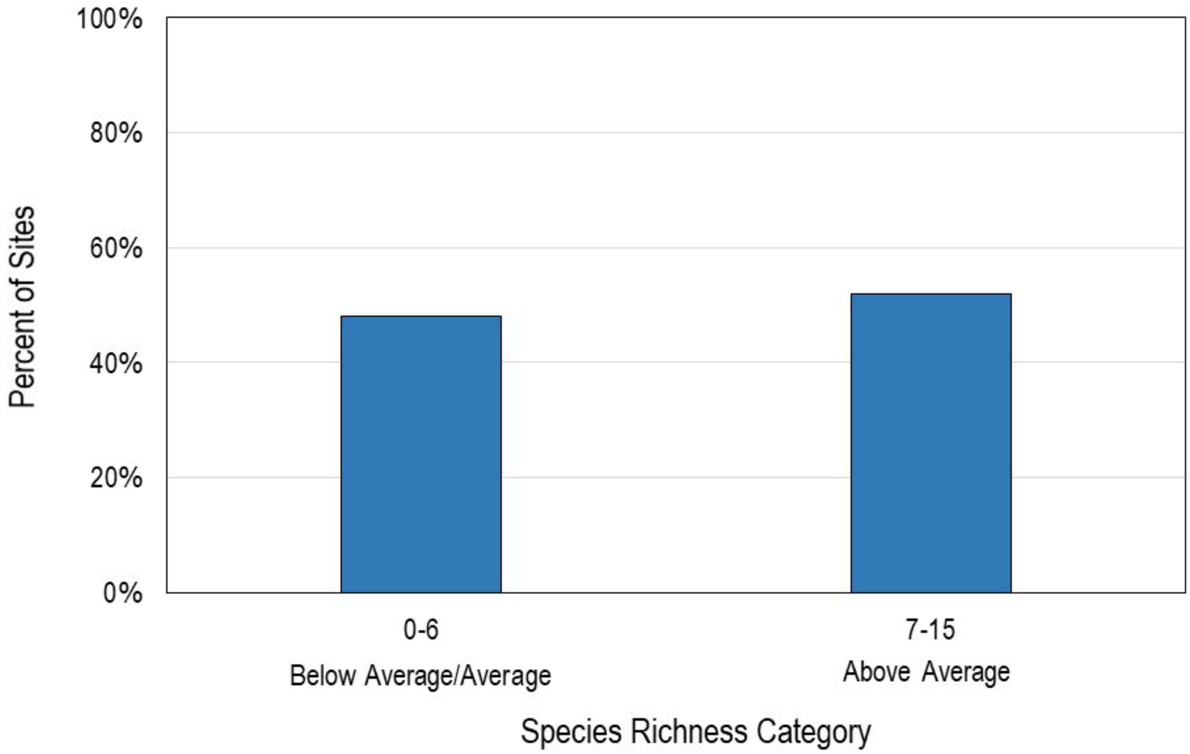


**Figure BATS1.1.** Bat species richness scores.
This graph shows the percentage of 157 bat survey sites falling into categories of species richness below average/average (0-6) and above average (≥7.0) from 2002 to 2019. The average is 6.6 bat species per site (Myers and others, in preparation). Eighty-one sites (52 percent) had species richness scores ≥7.0 (Myers and others, in preparation).

**Confidence: Low**

Surveys conducted at sites over a long sampling period and with unequal survey effort result in some uncertainty about the current status of species richness in some neighborhoods.

## Metric 2: Pallid Bat and Townsend's Big-eared Bat Detections

**Overview:** From 2002 to 2019, bat surveys were conducted at 157 sites on Conserved Lands in western San Diego County (Stokes and others 2005; SDNHM 2018; Myers and others, in preparation). Data on the presence and abundance of pallid bats and Townsend's big-eared bats were collected at each site.

**Metric Evaluation Period:** 2002-2019 (Baseline: 2002-2019; Current: 2002-2019)

**Baseline:** From 2002 to 2019, pallid and/or Townsend's big-eared bats were detected at a total of 65 of 157 sites (41 percent; Myers and others, in preparation). Pallid bats were observed at 36 sites (23 percent) and Townsend's big-eared bats at 48 sites (31 percent; fig. BATS2.1).

**2027 Progress to Reach Desired Condition:** To manage threats to foraging habitat and/or roosts at ≥5 sites with pallid bat and/or Townsend's big-eared bat (associated with 2022-2026 MSP objectives [SDMMP and TNC 2017]).

### Condition Thresholds:

- **Good:** ≥50 percent of sites have pallid bat and/or Townsend's big-eared bat detections.
- **Caution:** 40-49 percent of sites have pallid bat and/or Townsend's big-eared bat detections.
- **Concern:** 30-39 percent of sites have pallid bat and/or Townsend's big-eared bat detections.
- **Significant Concern:** <30 percent of sites have pallid bat and/or Townsend's big-eared bat detections.

### Current Condition: Caution

There is only one sampling period for this metric (2002-2019), so current condition is also the baseline condition. From 2002-2019 there were 65 (41 percent) of 157 sites with pallid and/or Townsend's big-eared bat detections (fig. BATS2.1). Of these, pallid bats were present at 36 sites (23 percent) and Townsend's big-eared bats at 48 sites (31 percent; Stokes and others 2005; SDNHM 2018; Myers and others, in preparation).

### Trend (2002-2019): Unknown

In the 1930s and 1940s, pallid bat and Townsend's big-eared bat were considered common and abundant in the coast, foothills, and inland valley topographic areas of western San Diego County (Krutzsch 1948). Surveys in San Diego County in the late 1990s and early 2000s detected pallid bat at 5-27 percent of sites in different topographic areas where in 1948 the bat was considered abundant (Miner and Stokes 2005). Similarly, Townsend's big-eared bat detections ranged from 13-33 percent of sites in different topographic areas where it was previously considered common or abundant (Miner and Stokes 2005).

Across the MSPA, pallid bats were detected at 23 percent of sites from 2002-2019 and Townsend's big-eared bats at 31 percent (Stokes and others 2005; SDNHM 2018; Myers and others, in preparation). Pallid bat is now in low abundance or is missing from many areas where it was detected in the 1940s, and there are no longer any known active maternity roosts (Miner and Stokes 2005; SDNHM 2018). For Townsend's big-eared bat, while there was a higher percentage of detections, there was a significant decline in maternity roosts (Miners and Stokes 2005; SDNHM 2018). More sampling is needed to determine if this is a declining trend.

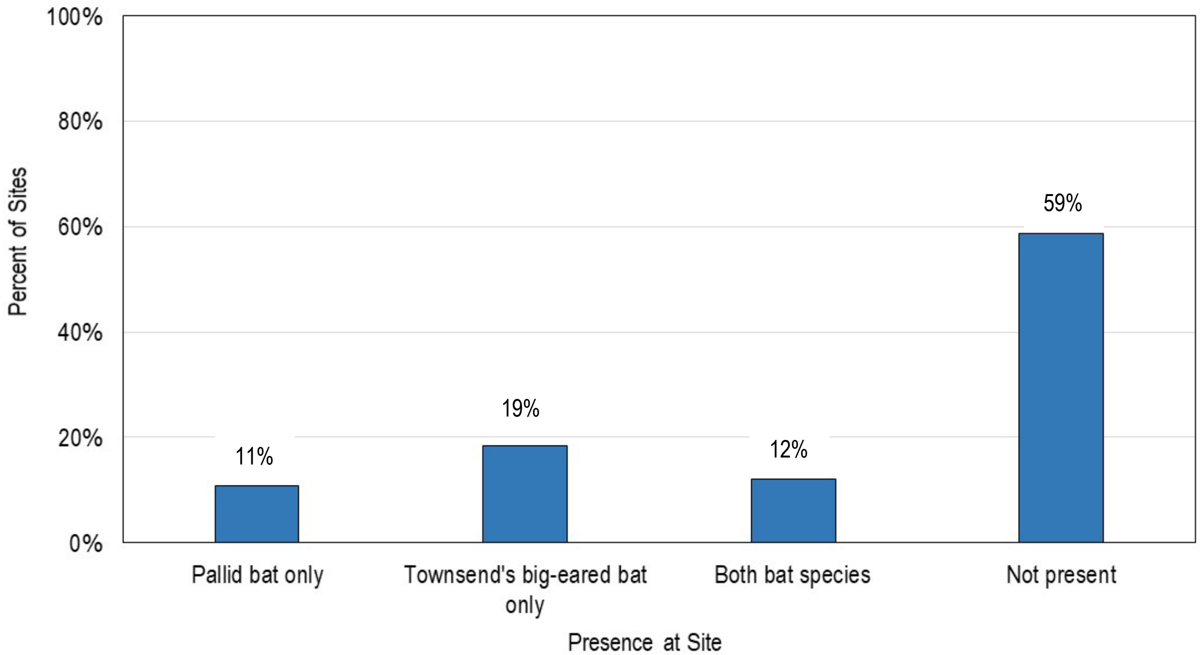


**Figure BATS2.1.** Pallid and big-eared bat detections.
This graph shows the percentage of 157 sites with pallid bat and/or Townsend's big-eared bat detections from 2002 to 2019 (Myers and others, in preparation).

### Confidence: Low

Surveys were conducted using different methods and levels of survey effort, and different types of data were collected in various surveys (abundance categorization versus percent of sites where a species was detected using various survey methodologies). However, there is also supplemental information about loss of roosting sites that indicate a potential declining trend over time in pallid and Townsend big-eared bat populations within the MSPA (Stokes and others 2005; SDNHM 2018; Myers and others, in preparation).

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## Mountain Lion – Species Indicator (Landscape Species)


### Why Is This Indicator Included?

In San Diego County, the average male mountain lion territory is 375 kilometers squared ($km^2$) (92,665 acres) and for females it is 193 $km^2$ (47,691 acres; Vickers and others 2017). A recent study of California mountain lions estimated, based on habitat and genetics modeling, that contiguous habitat ≥10,000 $km^2$ (2.47 million acres) is needed to maintain a genetically diverse and viable population of mountain lions (Dellinger and others 2020). Dellinger and others (2020) estimated that the Eastern Peninsular Ranges in San Diego and Riverside counties has 4,777 $km^2$ (1.18 million acres; 62 percent) protected out of 7,683 $km^2$ (1.90 million acres) of suitable mountain lion habitat.

The mountain lion (*Puma concolor*) is the top carnivore in southern California and is important in maintaining the biodiversity and integrity of natural communities. These large cats are wide-ranging and use a variety of habitats, preferring riparian and chaparral and avoiding open grassland and urban areas (Dickson and others 2005; Burdett and others 2010; Jennings and others 2015; Zeller and others 2017; Dellinger and others 2020).

Mountain lions are a key indicator of preserve system connectivity. They have very large territories and young lions disperse long distances (Beier 1995; Zeller and others 2017; Dellinger and others 2020). Protecting land and improving connectivity for mountain lions could also benefit other species, especially those that are wide roaming (Zeller and others 2017). Mountain lions also influence food webs and the flow of energy through natural ecosystems. Lions can change community composition and structure by affecting prey population dynamics, which impacts herbivory on plants and competition between herbivores (Ripple and Beschta 2006). In other cases, there may be short-term impacts on prey populations but no change in long-term dynamics (Hurley and others 2011). The mountain lion is also a charismatic species that sparks public interest and fascination.

## Stressors

There are a variety of threats facing mountain lions in southern California generally and San Diego County specifically. Southern California's human population grew rapidly over the last half century, leading to extensive habitat loss and fragmentation from urban and agricultural development (Vickers and others 2015). Despite conservation of large blocks of habitat, many mountain lion populations are small and isolated by freeways and surrounded by development (Vickers and others 2015, 2017; Dellinger and others 2020). Mountain lions have unusually high mortality rates in southern California, primarily from vehicle strikes and human conflicts (for example, depredation permits) (Vickers and others 2015). The lion mortality rate in the East Peninsular Range in San Diego County is one of the highest in the state (Vickers, pers. com.).

- **Climate Vulnerability:** Changing climate can increase frequency, intensity, and duration of droughts and negatively affect lion populations by reducing prey availability (Stoner and others 2018). Plant productivity in semi-arid regions is correlated with rainfall, and drought limits food availability for prey and causes prey populations to shrink. A reduction in prey availability can lower lion productivity and survival and adversely impact populations (Stoner and others 2018).
- **Human Use:** A growing human population results in less habitat for mountain lions free from human disturbance. There are increasing interactions between lions and humans that can result in safety and livestock protection concerns and in the death of the lions from depredation permits (Vickers and others 2015).
- **Connectivity:** Habitat loss and fragmentation are causing increasing risk to mountain lion populations in southern California. Mountain lions are constrained or blocked in moving between small, isolated populations, leading to loss of genetic diversity. Loss of connectivity is leading to a potential extinction vortex in the Santa Ana Mountains population and is likely to similarly affect the Eastern Peninsular Ranges population over time (Ernest and others 2014; Gustafson and others 2018; Benson and others 2019; Dellinger and others 2020).
- **Fire:** Increasing frequency of large-scale wildfires in shrublands is leading to conversion of shrublands to invasive, nonnative annual grassland, a habitat infrequently used by mountain lions. Fire in linkages and corridors can be impactful as loss of shrub and tree cover can lead to decreased connectivity between habitat patches (Jennings and others 2016).
- **Urbanization:** Loss and fragmentation of habitat is negatively impacting lion populations which require very large, unfragmented natural habitats to persist. Lions bordering urbanized and rural residential areas are at risk of death from vehicle collisions and conflicts with humans (Vickers and others 2015; Dellinger and others 2020).

## Desired Condition

MSP Roadmap Goal (SDMMP and TNC 2017):

*Enhance and expand conservation of areas occupied by mountain lions in San Diego County in large interconnected blocks (≥12,400 acres) of high-quality habitat with larger patches where habitat quality is lower, surrounded by a limited number of high use roads, and increase connectivity (and reduce potential road mortality) between occupied and suitable habitat areas to allow expansion and movement of mountain lion occurrences within San Diego County and adjacent counties to increase effective population size to sustainable levels and work to reduce depredation on livestock to ensure persistence in the MSP over the long-term (>100 years).*

## Current Condition Status

California's human population grew rapidly over the last half century, especially along the coast and in the south. This led to extensive mountain lion habitat loss and fragmentation from urban and agricultural development (Vickers and others 2015). Mountain lions require large areas of interconnected natural habitats to sustain populations over time (Dellinger and others 2020). There are 10 genetically distinct mountain lion populations in California and Nevada (Gustafson and others 2018). Most of San Diego County's mountain lions belong to the Eastern Peninsular Ranges population and are distributed in undeveloped valleys, foothills, and mountains to the east and north of the urbanized coastal plain (fig. MOLI0.1). A small number of mountain lions belong to the Santa Ana Mountains population and inhabit northwestern San Diego County, although most individuals in this population occur in Riverside and Orange counties. Over the last 25 years, several NCCPs were established to conserve sensitive species and their habitats, including mountain lions (Vickers and others 2017).

Despite conservation of large blocks of habitat, many mountain lion populations are small and isolated by freeways and surrounded by development. Young lions find it difficult to establish territories since most habitat is already occupied. A lack of habitat can lead to adult territorial males killing young dispersing lions, especially young males (Benson and others 2020). Mountain lions have unusually high annual mortality rates of 45 percent in southern California, primarily from vehicle strikes and human conflicts (that is, depredation permits) (Vickers and others 2015). The lion mortality rate in the East Peninsular Range is even higher and is one of the highest in the state (Vickers, pers. com.).

The combination of these factors has contributed to the loss of genetic diversity among most populations (Ernst and others 2014; Gustafson and others 2018; Dellinger and others 2020). Long-term persistence for mountain lion populations in San Diego County is dependent on re-establishing connections between the Eastern Peninsular Ranges population and populations in the Santa Ana Mountains and San Gabriel/San Bernardino Mountains (Dellinger and others 2020). In 2019, the State of California was petitioned to list the coastal and southern California mountain lion populations as endangered.

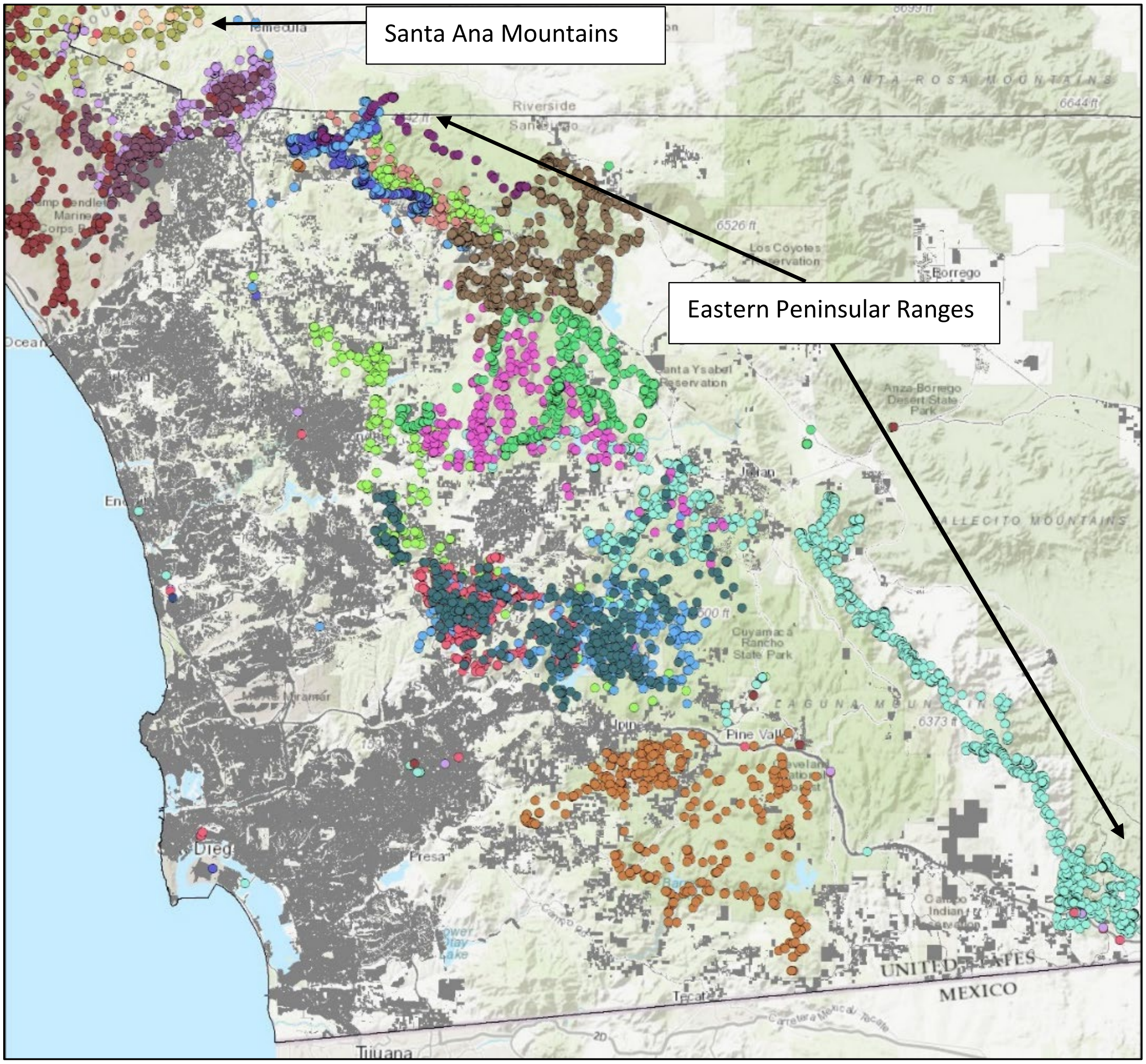


**Figure MOLI0.1.** Mountain lion distribution in San Diego County.
This map shows the global positioning system (GPS) telemetry points of mountain lions color coded by individual. Data were collected from 2005 to 2016 (Vickers and others 2017). Urbanized areas are shown in gray.

The overall condition status for the Mountain Lion Species Indicator in the MSPA is rated as Significant Concern (table MOLI0.1). This is because both Metrics 1 (genetic diversity) and 2 (conserved habitat) are ranked as Significant Concern. As more information becomes available, future reports will include additional metrics evaluating population size, survival, threats to survival and connectivity, and management to reduce threats. Confidence is high as data sources are recent, reliable, and comprehensive.

**Table MOLI0.1**. Current overall condition status for the Mountain Lion Species Indicator and period of baseline to current years comparison, metric conditions, trends, and confidence levels.

| Indicator/metric (baseline – current years) | Condition | Trend | Confidence |
|---|---|---|---|
| Mountain lion overall condition status | Significant Concern | Unknown | High |
| Metric 1: genetic diversity (1992-2016) | Significant Concern | Unknown | High |
| Metric 2: conserved habitat (1995-2020) | Significant Concern | Improving | High |

## Metric 1: Mountain Lion Genetic Diversity

**Overview:** Mountain lion populations have become isolated and small in southern California and are showing signs of inbreeding (Ernest and others 2014; Gustafson and others 2018). Small populations are vulnerable to loss of genetic diversity with higher levels of breeding among closely related individuals (that is, inbreeding). As inbreeding increases, individuals are likely to have deleterious alleles (one or more forms of a gene located at the same place on a chromosome). Inbreeding can lead to inbreeding depression with reduced reproductive success and survival (Benson and others 2019).

Florida panthers, a related species, experienced rapid decline in population growth as inbreeding depression reduced age-specific survival rates (Johnson and others 2010). Without immigration and gene flow, inbreeding depression increases the risk of rapid extirpation of mountain lion populations (Benson and others 2019).

An important measure of genetic diversity is effective population size which, simply put, is the number of individuals contributing genes to the next generation. An effective population size of ≥50 is considered the minimum to prevent inbreeding depression over five generations in the wild. Recent research indicates this minimum threshold should be increased to 100 individuals. An effective population size of ≥500 has been recommended to maintain enough genetic diversity to allow adaptation to changing conditions. Recent analyses indicate ≥1,000 individuals may be needed to maintain this evolutionary potential (Frankham and others 2014).

Other measures of genetic diversity include allelic richness (number of alleles at the same location on a chromosome), heterozygosity (having two different alleles), and internal relatedness which measures the relative level of inbreeding in a population (Keller and Waller 2020).

While the Eastern Peninsula Range mountain lion population in San Diego and Riverside counties is the largest in southern California (Gustafson and others 2018), it is well below the lower threshold of effective population size of 50 individuals (Ne estimated as 31.6 by Gustafson and others (2018) and 24 by Ernst and others (2014)) to avoid inbreeding and the more conservative threshold of 100 individuals (Frankham and others 2014; see text box). Genetic results and morphological traits such as kinked tails show the Santa Ana Mountains population is becoming highly inbred. A population viability analysis including inbreeding effects predicts the Santa Ana Mountains population is at risk of an extinction vortex and could disappear within 12 years (Benson and others 2019).

Increasing effective population size in southern California and avoiding inbreeding at the threshold of 50 individuals could be achieved by improving connectivity, resulting in an interconnected metapopulation of mountain lion populations in the San Gabriel/San Bernardino Mountains, Santa Ana Mountains, and Eastern Peninsular Ranges (Dellinger and others 2020). To retain evolutionary potential (effective population size of 500-1,000 individuals) would require improving connectivity between all California and Nevada populations (Frankham and others 2014; Dellinger and others 2020; see text box).

**Metric Evaluation Period:** 1992-2016 (Baseline: 1992-2016; Current: 1992-2016)

**Baseline:** The baseline is equal to the current estimate for mountain lion effective population sizes for the portion of the Eastern Peninsular Ranges in San Diego County and a second estimate is derived for the entire Eastern Peninsular Ranges, including San Diego and Riverside counties. The effective population size estimate for mountain lions sampled from 2000 to 2012 in western San Diego County is 24.3 individuals (Ernst and others 2014). The estimate for the entire Eastern Peninsular Ranges is 31.6 individuals based on samples collected from 1992 to 2016 (Gustafson and others 2018).

Mountain lions in San Diego County fall predominantly within the Eastern Peninsular Ranges population with a small number of individuals in the Santa Ana Mountains population (Ernest and others 2014). To maintain a genetically diverse population will require an interconnected metapopulation consisting of the San Gabriel/San Bernadino Mountains population, the Santa Ana Mountains population, and the Eastern Peninsular Ranges population. Effective population sizes for mountain lions sampled from 1992 to 2016 are 5.0 (n=22) in the San Gabriel/San Bernardino Mountains, 15.6 (n=48) in the Santa Ana Mountains, and 31.6 (n=120) in the Eastern Peninsular Ranges, which includes both San Diego and Riverside counties (Gustafson and others 2018). A previous study collected genetic samples from 2001 to 2012 from the Eastern Peninsular Ranges (primarily in San Diego County with 51 of 55 samples) and the Santa Ana Mountains (n=42). This study estimated effective population sizes for the Eastern Peninsular Ranges at 24 individuals and the Santa Ana Mountains at 5 (Ernst and others 2014).

**2027 Progress to Reach Desired Condition:** Effective population size of ≥50 individuals for an interconnected Santa Ana Mountains, Eastern Peninsular Ranges, and San Gabriel/San Bernardino Mountains metapopulation, including ≥30 individuals in San Diego County (associated with 2022-2026 MSP goals and objectives [SDMMP and TNC 2017]).

### Condition Thresholds:

- **Good:** Effective population size of ≥35 individuals in San Diego County.
- **Caution:** Effective population size of 30-34 individuals in San Diego County.
- **Concern:** Effective population size of 25-29 individuals in San Diego County.
- **Significant Concern:** Effective population size <25 individuals in San Diego County.

### Current Condition: Significant Concern

The current condition for the mountain lion effective population size is the same as the baseline and falls within the Concern category. An analysis of 55 mountain lion genetic samples (51 from San Diego County) collected from 2001 to 2012 in the Eastern Peninsular Ranges found an effective population size of 24.3 (Ernest and others 2014, table MOLI1.1). A second study (Gustafson and others 2018) estimated an effective population size of 31.6 for the Eastern Peninsular Ranges with a broader sampling distribution (San Diego and Riverside counties), more samples (n=120), and a longer time frame (1992-2016).

Other genetic measures not used in the condition thresholds also indicate concern in the current genetic condition of the Eastern Peninsular Ranges (table MOLI1.1). The Santa Ana Mountains and Eastern Peninsular Ranges populations are isolated from other populations in the state (Ernest and others 2014; Gustafson and others 2018). These two populations are also relatively isolated from each other. Of 146 mountain lions sampled over a 15-year period, only seven crossed Interstate 15 (Gustafson and others 2017). Of these, only one male was documented reproducing and contributing genes to subsequent generations. This male crossed from the Eastern Peninsular Ranges into the Santa Ana Mountains and sired 11 offspring and decreased inbreeding and increased heterozygosity in the Santa Ana Mountains population (Gustafson and others 2017).

### Trend (1992-2016): Unknown

Gustafson and others (2017) found evidence that the Eastern Peninsular Ranges population went through a significant genetic bottleneck. In this study, the authors estimated an effective population size was 37.4 individuals. A later study by Gustafson and others (2018) produced an effective population size estimate of 31.6 individuals (table MOLI1.1). Based on calculations presented in Ernst and others (2014), this contraction likely occurred 40-80 years before the sampling period of 1992-2016 and coincided with a period of freeway construction and urban development. These estimates of effective population size suggest that the genetic diversity of mountain lions in this area could possibly be declining, but more data are needed to determine a trend.

**Table MOLI1.1**. Genetic diversity measures for mountain lions in the Eastern Peninsular Range.

| Area sampled | SP | n | AR | Ho | He | Ne (95 percent CI) | Bottleneck Ne with allele frequencies ≥0.01 | Genetic bottleneck? | Source |
|---|---|---|---|---|---|---|---|---|---|
| Entire range | 1992-2016 | 120 | 3.1±0.1 | 0.44±0.03 | 0.44±0.03 | 31.6 (29.1-34.4) | 37.4 (34.5-40.5) | Yes | Gustafson and others 2018 |
| San Diego County | 2001-2012 | 55 | 2.0±0.2 | 0.43±0.04 | 0.41±0.04 | 24.3 (21.7-27.3) | | No | Ernst and others 2014 |

Abbreviations: SP = sampling period; n = sample size; AR = allelic richness; Ho = observed heterozygosity; He = expected heterozygosity; Ne = effective population size; CI = parametric confidence interval

**Confidence: High**

These analyses are based on extensive genetic sampling conducted from 1992 to 2016. There is overlap in samples and time periods in the analyses, and therefore, the measures are not completely independent.

## Metric 2: Conserved Mountain Lion Habitat

**Overview:** Individual annual survival of mountain lions in the Santa Ana Mountains and Eastern Peninsular Ranges is unusually low at 56 percent (Vickers and others 2015). The leading causes of death are vehicle collisions and depredation permits issued when a lion kills livestock. It is essential to maintain large interconnected and undeveloped habitat patches to avoid increasing mortality rates from road crossings and interactions with humans. It is estimated that 10,000 $km^2$ (2,471,054 acres) of contiguous habitat is required to maintain a genetically diverse mountain lion population (Dellinger and others 2020).

Mountain lions have very large territories. Male territories average 92,665 acres, and female territories average 47,691 acres in San Diego County, with a minimum territory size of 12,400 acres for females (Vickers and others 2017). For smaller territories that are closer to the minimum size, it is essential that all the habitats used be of high quality to support a female lion.

For the San Diego County portion of the Eastern Peninsular Ranges, excluding military and tribal lands, the goal is to conserve and manage habitat to maintain 25 female mountain lion territories. This goal is based on the number of female territories because male territories overlap with female territories. Military and tribal lands support additional lions that contribute to a larger population for San Diego County. Based on undeveloped land in large, contiguous patches (≥12,400 acres) and not in military or tribal ownership, there is enough land for at least 24 female mountain lions with an average territory size of 48,000 acres (Figure MOLI2.1).

The goal of conserving at least 25 female mountain lion territories will be revisited in the future with species experts and the Wildlife Agencies using modeled suitable habitat, connectivity analyses, and other information. The potential number of female territories that could be conserved as well as those likely to occur on tribal and military lands will provide an estimate for the number of female territories in the Eastern Peninsular Ranges in San Diego County. This assessment could lead to revisions of the condition criteria. It is estimated that 8,834 $km^2$ (2,182,929 acres) of suitable habitat is currently protected in the combined Eastern Peninsular Ranges, Santa Ana Mountains, and San Gabriel/San Bernardino Mountains (Dellinger and others 2020).

**Metric Evaluation Period:** 1995-2020 (Baseline: 1995; Current: 2020)

**Baseline:** In 1995, there were 26 patches of contiguous undeveloped land ≥12,400 acres (minimum female mountain lion territory) in western San Diego County. Marine Corps Base Camp Pendleton is 81 percent of the largest contiguous habitat patch. Tribal lands contribute substantially to 12 large patches. Military and tribal lands are outside the purview of multiple species conservation plans and are excluded from calculations of percent land conserved. In 1995, six of 26 (23 percent) contiguous habitat patches ≥12,400 acres had conservation levels of at least 70 percent (fig. MOLI2.1). A total of 508,123 acres were conserved in these large patches (Dewitz 2019; SDMMP 2020).

**2027 Progress to Reach Desired Condition:** No short-term progress milestone.

### Condition Thresholds:

- **Good:** ≥70 percent of contiguous undeveloped habitat conserved in >20 of the largest patches ≥12,400 acres.
- **Caution:** ≥70 percent of contiguous undeveloped habitat conserved in 16-20 of the largest patches ≥12,400 acres.
- **Concern:** ≥70 percent of contiguous undeveloped habitat conserved in 11-15 patches ≥12,400 acres.
- **Significant Concern:** ≥70 percent of contiguous undeveloped habitat conserved in ≤10 patches ≥12,400 acres.

### Current Condition: Significant Concern

In the current period (2020), eight (31 percent) of 26 patches of contiguous habitat ≥12,400 acres were ≥70 percent conserved (figs. MOLI2.1 and MOLI2.2). One large contiguous patch present in the baseline period (1995) was fragmented by development and roads and is no longer ≥12,400 acres. In 2020, a total of 615,659 acres were conserved in these large patches of natural lands.

### Trend (1995-2020): Improving

While one large patch was fragmented since 1995, there has been an increase from six to eight large patches ≥70 percent conserved. In addition, 15 other large patches (>12,400 acres) that fell short of the ≥70 percent conserved level did show increases in the amount of land conserved since 1995 (figs. MOLI2.1 and MOLI2.3).

**Confidence: High**

Geographic information systems (GIS) shapefiles for land use, roads, and Conserved Lands are relatively accurate for calculating patch sizes and amount of area conserved.

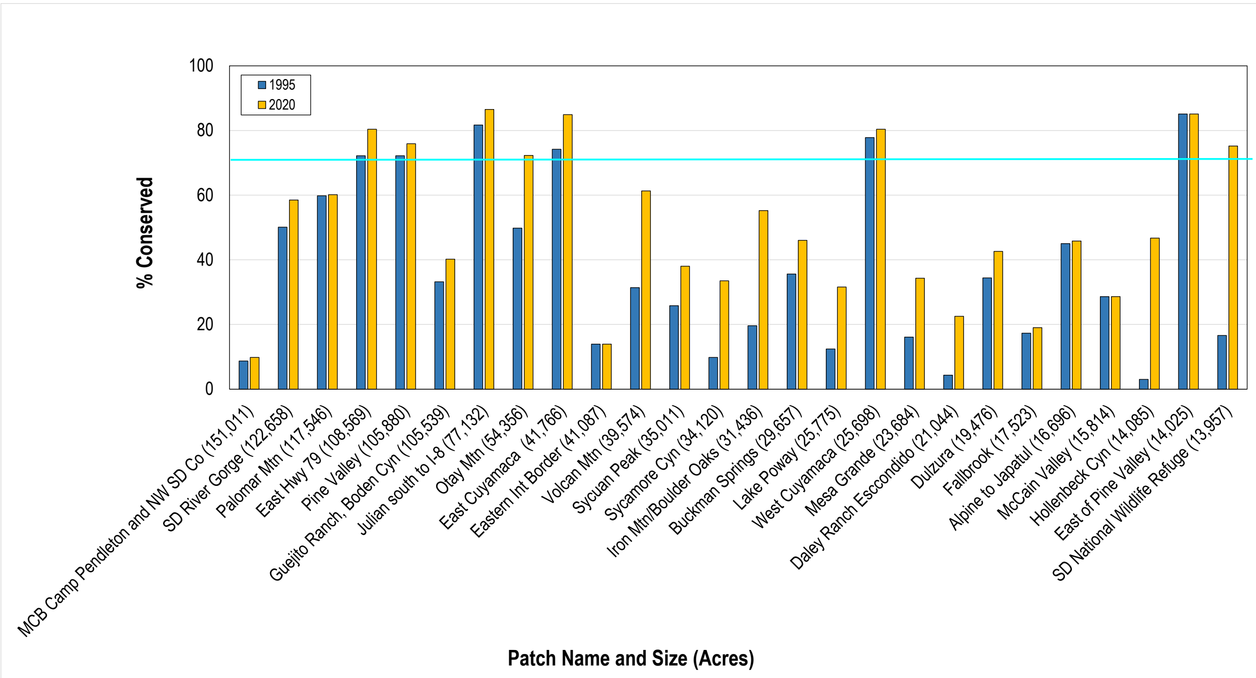


**Figure MOLI2.1.** Large contiguous undeveloped habitat patches conserved in San Diego County. This bar graph shows the percent of large, contiguous natural habitat patches ≥12,400 acres that were conserved in 1995 (baseline) and 2020 (current). The 70 percent conservation threshold used in Mountain Lion Metric 2 is represented by the light blue horizontal line. The numbers in parentheses are size of patches in acres. The largest patch, MCB Camp Pendleton, is 80 percent military lands, but private lands in conservation exceed the 12,400-acre minimum.

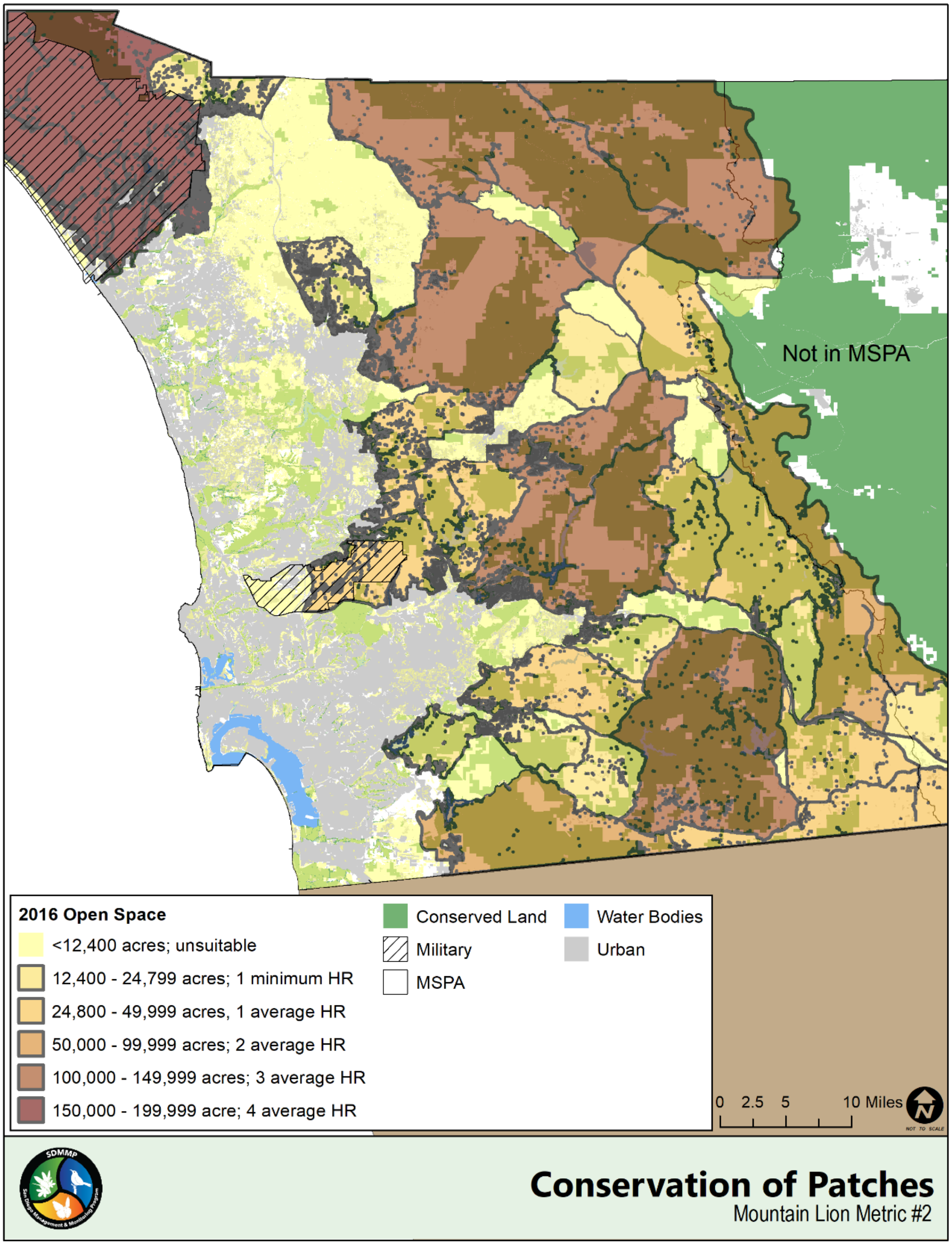


**Figure MOLI2.2.** Conserved mountain lion patches in 2020. This map shows contiguous patches of undeveloped Conserved Lands in 2020. Minimum mountain lion female home ranges (HR) of 12,400 acres represent marginal patch sizes, and patches larger than the average female home range (47,691 acres) represent more suitable patch sizes.

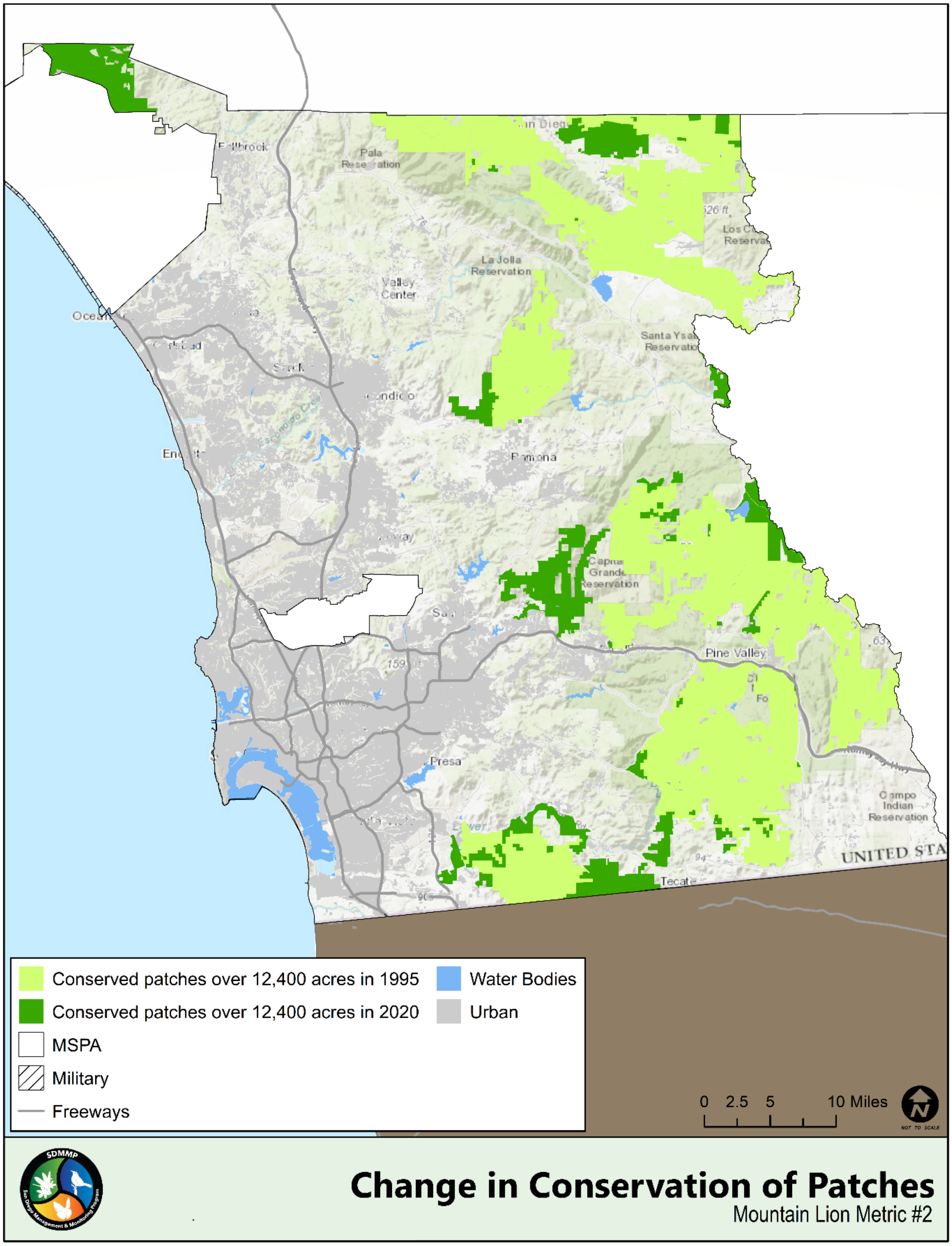


**Figure MOLI2.3.** Change in patch conservation from 1995 to 2020. This map shows the change in conservation for 26 patches of undeveloped lands ≥12,400 acres in western San Diego County. The minimum size of a female mountain lion territory is 12,400 acres.

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## Encinitas Baccharis – Species Indicator (Rare and Specialist Species)


**Why Is This Indicator Included?**

Encinitas baccharis (*Baccharis vanessae*) is an inconspicuous shrub in openings and the understory of chaparral vegetation communities. It is a rare endemic restricted to San Diego County coastal and foothill areas (USFWS 2011). This species was discovered in 1976 (Beauchamp 1980). It was declining by the 1980s and listed by the State of California as endangered in 1987 and by the U.S. Fish and Wildlife Service (USFWS) as threatened in 1996 (USFWS 2011).

Encinitas baccharis was selected as an indicator to assess how well the regional preserve system is protecting a rare endemic species of high conservation concern to managers. Encinitas baccharis is also representative of small shrubs that are

> Encinitas baccharis is dioecious (Beauchamp 1980), requiring male and female plants in close proximity to allow pollination by insects and wind to produce fertile seeds for reproduction. Seeds are thought to be wind dispersed and short-lived in the soil seedbank. Encinitas baccharis is a relatively short-lived plant and may be a poor competitor with taller and more robust shrubs. Older plants have reduced reproductive capacity, a potential threat for small populations (USFWS 2011). Disturbance, such as fire, opens dense chaparral habitat for Encinitas baccharis to colonize and produce young plants (Messina 2017).

fire-adapted and relatively rare and patchily distributed in the understory and small openings of southern maritime chaparral on coastal mesas and more inland southern mixed chaparral communities of western San Diego County.

### Stressors

The primary threat faced by Encinitas baccharis has been urban development leading to habitat loss, fragmentation, and degradation (USFWS 2011). Other threats include small populations vulnerable to demographic and environmental stochasticity, human altered fire regimes, fuel modification and fire suppression, trampling, and nonnative plants (USFWS 2011; Messina 2017; USFWS 2021; SDMMP 2021).

- **Climate Vulnerability:** Increasing frequency, intensity, and duration of droughts can reduce plant germination, seed production, and survival (Williams and Hobbs 1989; USFWS 2011).
- **Invasive Plants:** Nonnative annual forbs and grasses are increasing in distribution and abundance and may compete with Encinitas baccharis for resources. Regional Inspect and Manage monitoring in 2016, 2017, and 2019 (SDMMP 2021) showed nonnative forbs invaded about 3 percent of occurrences in 2016 and nonnative grasses invaded 9 to 25 percent of occurrences, depending on the year.
- **Competitive Native Plants:** Encinitas baccharis occurs in chaparral habitats where it is a poor competitor with taller, more robust shrubs. It relies on disturbances to open up habitat for colonization and recruitment (Messina 2017). Regional Inspect and Manage monitoring in 2016, 2017, and 2019 found that 7 to 37 percent of occurrences were threatened by competition with native plants (SDMMP 2021).
- **Fire:** Encinitas baccharis is an early successional species and dependent on fire to open areas to allow them to grow without taller, larger shrubs nearby (USFWS 2011; Messina 2017). In areas where fire has been suppressed, other shrubs can crowd out Encinitas baccharis (SDMMP 2021). Fuel modification and other fire suppression activities can impact this inconspicuous and easily overlooked plant. Frequent fire can also result in insufficient time that plants need to resprout and build up reserves between fire events (USFWS 2011).
- **Urbanization:** Urban development has caused considerable habitat loss and degradation and caused extirpation of some Encinitas baccharis occurrences (USFWS 2011).
- **Connectivity:** Habitat loss and fragmentation may reduce connectivity between Encinitas baccharis populations. This can lead to small, isolated populations vulnerable to extirpation (USFWS 2011). This is of particular concern for Encinitas baccharis, as both male and female plants must be in a population for pollination and seed production. However, a recent genetic study found that there was no strong genetic structure among occurrences (Milano and Vandergast 2018).

## Desired Condition

MSP Roadmap Goal (SDMMP and TNC 2017):

*Maintain or enhance existing Encinitas baccharis occurrences to ensure multiple conserved occurrences with self-sustaining populations to increase resilience to environmental and demographic stochasticity, maintain genetic diversity, and ensure persistence over the long term (>100 years) in chaparral vegetation communities.*

## Current Condition Status

Encinitas baccharis is restricted to the coast and foothills in San Diego County with a relatively small number of extant occurrences (USFWS 2011; SDMMP 2021), most of which are small with less than 100 plants (SDMMP 2021). This is a threat to the species given the dioecious nature of the plant (that is, having separate male and female plants); reproduction requires male and female plants in close proximity (USFWS 2011). Field visits have not verified many young plants in currently monitored occurrences, although botanists have located some seedlings and young plants in two occurrences. This raises concerns about successful reproduction and aging plants, especially since soil seed banks are considered short-lived (USFWS 2011). In general, small populations are vulnerable to extirpation from demographic and environmental stochasticity (Lacy 2000; Melbourne and Hastings 2008). Other threats include lack of fire in coastal areas resulting in dense chaparral with few openings for Encinitas baccharis to colonize (Messina 2017; USFWS 2011).

The overall condition status for the Encinitas Baccharis Indicator is Caution based on consideration of the three metric condition values (table BAVA0.1). There are signs of potential improvement of the species status due to the discovery and conservation of new occurrences (Metric 1) and some increases in population size (Metric 2), although most occurrences are small and some are declining (SDMMP 2021). Besides the threat of small and isolated occurrences with little sign of recent recruitment, other landscape-scale threats are an altered fire regime and long-term drought. Monitoring shows some serious threats that can be managed at occurrences including competitive native plants, nonnative annual grasses and forbs, trails, trampling, and dumping (Metric 3).

**Table BAVA0.1.** Current overall condition status for Encinitas Baccharis Indicator and period of baseline to current years comparison for metric conditions, trends, and confidence levels.

| Indicator/metric (baseline – current years) | Condition | Trend | Confidence |
|---|---|---|---|
| Encinitas baccharis overall condition status | Caution | Unknown | Moderate |
| Metric 1: conserved occurrences (1996-2020) | Good | Improving | Moderate |
| Metric 2: occurrence status (1995-2020) | Significant Concern | Unknown | Low |
| Metric 3: threats to occurrences (2016-2020) | Caution | Unknown | High |

## Metric 1: Conserved Occurrences

**Overview:** Since the mid-1990s, implementation of the multiple species habitat conservation plans has increased conservation of Encinitas baccharis. To track conservation and management of MSP species, the SDMMP created the MOM database (SDMMP 2020). MOM is a database of species occurrences on Conserved Lands in western San Diego County. Data are compiled from many sources including federal, state, county and city agencies, biological consulting firms, and museums and herbaria. The SDMMP adds new locations discovered from regional survey and monitoring projects. A rare plant occurrence is a population of plants >0.25 miles from the next nearest population.

**Metric Evaluation Period**: 1996-2020 (Baseline: 1996; Current: 2020)

**Baseline:** In 1996, at the time of federal listing, 19 Encinitas baccharis occurrences were known in San Diego County (fig. BAVI1.1; USFWS 1996, 2011, 2021). Sixteen (84 percent) of the 19 occurrences were extant, and 13 (81 percent) of these extant occurrences were conserved (USFWS 1996, 2011, 2021). Three occurrences were considered extirpated.

**2027 Progress to Reach Desired Condition:** Enhance and maintain ≥25 conserved extant occurrences (associated with 2022-2026 MSP goals and objectives).

### Condition Thresholds:

- **Good:** ≥25 conserved and extant or presumed extant occurrences.
- **Caution:** 15-24 conserved and extant or presumed extant occurrences.
- **Concern:** 10-14 conserved and extant or presumed extant occurrences.
- **Significant Concern:** <10 conserved and extant or presumed extant occurrences.

### Current Condition: Good

In 2020, the number of known Encinitas baccharis occurrences in San Diego County increased to 45, with 36 (80 percent) conserved (figs. BAVA1.1 and BAVA1.2; USFWS 2011, 2021; SDMMP 2020, 2021). There are some differences in data between the USFWS 5-Year Reviews in 2011 and 2021 (USFWS 2011, 2021) due to changes to occurrence information in the CNDDB. This metric incorporates the more recent information used in the 2021 USFWS 5-Year Review (USFWS 2021).

Of the 45 occurrences, 30 (67 percent) are extant or presumed extant. Twenty-nine (97 percent) of these occurrences are conserved, so the condition status is Good. Seventeen of these 30 occurrences are extant and conserved, and the other 13 are presumed extant, as plants were detected 10-20 years ago with suitable habitat remaining (USFWS 2021).

The remaining 15 of 45 known occurrences are considered extirpated or possibly extirpated as there is no information on population status for the last 20 years or the habitat is degraded or partially developed (USFWS 2021). Seven conserved occurrences and eight unconserved occurrences are extirpated or possibly extirpated.

### Trend (1996-2020): Improving

The number of known occurrences and the number of conserved occurrences have increased over time (fig. BAVA1.2). This is true for both the total number of conserved occurrences and the number of extant and conserved occurrences.

### Confidence: Moderate

Information is highly reliable for occurrences included in the San Diego Regional Inspect and Manage Monitoring Program. However, some occurrences on privately Conserved Lands are not accessible for regional monitoring, and current information on their population status is lacking.

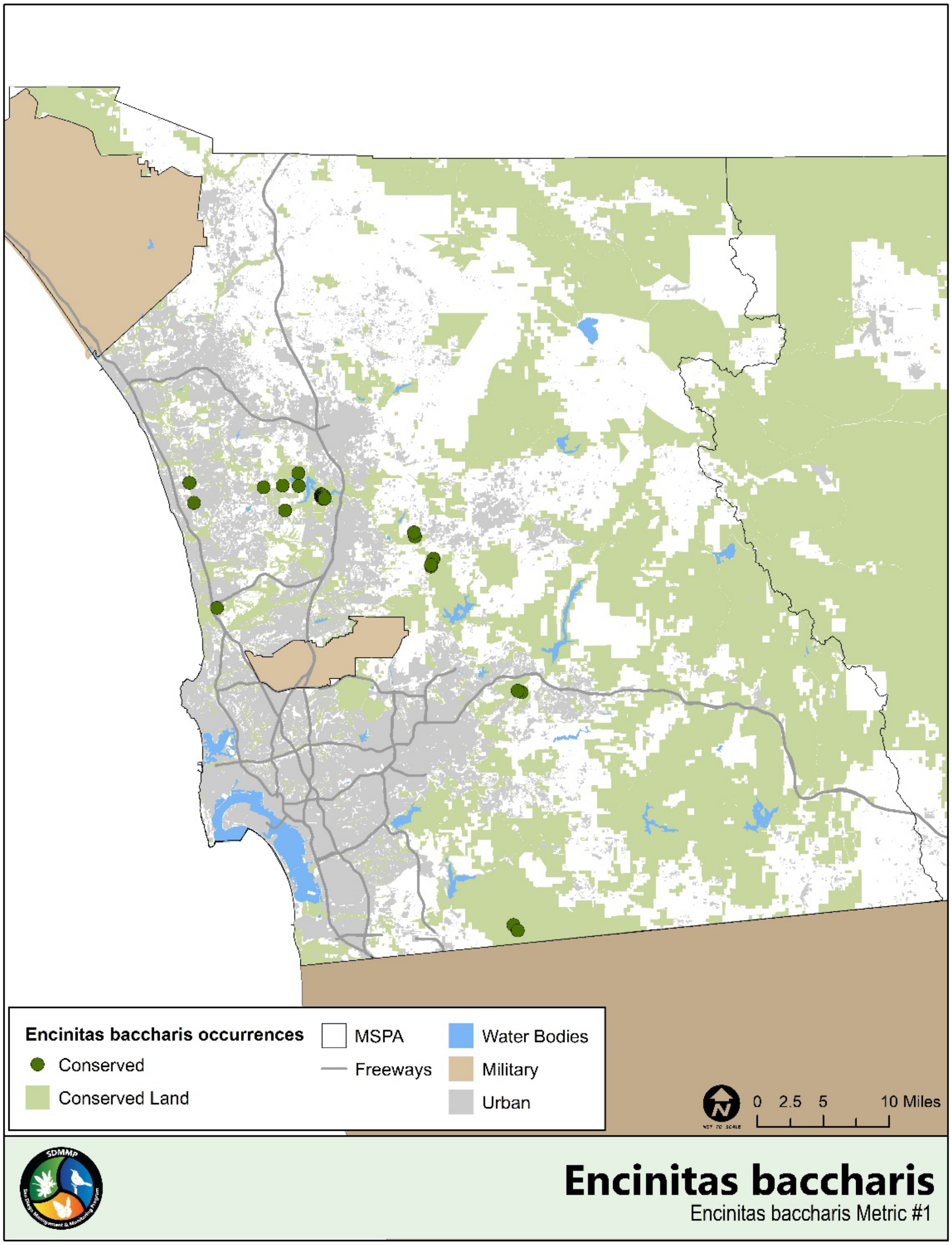


**Figure BAVA1.1.** Conserved Encinitas baccharis occurrences in the MSPA in 2020.
This map shows the conserved occurrences (green) of Encinitas baccharis that were monitored in San Diego County in the period 2016-2020.

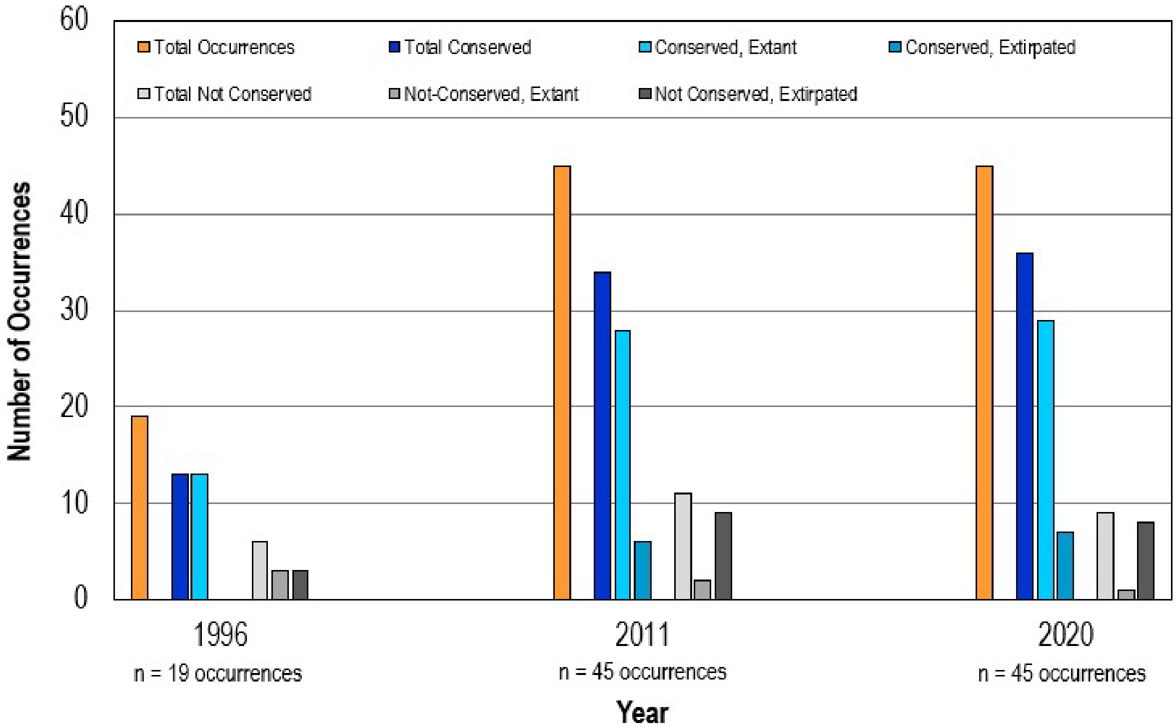


**Figure BAVA1.2.** Number of occurrences and conservation status of Encinitas baccharis over time. This bar graph shows change in the number of occurrences and conservation status of Encinitas baccharis in 1996, 2011, and 2020. Number of conserved occurrences (n) are shown in orange, dark blue, and light blue, and occurrences not conserved are shown in shades of grey.

## Metric 2: Occurrence Status on Conserved Lands

**Overview:** Occurrence status for Encinitas baccharis is measured in terms of numbers of plants (population size) with the goal of increasing occurrence size and/or having it remain stable. Occurrences with stable populations do not decline over time. The MSP Framework Rare Plant Management Plan (CBI and others 2021) defines population size classes for shrub occurrences as: small (<100 plants), medium (100 to 500 plants), and large (>500 plants). Occurrences with small numbers of plants are vulnerable to extirpation from environmental and demographic stochasticity (Lacy 2000; Melbourne and Hastings 2008). Small Encinitas baccharis occurrences are especially vulnerable because both male and female plants are required for successful reproduction. Besides a balanced sex ratio of plants, openings in chaparral communities are required for Encinitas baccharis to colonize and for occurrence size to expand (Messina 2017; USFWS 2011).

SDMMP coordinates regional Inspect and Manage (IMG) for 30 rare plant species (SDMMP 2012). The program began in 2014 and is conducted annually. Monitoring data are collected by land managers and botanists contracted by San Diego Association of Governments (SANDAG) to collect data for “gap” occurrences that are not monitored by land managers. Data are collected on occurrence status, habitat characteristics, and threat assessments using a standardized protocol (SDMMP 2021).

**Metric Evaluation Period:** 1995-2020 (Baseline: 1995; Current: 2020)

**Baseline:** In 1995, there were five or six major occurrences of Encinitas baccharis with >100 plants (Ogden 1995). Of these, three occurred in the MSCP area (4S Ranch, Lake Hodges, and Del Dios Highway) in addition to a few smaller occurrences near Poway (Iron Mountain).

**2027 Progress to Reach Desired Condition:** Increase population size at ≥3 small (defined as <100 plants), conserved Encinitas baccharis occurrences through management to reduce threats or through natural expansion under favorable conditions (associated with 2022-2026 MSP objectives). Maintain stability of enhanced occurrences by managing threats to avoid a decline in population size.

### Condition Thresholds:

- **Good:** Since 1995, ≥7 small, conserved Encinitas baccharis occurrences have increased numbers of plants either through management or natural expansion under favorable conditions, and these populations are stable or increasing over time.
- **Caution:** Since 1995, 5-6 small, conserved Encinitas baccharis occurrences have increased numbers of plants either through management or natural expansion under favorable conditions, and these populations are stable or increasing over time.
- **Concern:** Since 1995, 3-4 small, conserved Encinitas baccharis occurrences have increased numbers of plants either through management or natural expansion under favorable conditions, and these populations are stable or increasing over time.
- **Significant Concern:** Since 1995, ≤2 small, conserved Encinitas baccharis occurrences have increased numbers of plants either through management or natural expansion under favorable conditions, and these populations are stable or increasing over time.

### Current Condition: Significant Concern

Regional monitoring shows that the average occurrence size (that is, number of plants) was less than 200 plants in 2016, 2017, and 2019 (fig. BAVA2.1). Beginning in 2017, monitoring was switched to every other year, so there is no monitoring data for 2018 and 2020. Over time, the number of occurrences monitored increased from eight in 2016 to 14 occurrences in 2019. Seventeen conserved extant occurrences have information on population size as of 2019; 13 (76 percent) were small, three (18 percent) were medium, and one (6 percent) was large.

Two small occurrences in 2016 increased to become medium in size in 2019. Because available data suggest that only two occurrences increased in size, this metric falls in the Significant Concern category. The remaining small occurrences either stayed the same or declined slightly. There are three small occurrences with ≤5 plants.

### Trend (1995-2020): Unknown

In 1995, there were five or six major occurrences of Encinitas baccharis with >100 individuals and a few small occurrences (<100 individuals) (Ogden 1995). Three of the major occurrences were conserved in the MSCP and remain extant. One is medium in size (Del Dios), and there is no recent information on the status of the other two major occurrences (Lake Hodges and 4S Ranch).

In 2016, seven of eight (88 percent) conserved occurrences at the start of regional Inspect and Manage Monitoring Program for Encinitas baccharis were small (<100 plants; SDMMP 2021). One newly discovered occurrence was large with 672 shrubs. In 2019, the number of conserved occurrences with occurrence size estimates increased to 17. Of these, the large occurrence grew to over 900 plants, and two small occurrences increased in size to the medium category. These increases may be partially explained by more extensive efforts to map shrubs under the canopy. A third occurrence, not monitored in 2016, is also medium in size. Overall, the trend is uncertain with more years of monitoring data required to determine a trend.

### Confidence: Low

This metric is based upon Regional Rare Plant Inspect and Manage monitoring data, which is typically reliable for counts of plants in occurrences. However, Encinitas baccharis is particularly difficult to detect, accurately map, and count because it typically occurs in the understory of chaparral vegetation. There may be larger occurrences spatially distributed over a large area underneath the canopy of dense chaparral. A genomic study shows little genetic differentiation among occurrences, suggesting there may be undiscovered occurrences facilitating gene flow between known occurrences (Milano and Vandergast 2018). The increase in numbers for two occurrences between 2016 and 2019 may be due in part to an increase in mapping effort. It is also difficult to determine a trend since the 1995 information is lacking specific numbers (Ogden 1995) and recent monitoring data are unavailable due to access restrictions for two of the three MSCP major occurrences documented in 1995. In the future, there will be increased effort into mapping the full extent of occurrences to improve data quality.

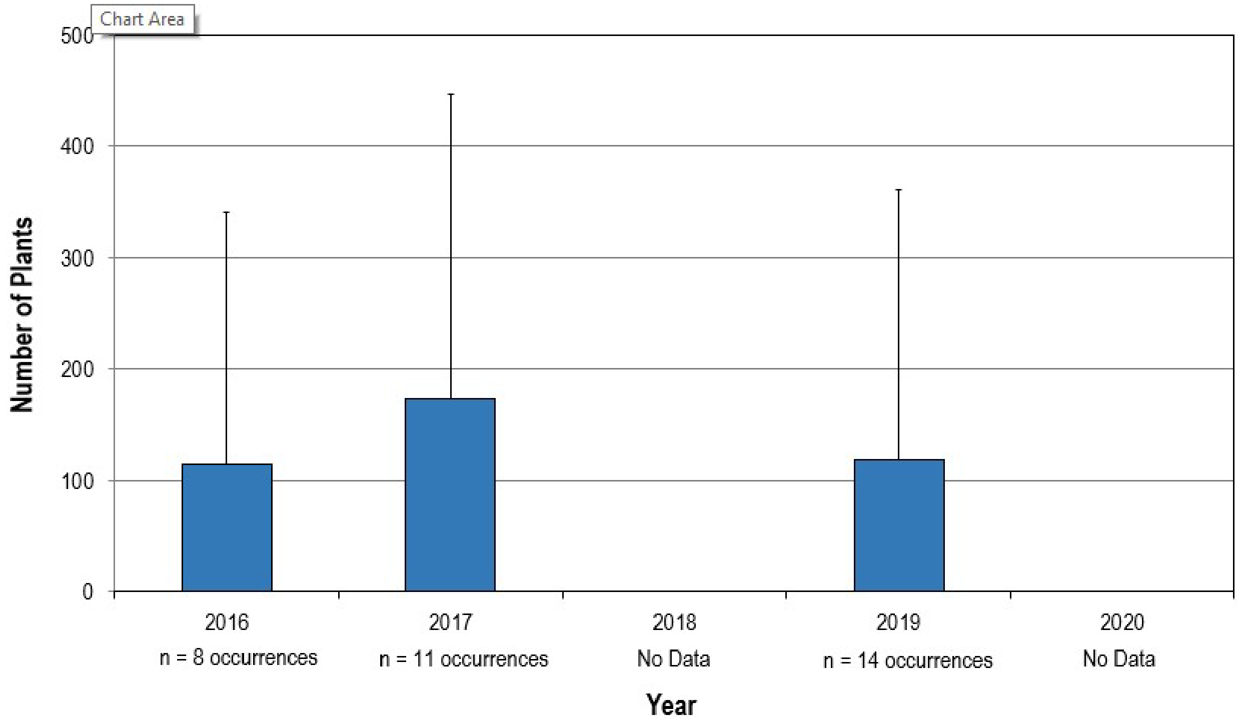


**Figure BAVA2.1.** Average Encinitas baccharis occurrence size from 2016 to 2020.
This bar graph shows the average number ± standard deviation of plants counted or estimated at Encinitas baccharis occurrences during IMG monitoring in 2016, 2017, and 2019.

## Metric 3: Threats to Occurrences on Conserved Lands

**Overview:** Regional Inspect and Manage monitoring started in 2016 and is now scheduled biennially for Encinitas baccharis (SDMMP 2021). The standardized protocol assesses habitat associations and threats. Monitored threats are specific to occurrences and at a scale that can be managed by land managers. Some landscape-scale threats, such as urbanization and wildfire, are not explicitly measured in this metric. However, there are indirect measures of these larger threats, such as edge effects from urbanization like dumping, trampling, encampments, and fuel modification zones. Some of the more common threats for rare plants that are monitored include invasive, nonnative annual forbs and grasses, encroachment by native and nonnative shrubs, trampling, dumping, altered hydrology, erosion, soil compaction, and trails (SDMMP 2021). Threats levels are categorized based on the percent of the maximum mapped extent for an Encinitas baccharis occurrence that is affected by the threat. Threat levels are categorized as:

1 = 0 percent in maximum extent or adjacent 10-m buffer;

2 = 0 percent in maximum extent but threat detected in surrounding 10-m buffer;

3 = >0 to <10 percent of maximum extent;

4 = 10 to <25 percent of maximum extent;

5 = 25 to <50 percent of maximum extent;

6 = 50 to <75 percent of maximum extent; and

7 = ≥75 percent of maximum extent.

Monitored threats are considered serious threats if threat levels are category 5 to 7 (≥25 percent of maximum extent affected) and suggest that management intervention could be beneficial.

**Metric Evaluation Period:** 2016-2020 (Baseline: 2016; Current: 2020)

**Baseline:** In 2016, a total of five of eight (63 percent) conserved Encinitas baccharis occurrences were affected by one or more serious threats encompassing ≥25 percent of the occurrence's maximum extent. The primary serious threats were competitive native plants at three occurrences (38 percent) followed by invasive, nonnative grasses and forbs, dumping, and trampling at one (12.5 percent) or two (25 percent) occurrences each (fig. BAVA3.1; SDMMP 2021).

**2027 Progress to Reach Desired Condition:** Reduce serious threats encompassing ≥25 percent of an occurrence's maximum extent to less than 20 percent of conserved, extant Encinitas baccharis occurrences (associated with 2022-2026 MSP goals and objectives).

### Condition Thresholds:

- **Good:** ≤25 percent of conserved Encinitas baccharis occurrences have one or more serious threats encompassing ≥25 percent of the occurrence's maximum extent.
- **Caution:** 26-50 percent of conserved Encinitas baccharis occurrences have one or more serious threats encompassing ≥25 percent of the occurrence's maximum extent.
- **Concern:** 51-75 percent of conserved Encinitas baccharis occurrences have one or more serious threats encompassing ≥25 percent of the occurrence's maximum extent.
- **Significant Concern:** >75 percent of conserved Encinitas baccharis occurrences have one or more serious threats encompassing ≥25 percent of the occurrence's maximum extent.

### Current Condition: Caution

In 2019, a total of five of 14 (36 percent) of Encinitas baccharis occurrences had one or more serious threats affecting ≥25 percent of the maximum extent. Trail disturbance was the greatest threat to Encinitas baccharis occurrences at three (21 percent) of 14 occurrences (fig. BAVA3.1). Other serious threats affecting one or two occurrences were nonnative grasses, competitive native plants, dumping, and trampling.

### Trend (2016-2020): Unknown

Overall, the incidence of serious threats (≥25 percent of maximum extent) is at a moderate level for Encinitas baccharis occurrences on Conserved Lands (fig. BAVA3.1). Top threats include cover of native competitive plants and trail disturbance, followed by invasive, nonnative grasses and trampling (fig. BAVA3.1). There is no evident trend, although threats were lowest overall in 2019 when the largest number of occurrences were sampled.

**Confidence: High**

Regional Rare Plant Inspect and Manage data are collected with a standardized protocol that is accurate at categorizing threats within the maximum mapped extent of Encinitas baccharis occurrences. There is uncertainty defining the maximum extent as this species often grows in the understory of larger shrubs and is relatively inconspicuous. However, this uncertainty is reduced somewhat as threat categorization includes an assessment of a buffer area around the maximum mapped extent.

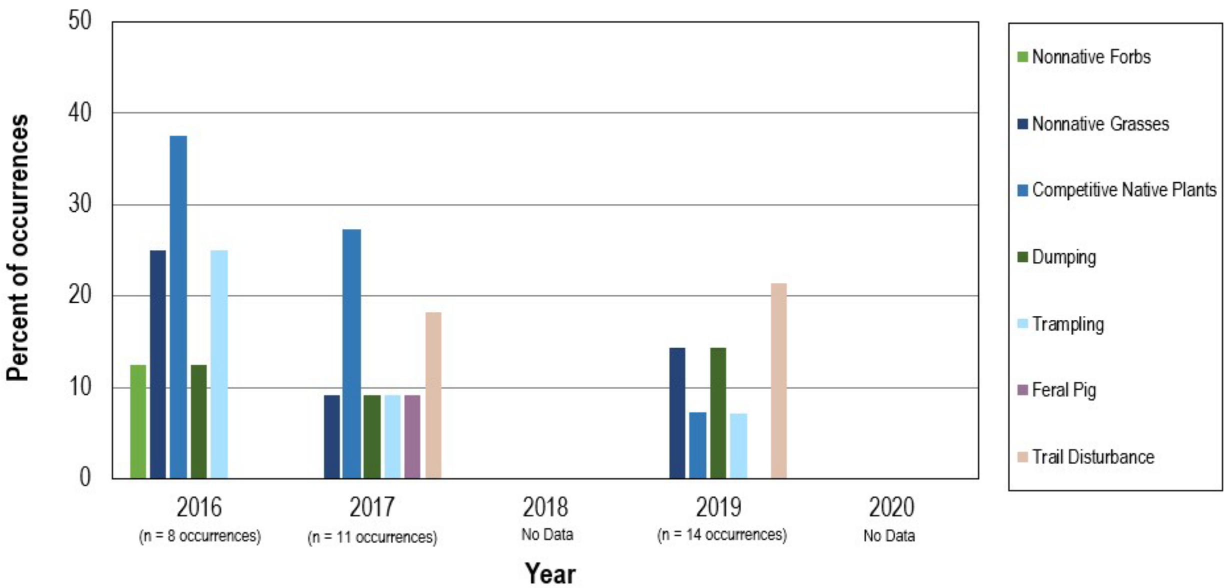


**Figure BAVA 3.1.** Percent of Encinitas baccharis occurrences with various types of serious threats encompassing ≥25 percent of the maximum extent from 2016 to 2020.
This bar graph shows the percent of occurrences with serious threats including nonnative forbs (light green), nonnative grasses (dark blue), competitive native plants (blue), dumping (blue), trampling (light blue), feral pigs (purple), and trail disturbance (salmon).

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## San Diego Thornmint – Species Indicator (Rare and Specialist Species)


Photo: Patricia Gordon-Reedy, CBI

**Why Is This Indicator Included?**

San Diego thornmint (*Acanthomintha ilicifolia*) is a small annual plant in the mint family (Lamiaceae). It is endemic to San Diego County and northern Baja California, Mexico (Hickman 1993). San Diego thornmint was listed as endangered by the State of California in 1982 and as threatened by USFWS in 1998 (USFWS 2009).

San Diego thornmint was selected as an indicator to assess how well the regional preserve system is protecting a rare endemic species of high conservation concern and with very restrictive habitat requirements. San Diego thornmint is also representative of other herbaceous annual plants restricted to clay soils in CSS, chaparral, and native grassland vegetation communities in western San Diego County.

San Diego thornmint is found in openings in CSS, chaparral, and native grassland. It is restricted to gabbro and clay soils, which often limits plants to small clay lens (CBI 2018). Occurrences fluctuate widely in size associated with growing season precipitation and winter temperatures (CBI 2018). Overall, the species has been declining in abundance over the long-term and currently faces a high level of threats.

## Stressors

Over the last 50 years, San Diego thornmint occurrences have declined and been extirpated due to habitat loss, fragmentation, and degradation (USFWS 2009, SDMMP 2021). Most occurrences are small and have declined over time with a number being extirpated, although there have been recent increases in population size for some occurrences due to management and favorable environmental conditions (SDMMP 2021). Studies have demonstrated genetic structure among populations that may be indicative of local adaptation to environmental conditions (DeWoody and others 2018; Milano and Vandergast 2018). The smallest occurrence shows signs of low genetic diversity (Milano and Vandergast 2018). San Diego thornmint faces high levels of threats from invasive, nonnative plants and frequent prolonged and intense droughts. Best management practices to remove nonnative grass thatch and control nonnative plants are effective at enhancing and restoring thornmint occurrences (CBI and others 2021).

- **Climate Vulnerability:** Increasing frequency, intensity, and duration of droughts are negatively affecting some San Diego thornmint occurrences. Drought can reduce plant germination, seed production, and survival. San Diego thornmint occurrences are considered at risk of extirpation under future climate scenarios (CBI 2018).
- **Invasive Plants:** Nonnative, annual forbs and grasses are increasing in distribution and abundance (SDMMP 2021). Nonnative grasses, such as *Brachypodium distachyon*, invade natural habitat, create dense patches of thatch, and compete for space, soil moisture, light, and nutrients. This type of invasion can depress San Diego thornmint occurrences or cause occurrence extirpations (CBI and others 2021a).
- **Fire:** Increasing frequency of large-scale wildfires in shrublands is leading to the conversion of native shrublands and grasslands to invasive, nonnative annual grassland (Keeley and Brennan 2012). This conversion can cause loss or reductions of thornmint occurrences (SDMMP 2021).
- **Urbanization:** Urban development has caused habitat loss and degradation and caused the extirpation of San Diego thornmint occurrences (USFWS 2009).
- **Connectivity:** Habitat loss and fragmentation may reduce connectivity between San Diego thornmint occurrences. This can lead to small, isolated occurrences which can lose genetic diversity and for which demographic rescue from other occurrences is unlikely (DeWoody and others 2018; Milano and Vandergast 2018).
- **Human Use of Preserves:** Trampling from hikers and mountain bikers can impact clay lens habitat and harm plants (SDMMP 2021).

### Desired Condition

MSP Roadmap Goal (SDMMP and TNC 2017):

*Maintain large occurrences, enhance small occurrences, and establish new occurrences of San Diego thornmint to buffer against environmental stochasticity, maintain genetic diversity, and promote connectivity, thereby enhancing resilience within and among Management Units over the long-term (>100 years) in native habitats.*

### Current Condition Status

The overall condition status for the San Diego Thornmint Indicator is Caution based on consideration of all three metrics (table ACIL0.1). While Metrics 2 and 3 have not changed over the longer term, there has been a large increase in the number of conserved occurrences (Metric 1). For Metric 2, occurrence size has recently increased in response to management and favorable environmental conditions in 2019 and 2020 following intensive drought in 2014 and 2015. Threat levels (Metric 3) are relatively high at conserved San Diego thornmint occurrences, especially from nonnative annual grasses and forbs. The condition of thornmint can improve over time with management and supports an overall improving trend, although more years of data are required to evaluate this potential trend into the future.

**Table ACIL0.1.** Current overall condition status for the San Diego Thornmint Species Indicator and period of baseline to current years comparison for metric conditions, trends, and confidence levels.

| Indicator/metric (baseline - current years) | Condition | Trend | Confidence |
|---|---|---|---|
| San Diego thornmint overall condition status | Caution | Improving | Moderate |
| Metric 1: conserved occurrences (1998-2020) | Good | Improving | Moderate |
| Metric 2: occurrence status (1986-2020) | Caution | No Change | Moderate |
| Metric 3: threats to occurrences (2014-2020) | Concern | No Change | High |

## Metric 1: Conserved Occurrences

**Overview:** The number of San Diego thornmint known occurrences has increased since the mid-1990s as well as the number that are conserved due to implementation of multiple species conservation plans (USFWS 2009; SDMMP 2020, 2021).

**Metric Evaluation Period:** 1998-2020 (Baseline: 1998; Current: 2020)

**Baseline:** In 1998, 52 San Diego thornmint occurrences were known in San Diego County (USFWS 2009). Thirty-two (62 percent) occurrences were extant, and urbanization had caused the loss of 20 others (38 percent). Only nine (28 percent) of the 32 extant occurrences were conserved.

**2027 Progress to Reach Desired Condition:** Conduct enhancement and restoration actions so that ≥30 conserved occurrences remain extant (associated with 2022-2026 MSP objectives).

### Condition Thresholds:

- **Good:** ≥30 conserved known extant occurrences.
- **Caution:** 25-29 conserved known extant occurrences.
- **Concern:** 20-24 conserved known extant occurrences.
- **Significant Concern:** <20 conserved known extant occurrences.

### Current Condition: Good

In 2020, the number of known San Diego thornmint occurrences increased to 84, with 61 (73 percent) conserved (figs. ACIL1.1 and ACIL1.2; USFWS 2009; SDMMP 2020, 2021). Fourty-eight (91 percent) of 53 extant or presumed extant occurrences were conserved (USFWS 2009; SDMMP 2020, 2021). Of the 48 extant or presumed extant conserved occurrences, at least one plant was observed at 35 occurrences in at least one year during 2014-2020 IMG monitoring. The 35 known extant occurrences were used to evaluate the condition criteria as Good. The other 13 presumed extant occurrences were not counted toward meeting the condition criteria. These occurrences require further surveys to determine plant presence, have had no plants detected in recent surveys but have suitable habitat and/or are historic observations, and at least two have no permitted access (SDMMP 2020, 2021). Thirteen other conserved occurrences were extirpated or potentially extirpated (that is, no plants were recently documented). Of these occurrences, 12 had unsuitable habitat at the mapped location, and one had no access or recent information (USFWS 2009; SDMMP 2020, 2021).

### Trend (1998-2020): Improving

Conservation of San Diego thornmint has increased with time (fig. ACIL1.2; USFWS 1998, 2009; SDMMP 2021). The number of known occurrences increased from 52 in 1998, to 80 in 2009, and 84 in 2020. Conserved occurrences also increased from nine (28 percent) in 1998, to 42 (53 percent) in 2009, to 61 (73 percent) in 2020 (USFWS 1998, 2009; SDMMP 2021).

### Confidence: Moderate

Information is reliable for occurrences in the Regional Rare Plant Inspect and Manage Monitoring Program. However, there are occurrences on private Conserved Lands for which there is no current information, and recent monitoring indicated that some conserved occurrences had suitable habitat but no plants.

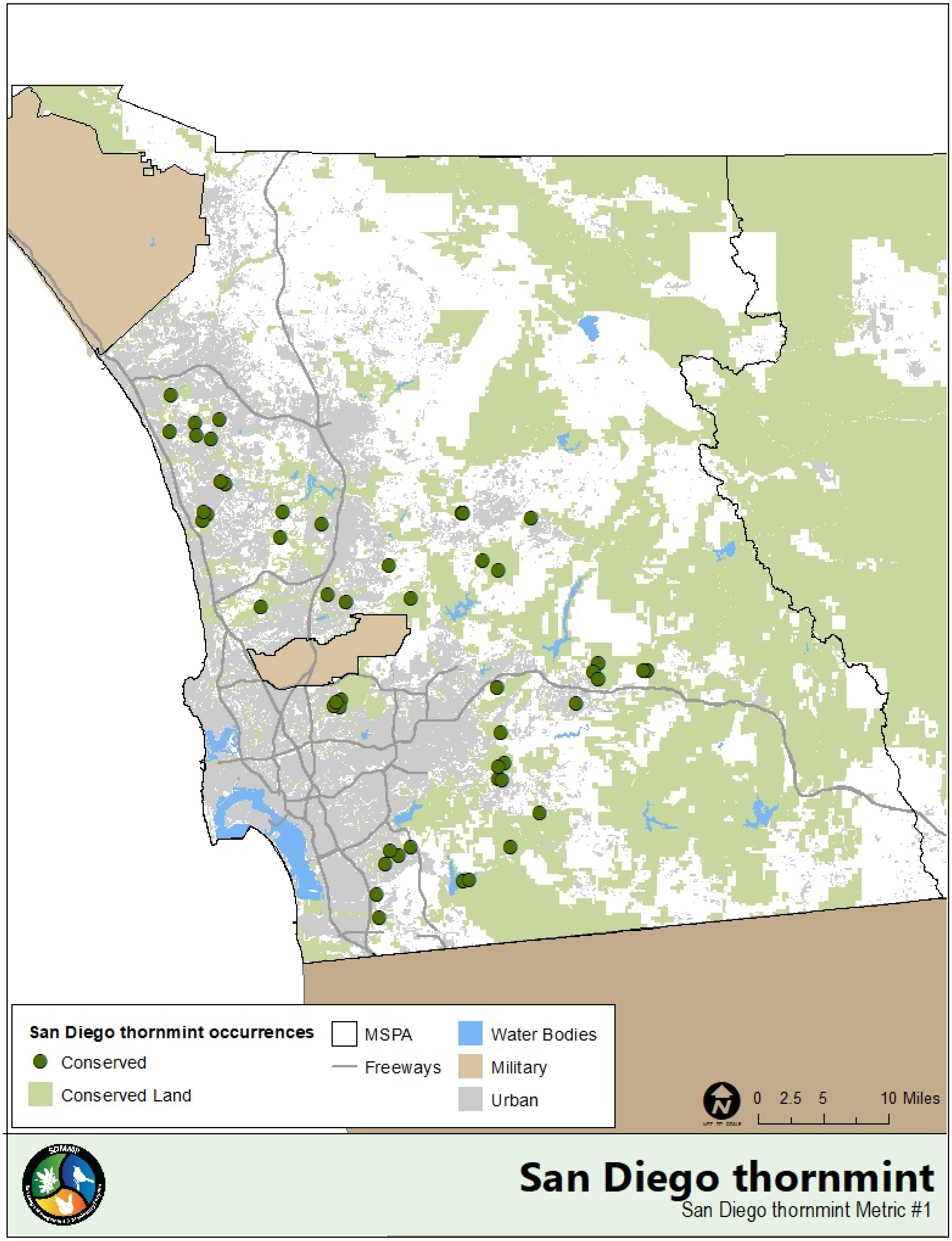


**Figure ACIL1.1.** Conserved San Diego thornmint occurrences in the MSPA in 2020.
This map shows the conserved occurrences (green) of San Diego thornmint that were monitored in San Diego County in the period 2014-2020.

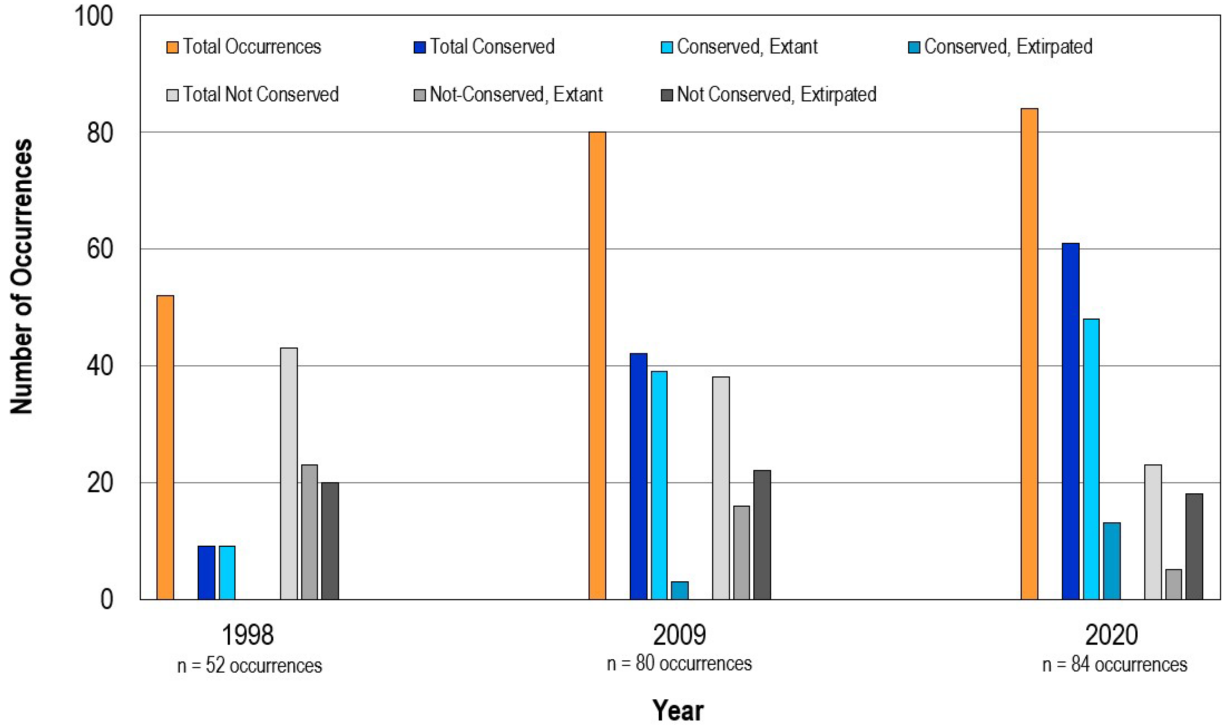


**Figure ACIL1.2.** Conservation status of San Diego thornmint occurrences in 1998, 2009, and 2020. This bar graph shows change in the number of occurrences and conservation status of San Diego thornmint in 1998, 2009, and 2020. Number of conserved occurrences (n) are shown in orange, dark blue, and light blue, and occurrences not conserved are shown in shades of grey.

## Metric 2: Occurrence Status on Conserved Lands

**Overview:** Occurrence status for San Diego thornmint is measured in terms of population size with the goal of increasing occurrence size and/or having it remain stable. San Diego thornmint occurrence size fluctuates annually in response to precipitation patterns (fig. ACIL2.1), making it difficult to determine trends. Occurrences with stable populations may fluctuate in number of plants in response to rainfall but do not show a consistent declining trend during years with above average rainfall. Forty-nine occurrences were evaluated for historic and recent (2014-2018) occurrence size in the MSP Framework Rare Plant Management Plan (CBI and others 2021a). Occurrence sizes of annual plants are categorized in this plan as small (<1,000 plants), medium (1,000 to 10,000 plants), or large (>10,000 plants).

Small occurrences are vulnerable to extirpation from environmental and demographic stochasticity (Lacy 2000; Melbourne and Hastings 2008, CBI and others 2021a). Some San

Diego thornmint occurrences are restricted to small clay lens habitat and do not have potential to be large (CBI 2018). Many occurrences were historically large and declined over time with some becoming extirpated (USFWS 2009; SDMMP 2021). SDMMP coordinated annual regional IMG monitoring for San Diego thornmint from 2014 through 2020 (SDMMP 2021). All monitored occurrences are assessed for threats and potential to enhance or restore occurrence size and stability (CBI and others 2021a). Best management practices include nonnative plant control and seed collection, bulking, and redistribution (CBI and others 2021a,b).

**Metric Evaluation Period:** 1986-2020 (Baseline: 1986-2009; Current: 2011-2020)

**Baseline:** Maximum occurrence size data (that is, numbers of plants) were compiled for 44 San Diego thornmint occurrences surveyed between 1986 and 2009 using a variety of methods and different levels of survey effort with a minimum of one survey (USFWS 2009). Based on the occurrence size classes listed above, 26 (59 percent) were small, 14 (32 percent) were medium, and four (9 percent) were large.

**2027 Progress to Reach Desired Condition:** Increase population size at ≥5 small San Diego thornmint occurrences through management to reduce threats or natural expansion under favorable conditions (associated with 2022-2026 MSP objectives). Maintain stability of enhanced occurrences by managing threats to avoid a decline in population size.

### Condition Thresholds:

- **Good:** Since 1986, ≥15 of the small, conserved San Diego thornmint occurrences have increased numbers of plants through management or natural expansion under favorable environmental conditions, and these populations are stable or increasing over time.
- **Caution:** Since 1986, 10-14 of the small, conserved San Diego thornmint occurrences have increased numbers of plants through management or natural expansion under favorable environmental conditions, and these populations are stable or increasing over time.
- **Concern:** Since 1986, 5-9 of the small, conserved San Diego thornmint occurrences have increased numbers of plants through management or natural expansion under favorable environmental conditions, and these populations are stable or increasing over time.
- **Significant Concern:** Since 1986, <5 of the small, conserved San Diego thornmint occurrences have increased numbers of plants through management or natural expansion under favorable environmental conditions, and these populations are stable or increasing over time.

### Current Condition: Caution

In 2020, there were 49 conserved occurrences for which there was monitoring data (SDMMP 2020, 2021). Of these occurrences, 31 (63 percent) were small, 15 (31 percent) were medium, and three (6 percent) were large. Of the 31 small, conserved occurrences, 22 could possibly be enhanced to increase size or restored to re-establish extirpated occurrences.

Since 1986, 13 small conserved occurrences have been recorded increasing to medium or large size (SDMMP 2020, 2021). However, during that time, many other occurrences have declined in number. Eight occurrences expanded between 2018 and 2020, probably due to favorable environmental conditions with above average rainfall following drought. Management implemented from 2011 to 2020 expanded at least five other small occurrences. Of these five managed occurrences, two of the small occurrences increased to large size (South Crest and Rice Canyon), while three increased to medium size (Hollenbeck Canyon, Wright's Field, and Los Peñasquitos Canyon).

### Trend (1986-2020): No Change

In the baseline period (1986-2009), population size classes for 44 occurrences were 59 percent small, 32 percent medium, and 9 percent large. Of the 49 occurrences with population size information in 2020, 63 percent were small, 31 percent medium, and 6 percent large. This indicates no long-term change in the proportion of small, medium, and large size classes over time. Between 2014 and 2020, average size fluctuated widely between different occurrences and within the same occurrence over time (fig. ACIL2.1). Average occurrence size was greatest in 2017, an above average rainfall year, when one occurrence had over 775,000 plants, skewing the average higher. This was the only year an occurrence was documented with so many plants.

Indications are that occurrence size recently increased with favorable weather conditions (that is, increased precipitation) and with management, although the occurrences are not directly comparable with the earliest time period (UFSWS 2009). In 2018, a drought year, 39 of 49 (80 percent) conserved occurrences evaluated in the MSP Framework Rare Plant Management Plan were classified as small, with less than 1,000 plants (CBI and others 2014, 2021a). Fourteen percent of occurrences were medium size and 6 percent large. In 2019 and 2020, eight occurrences increased from small to medium size with favorable weather conditions. Five other small occurrences increased to medium or large size with enhancement and restoration. While the overall long-term trend is considered to be unchanging, there is a potential shorter-term trend showing occurrence size increasing in some cases with more favorable weather conditions and management.

### Confidence: Moderate

This metric includes a mixture of data. Our confidence in characterizing occurrence status is dependent on time period. Data collected during the baseline period (1986-2009) used different methodologies in different years and over varying numbers of surveys, with some occurrences surveyed on only one day (USFWS 2009). In contrast, Regional Rare Plant Inspect and Manage monitoring data from 2014 to 2020 is reliable, comprehensive, and collected annually with the same protocol (SDMMP 2021).

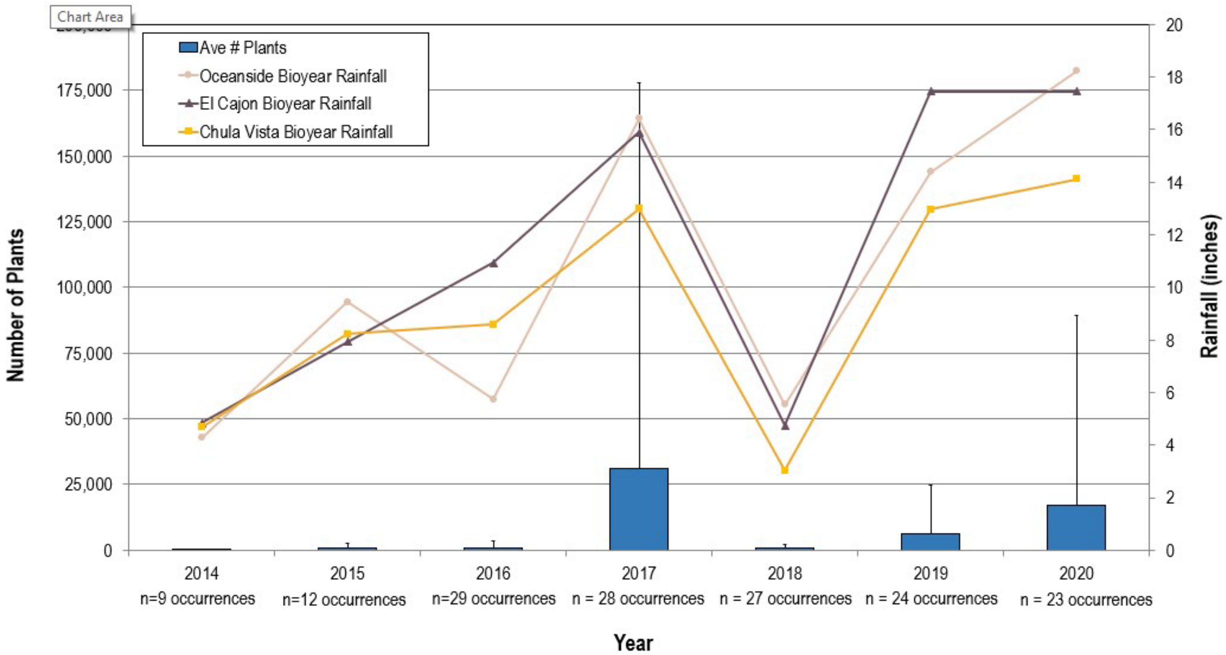


**Figure ACIL2.1.** Bioyear rainfall and average San Diego thornmint population size from 2014 to 2020. This bar graph shows the average number ± standard deviation of plants counted or estimated at San Diego thornmint occurrences during IMG monitoring. The three lines represent bioyear rainfall (growing season rainfall from October 1 – September 30) at weather stations near San Diego thornmint occurrences. Numbers of plants are greater in years with higher rainfall amounts.

## Metric 3: Threats to Occurrences on Conserved Lands

**Overview:** Regional Inspect and Manage monitoring data (SDMMP 2021) are used to assess habitat and threats at conserved San Diego thornmint occurrences as described above in Metric 3 for Encinitas baccharis. Threat levels are categorized based on percent of the mapped maximum extent of a San Diego thornmint occurrence that is affected by the threat. Threat levels are categorized as:

1 = 0 percent in maximum extent or adjacent 10 m buffer;

2 = 0 percent in maximum extent but threat detected in surrounding 10 m buffer;

3 = >0 to <10 percent of maximum extent;

4 = 10 to <25 percent of maximum extent;

5 = 25 to <50 percent of maximum extent;

6 = 50 to <75 percent of maximum extent; and

7 = ≥75 percent of maximum extent.

Monitored threats are considered serious threats if threat levels are at category 5 to 7 (≥25 percent of maximum extent affected) and suggest that management intervention could be beneficial.

The regional Rare Plant Framework Management Plan prioritizes management actions for San Diego thornmint occurrences (CBI and others 2021a). The plan uses monitoring data and results from genetic studies, BMP trials, and other research to evaluate occurrences and identify and prioritize management recommendations. An accompanying seed plan recommends seed sources, collection BMPs, conservation banking, and seed bulking actions.

**Metric Evaluation Period:** 2014-2020 (Baseline: 2014; Current: 2020)

**Baseline:** In 2014, two (22 percent) of nine conserved San Diego thornmint occurrences were affected by one or more serious threats encompassing ≥25 percent of the occurrence's maximum extent. During this extreme drought year, the two thornmint occurrences had serious invasions (≥25 percent of mapped extent) by nonnative, annual grasses and forbs (fig. ACIL3.1; SDMMP 2021).

**2027 Progress Towards Desired Condition:** In years with average to above average rainfall, reduce serious threats (>25 percent of maximum extent) to less than 36 percent of conserved occurrences (associated with 2022-2026 MSP objectives).

### Condition Thresholds:

- **Good:** ≤25 percent of conserved San Diego thornmint occurrences have one or more serious threats encompassing ≥25 percent of the occurrence's maximum extent.
- **Caution:** 26-50 percent of conserved San Diego thornmint occurrences have one or more serious threats encompassing ≥25 percent of the occurrence's maximum extent.
- **Concern:** 51-75 percent of conserved San Diego thornmint occurrences have one or more serious threats encompassing ≥25 percent of the occurrence's maximum extent.
- **Significant Concern:** >75 percent of conserved San Diego thornmint occurrences have one or more serious threats encompassing ≥25 percent of the occurrence's maximum extent.

### Current Condition: Concern

In 2020, a total of 16 (64 percent) of 25 monitored San Diego thornmint occurrences had one or more serious threats affecting ≥25 percent of the maximum extent. This was an above average rainfall year, and nonnative grasses and forbs were the greatest threat to San Diego thornmint occurrences (fig. ACIL3.1). Nine (36 percent) occurrences were invaded by nonnative forbs, and 12 (48 percent) occurrences were invaded by nonnative grasses. The threat of nonnative invasive grasses and forbs was greatest in average or above average rainfall years, such as 2020. Other serious threats at one or two occurrences each include competitive native plants and slope movement.

### Trend (2014-2020): No Change

The level of nonnative plant invasion for conserved San Diego thornmint occurrences fluctuates with rainfall (fig. ACIL3.1). In drought years, about 20-30 percent of occurrences have serious invasions. During average to above average rainfall years, 50 percent or more of occurrences are invaded by one or both types of invasive annual plants (that is, nonnative grasses and forbs). Many of these occurrences have more than 75 percent of the mapped extent covered by nonnative plants. The trend is relatively unchanged over the last 5 years. Other threats such as competitive native plants, slope movement, altered hydrology, and erosion each affected about 5 percent of occurrences in one or more years.

### Confidence: High

Regional Rare Plant Inspect and Manage data are collected with a standardized protocol and accurately categorize threats to conserved San Diego thornmint occurrences.

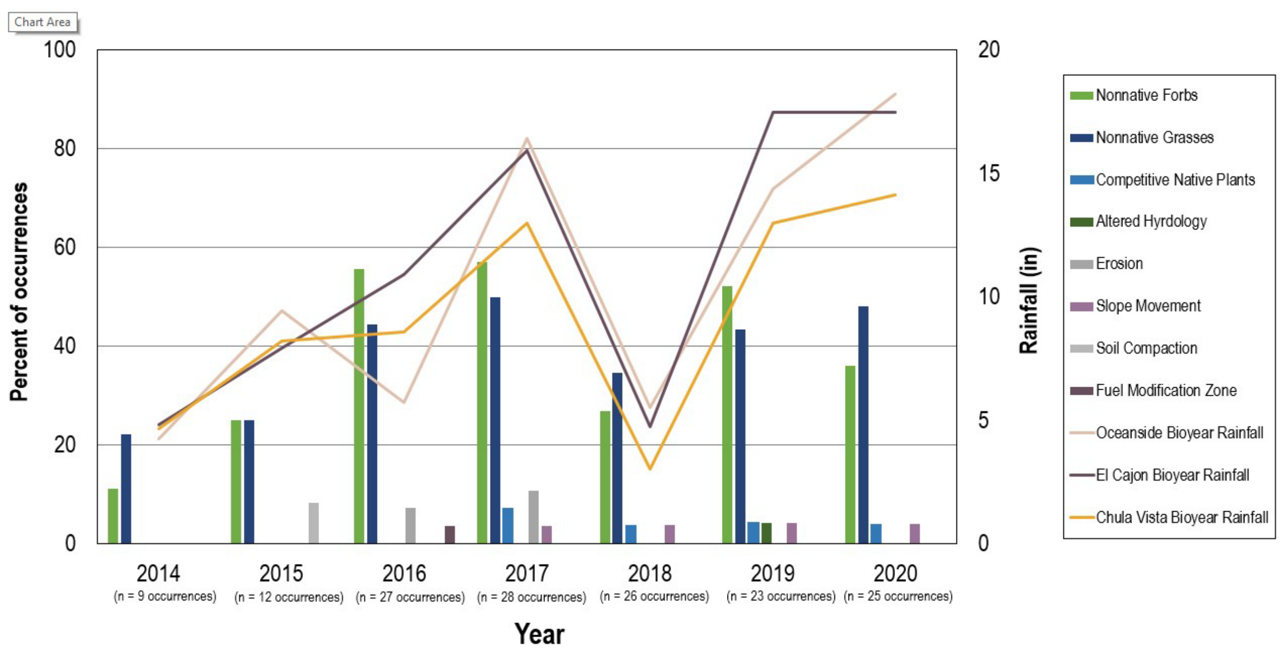


**Figure ACIL 3.1** Bioyear rainfall and percent of San Diego thornmint occurrences with ≥25 percent of mapped extent affected by various threats from 2014 to 2020.
This bar graph shows the percent of occurrences with serious threats including nonnative forbs (light green), nonnative grasses (dark blue), competitive native plants (blue), altered hydrology (dark green), erosion (gray), slope movement (purple), soil compaction (light gray) and fuel modification (dark gray).

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## Willowy Monardella – Species Indicator (Rare and Specialist Species)


**Why Is This Indicator Included?**

Willowy monardella (*Monardella viminea*) is a perennial subshrub in the mint family (Lamiaceae). It is a rare endemic species restricted to a very small area of central San Diego County (Elvin and Sanders 2003). Willowy monardella was listed as endangered by the State of California in 1979 and as endangered by the USFWS in 1998 (CNDDB 2012; USFWS 2008).

Willowy monardella occurs in a 72-square mile area of central San Diego County (USFWS 2008). Most occurrences are on Marine Corps Air Station (MCAS) Miramar. Willowy monardella is found in sandy and rocky washes, floodplains, and benches of perennial streams that flow only after heavy rains. The species is declining from a variety of threats (USFWS 2008; SDMMP 2021).

USFWS recognized a change in taxonomy in 2012 (USFWS 2012) that split the original subspecies *Monardella linoides* subsp. *viminea* into two full species based on genetics: *Monardella viminea* (willowy monardella) and *Monardella stoneana* (Jennifer's monardella) (Prince 2009). Willowy monardella remained listed as endangered in central San Diego County, and Jennifer's monardella was removed from protected status.

Willowy monardella was selected as an indicator to assess how well the regional preserve system is protecting a rare endemic species of high conservation concern and very limited distribution.

This species also represents extremely rare alluvial scrub communities in central San Diego County.

### Stressors

From the 1970s to 1990s, monardella occurrence extirpations were caused by urban development, road construction, and sand and gravel mining (USFWS 2008). Willowy monardella also continues to be threatened by high fire frequency, invasive nonnative plants, competitive native plants, drought, increasing temperatures, altered hydrology, and flooding (USFWS 2008; SDMMP 2021).

- **Altered Hydrology:** Urbanization increases area of impervious surface in a watershed and causes perennial streams to change to year-round flows (White and Greer 2006). In these watersheds, intense flooding washes away plants and habitat (Greer and Cheong 2005).
- **Climate Vulnerability:** Increasing frequency, intensity, and duration of droughts are negatively affecting willowy monardella occurrences (Kasselbaum 2015; SDMMP 2021). Drought and heat reduce plant germination, seed production, and survival. Extreme rainfall events, which are increasing with changing climate, wash out monardella plants and remove habitat (Greer and Cheong 2005; Kasselbaum 2015).
- **Invasive Plants:** Nonnative annual forbs and grasses are increasing in distribution and abundance. They invade natural habitat and create dense patches of thatch competing with native plants for space, soil moisture, light, and nutrients. This type of invasion is affecting some willowy monardella occurrences (Kasslebaum 2015; SDMMP 2021).
- **Fire:** Increasing frequency of large-scale wildfires facilitated invasion of willowy monardella habitats by nonnative annual grasses (SDMMP 2021). This invasion can cause reductions in willowy monardella occurrences (USFWS 2008).
- **Urbanization:** Urban development has caused the extirpation of willowy monardella occurrences through habitat loss and degradation (USFWS 1998, 2008).
- **Human Use of Preserves:** Trampling from hikers and mountain bikers can impact willowy monardella (SDMMP 2021).

### Desired Condition

MSP Road Map Goal (SDMMP and TNC 2017):

*Maintain or enhance existing willowy monardella occurrences and establish new occurrences, as needed, to ensure multiple conserved occurrences with self-sustaining populations to increase resilience to environmental and demographic stochasticity, maintain genetic diversity, and ensure persistence over the long term (>100 years).*

### Current Condition Status

Willowy monardella has a very small range, and occurrences are continuing to decline, even when protected from development. In 1998, the final rule listing the taxon as endangered indicated there were around 6,000 plants (USFWS 2008). That has decreased to only a few thousand plants in recent years (Vernadero Group 2018; SDMMP 2021). Most populations on Conserved Lands are small; however, in the larger canyons (that is, West Sycamore, Sycamore, and Spring Canyons), there are more plants upstream on private and military lands, indicating some of the small occurrences on Conserved Lands could be part of larger populations (Vernadero Group 2018; SDMMP 2021). A genetic study of occurrences on MCAS Miramar and in the regional preserve system found no distinct genetic clusters and little evidence for low genetic diversity except for a small occurrence in Spring Canyon on Conserved Lands (Milano and Vandergast 2018). The conserved Spring Canyon occurrence is small and at the bottom of the canyon with more plants upstream on private lands. However, it is not clear whether they form a connected population with the plants upstream.

The overall condition status for the Willowy Monardella Species Indicator is Concern based on consideration of all three metrics (table MOVI0.1). There has been progress in conserving occurrences in the regional preserve system and MCAS Miramar (Metric 1). However, most populations are small (Metric 2), and this species faces a high degree of threat (Metric 3). Additional metrics related to management may be developed in the future.

**Table MOVI0.1**. Current overall condition status for Willowy Monardella Species Indicator and period of baseline to current years comparison for metric conditions, trends, and confidence levels.

| Indicator/metric (baseline – current years) | Condition | Trend | Confidence |
|---|---|---|---|
| Willowy monardella overall condition status | Concern | Unknown | Moderate |
| Metric 1: conserved occurrences (1998-2020) | Caution | Improving | Moderate |
| Metric 2: population status (1998-2020) | Significant Concern | Declining | High |
| Metric 3: threats to occurrences (2014-2020) | Concern | No Change | High |

## Metric 1: Conserved Occurrences

**Overview:** Since the mid-1990s, the MSCP has increased conservation of willowy monardella occurrences. The largest occurrences are on MCAS Miramar, where they are protected and managed (USFWS 1998, 2008, 2012; Kasselbaum 2015). Many of the MCAS Miramar plants and adjacent plants on Conserved Lands constitute a single occurrence (that is, are less than 0.25 miles apart). This is the case for the West Sycamore Canyon, Sycamore Canyon, and Spring Canyon occurrences. MCAS Miramar occurrences are considered to have similar protection as plants on Conserved Lands and are considered conserved for the purposes of this analysis.

**Metric Evaluation Period:** 1998-2020 (Baseline: 1998; Current: 2020)

**Baseline:** In 1998, there were 25 known occurrences of willowy monardella in San Diego County (USFWS 1998, 2008, 2012). At that time, willowy monardella and Jennifer's monardella were considered the same subspecies, but they are now classified as separate species (see text box; USFWS 2012). The following numbers exclude the two Jennifer's monardella occurrences that were classified as willowy monardella at the time of listing. In 1998, there were 18 extant and seven extirpated willowy monardella occurrences. Six of the 18 (33 percent) extant occurrences were conserved.

**2027 Progress Towards Desired Condition:** Conduct enhancement and restoration actions so that ≥13 conserved occurrences remain extant (associated with 2022-2026 MSP objectives).

**Condition Thresholds:**

These thresholds were set based on the current number of extant occurrences of willowy monardella and the feasibility of protection on Conserved Lands and military lands combined with establishment of new occurrences on Conserved Lands. The intent is to halt the decline of this species. If management is effective at establishing new occurrences and increasing the number of conserved extant occurrences, then conservation targets could be increased in the future.

- **Good:** ≥15 conserved and extant willowy monardella occurrences
- **Caution:** 10-14 conserved and extant willowy monardella occurrences
- **Concern:** 5-9 conserved and extant willowy monardella occurrences
- **Significant Concern:** <5 conserved and extant willowy monardella occurrences

### Current Condition: Caution

In 2020, willowy monardella occurrences known in San Diego County increased to 31 with 19 (61 percent) conserved (figs. MOLIV1.1 and MOLIV1.2; USFWS 2008 and 2012, CNDDB 2020, SDMMP 2020, 2021). Of the 16 extant or presumed extant occurrences, 13 (81 percent) are conserved in the regional preserve system or protected on MCAS Miramar. Three conserved occurrences were extirpated. The 13 conserved and extant occurrences are used to determine the condition category of Caution. All but one of the new occurrences discovered since the species was listed are within the same watersheds evaluated in 1998 at the time of listing. Most occurrences are on MCAS Miramar, where they are monitored and protected from disturbance.

### Trend (1998-2020): Improving

The level of conservation of willowy monardella occurrences has increased over time (fig. MOLIV1.2). This is true for both total number of occurrences and number of extant occurrences in 1998 (USFWS 1998), 2008 (USFWS 2008), and 2020 (SDMMP 2021).

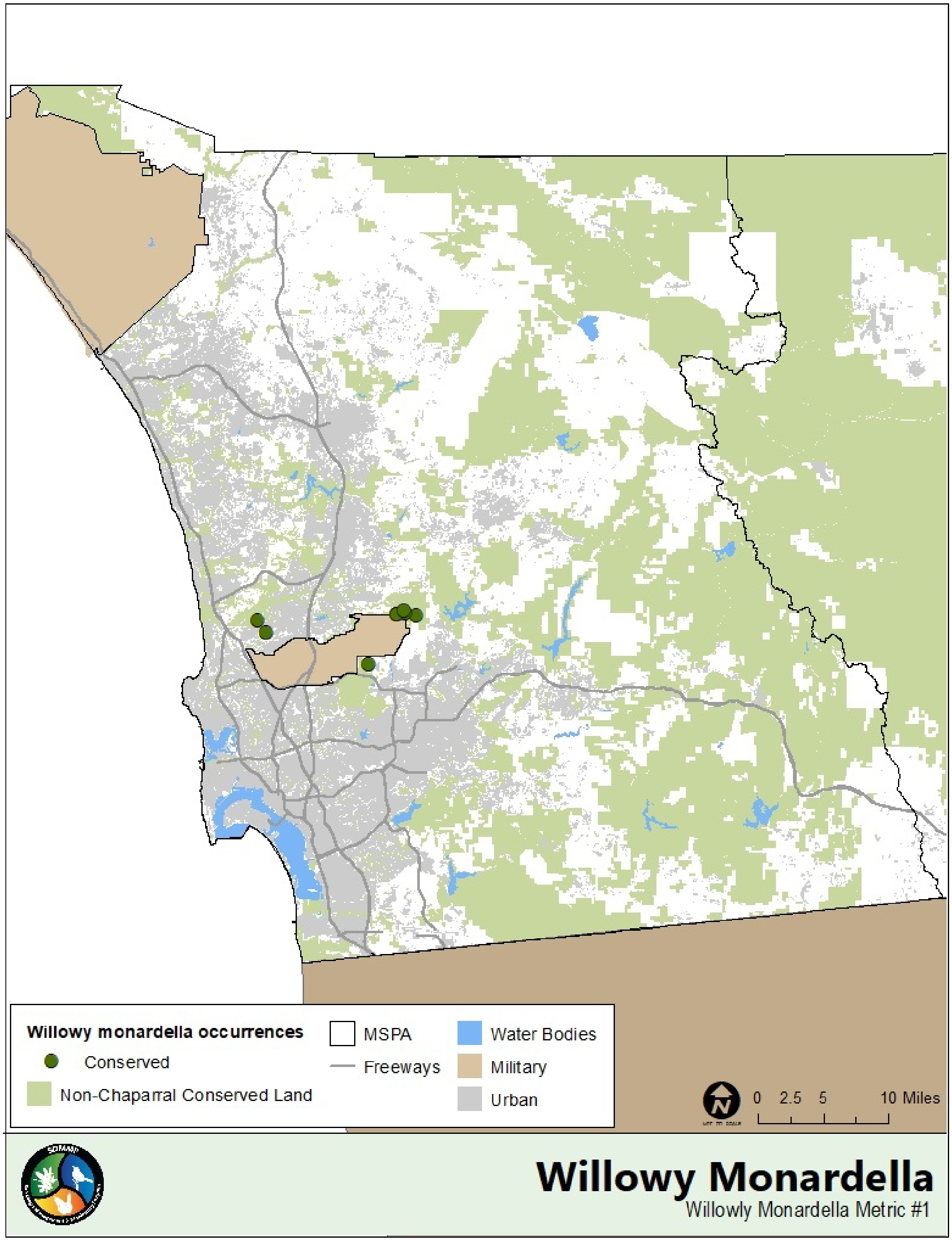


**Figure MOLIV1.1.** Conserved willowy monardella occurrences in the regional preserve system in 2020. This map shows the conserved occurrences (green) of willowy monardella that were monitored in San Diego County in the period 2014-2020. This figure does not show occurrences on MCAS Miramar, some of which extend onto Conserved Lands.

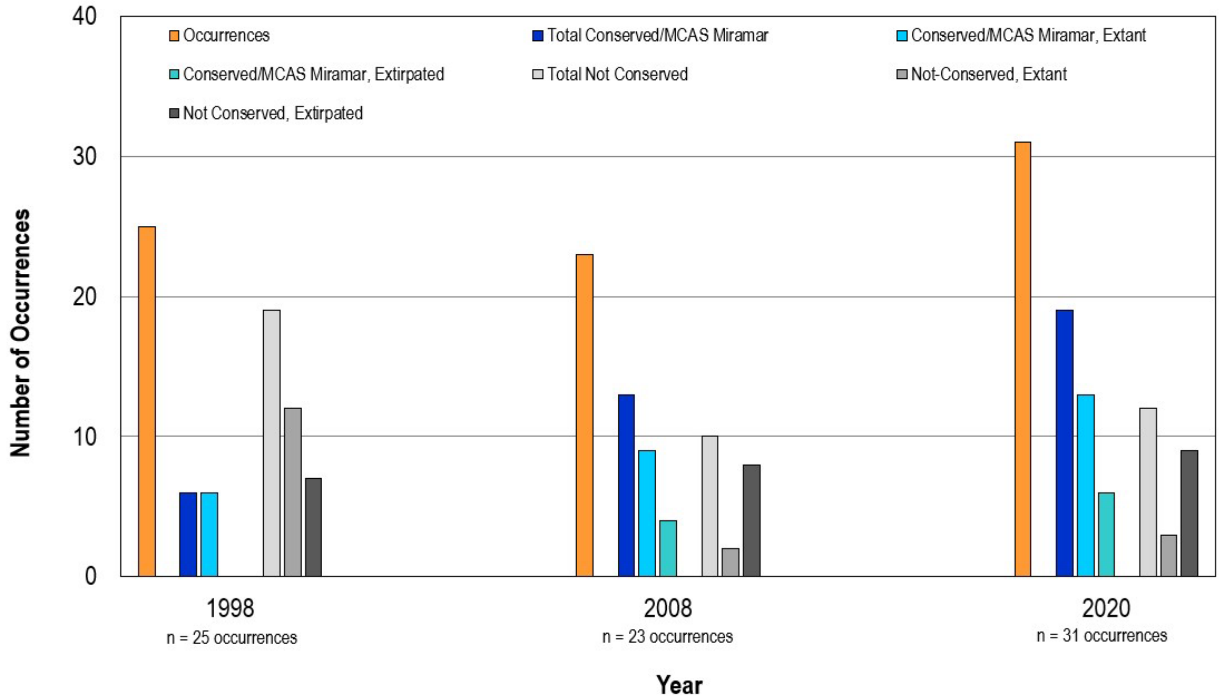


**Figure MOLIV1.2.** Conservation status of willowy monardella in 1996, 2008, and 2020.
This bar graph shows change in the number of occurrences and the conservation status of willowy monardella in 1998, 2008, and 2020. Number of conserved occurrences (n) are shown in orange, dark blue, and light blue, and occurrences not conserved are shown in shades of grey.

**Confidence: Moderate**

Information is highly reliable for willowy monardella occurrences included in the San Diego Regional Inspect and Manage Monitoring Program (SDMMP 2021) and recent survey report from MCAS Miramar (Vernadero 2018). There is some confusion about labeling occurrences that are on a mixture of private lands, military lands, and Conserved Lands. In some cases, an area described in the 1998 listing package as a population (USFWS 1998) is considered in 2020 to support several occurrences that are >0.25 miles from each other.

## Metric 2: Occurrence Status on Conserved Lands

**Overview:** Occurrence status for willowy monardella is measured in terms of occurrence size (that is, number of plants) with the goal of increasing occurrence size and/or having it remain stable. Occurrences with stable populations do not decline over time. Based on the MSP Framework Rare Plant Management Plan (CBI and others 2021), the occurrence size classes for willowy monardella are: small (<100 plants), medium (100 to 500 plants), and large (>500 plants).

The MSP Framework Management Plan assigned the seven extant conserved occurrences known in the regional preserve system in 2018 into size classes based on 2014 to 2018 Inspect and Manage monitoring data (CBI and others 2021; SDMMP 2021). The size classification completed in 2018 and updated in 2020 is used in the condition thresholds to compare increases in population size through management actions or natural population growth under favorable environmental conditions. During 2014 to 2018, there were six small occurrences and one medium occurrence on Conserved Lands. The medium occurrence and two of the small occurrences are in canyons with larger numbers of plants on MCAS Miramar and adjacent private lands (that is, West Sycamore Canyon, Sycamore Canyon, and Spring Canyon). The Spring Canyon occurrence on Conserved Lands has low genetic diversity compared with other occurrences on Conserved Lands and MCAS Miramar (Milano and Vandergast 2018). This indicates that these plants on Conserved Lands may not be connected to the large number of plants upstream on private land. Small occurrences are vulnerable to extirpation from environmental and demographic stochasticity (Lacy 2000; Melbourne and Hastings 2008). A study was conducted in 2021 to identify and prioritize sites with suitable hydrology and habitat to establish new occurrences and enhance existing occurrences of willowy monardella on Conserved Lands (AECOM 2022).

**Metric Evaluation Period:** 1998-2020 (Baseline: 1998; Current: 2018-2020)

**Baseline:** In 1998, there were 18 extant willowy monardella occurrences, of which five (28 percent) supported <100 individuals (USFWS 1998, 2012). This does not include the two Jennifer's monardella occurrences.

**2027 Progress Towards Desired Condition:** Increase population size at ≥4 small, conserved willowy monardella occurrences through management to reduce threats or promote natural expansion under favorable conditions (associated with 2022-2026 MSP objectives). Maintain stability of enhanced occurrences by managing threats to avoid a decline in population size.

### Condition Thresholds:

- **Good:** Since 1998, ≥6 of the small conserved willowy monardella occurrences have increased numbers of plants either through management or natural expansion under favorable conditions, and these populations are stable or increasing over time.
- **Caution:** Since 1998, 4-5 of the small conserved willowy monardella occurrences have increased numbers of plants either through management or natural expansion under favorable conditions, and these populations are stable or increasing over time.
- **Concern:** Since 1998, 2-3 of the small conserved willowy monardella occurrences have increased numbers of plants either through management or natural expansion under favorable conditions, and these populations are stable or increasing over time.

- **Significant Concern:** Since 1998, <2 of the small conserved willowy monardella occurrences have increased numbers of plants either through management or natural expansion under favorable conditions, and these populations are stable or increasing over time.

### Current Condition: Significant Concern

No small occurrences are known to have increased in size since 1998 on Conserved Lands. In 2020, there were six small occurrences (86 percent) and one medium (14 percent) occurrence on Conserved Lands that could potentially be enhanced to increase population size. Except for 2015, the average occurrence size is less than 100 plants (fig. MOLIV2.1; SDMMP 2021). Since 2006, there have been three projects to enhance willowy monardella occurrences. These occurrences are still small, and in one case, management is ongoing. As efforts have not yet successfully increased the number of plants in these occurrences, this metric is considered Significant Concern.

### Trend (1998-2020): Declining

Throughout the range, the trend for willowy monardella occurrence size is Declining on conserved and military lands. In 1998, 22 percent of occurrences were small. In 2020, 86 percent of occurrences in the regional preserve system were considered small. Similarly, a base-wide survey at MCAS Miramar in 2017 documented a decline in abundance with 972 clumps, a loss of 278 clumps from previous surveys (Vernadero 2018).

All seven of conserved occurrences monitored with Inspect and Manage protocol have declined substantially. Consistent monitoring efforts from 2016 and 2020 document that the average population size has decreased by 50 percent (fig. MOLIV2.1). Three occurrences have less than 20 plants. One occurrence in Sycamore Canyon with 390 plants in 2003 is down to a single plant since 2015.

### Confidence: High

This metric is based upon Regional Rare Plant Inspect and Manage monitoring data, which has a High confidence in capturing occurrence status. The baseline data from 1998 is of lower quality but sufficient to assign population age classes and compare with current size classes.

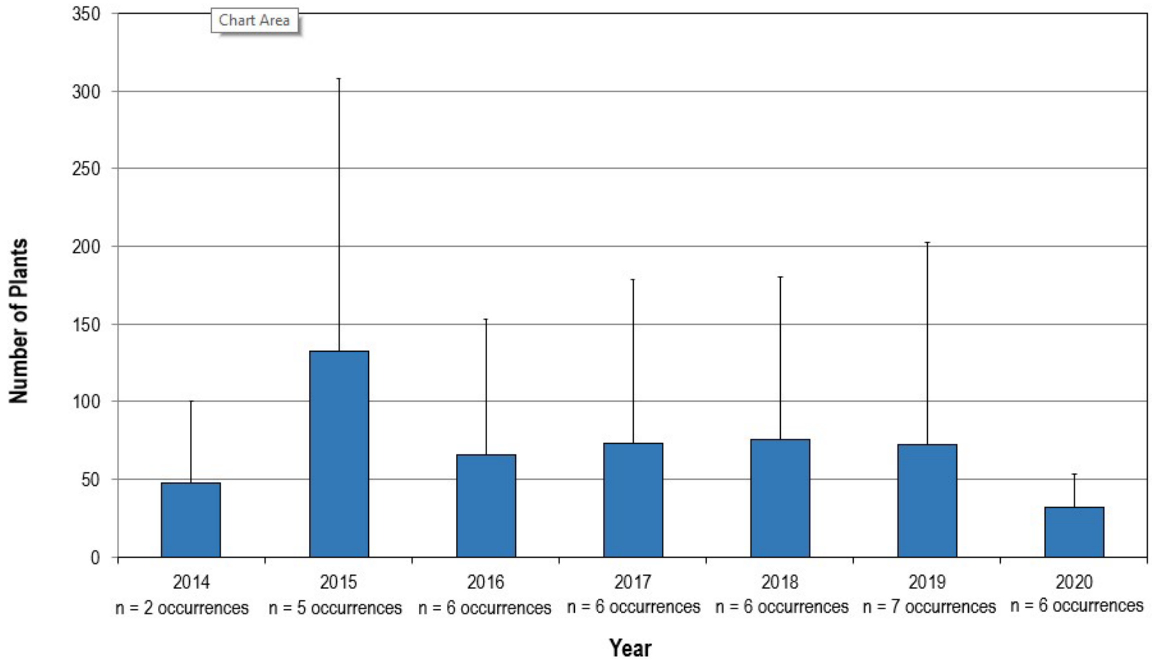


**Figure MOLIVI2.1.** Average willowy monardella occurrence size from 2014 to 2020.
This bar graph shows the average number ± standard deviation of plants counted or estimated at willowy monardella occurrences during IMG monitoring.

## Metric 3: Threats to Occurrences on Conserved Lands

**Overview:** Regional Inspect and Manage monitoring data (SDMMP 2021) are used to assess habitat and threats at conserved willowy monardella occurrences as described above in Metric 3 for Encinitas baccharis. Threat levels for an occurrence are categorized based on the percent of the mapped maximum extent of a willowy monardella occurrence that is affected by a threat. Threat levels are categorized as:

1 = 0 percent in maximum extent or adjacent 10-m buffer;

2 = 0 percent in maximum extent but threat detected in surrounding 10-m buffer;

3 = >0 to <10 percent of maximum extent;

4 = 10 to <25 percent of maximum extent;

5 = 25 to <50 percent of maximum extent;

6 = 50 to <75 percent of maximum extent; and

7 = ≥75 percent of maximum extent.

Monitored threats are considered serious threats if threat levels are at category 5 to 7 (≥25 percent of maximum extent affected) and suggest that management intervention could be beneficial.

A regional Rare Plant Framework Management Plan was developed to prioritize management actions for willowy monardella (CBI and others 2021). The plan uses monitoring data and results from genetic studies, BMP trials, and other research to evaluate occurrences and identify and prioritize management recommendations. An accompanying seed plan recommends seed sources, collection BMPs, conservation banking, and seed bulking actions.

**Metric Evaluation Period:** 2014-2020 (Baseline: 2014-2015; Current: 2020)

**Baseline:** Serious threats (>25 percent of maximum extent) to willowy monardella occurrences in 2014 were altered hydrology, erosion, and urban runoff at one of two (50 percent) monitored occurrences (fig. MOLIV3.1; SDMMP 2021). In 2015, when five occurrences were monitored, one occurrence (20 percent) had multiple serious threats, including invasion by nonnative grasses and forbs, altered hydrology, and urban runoff.

**2027 Progress Towards Desired Condition:** Reduce serious threats encompassing >25 percent of an occurrence's maximum extent to less than 20 percent of conserved extant willowy monardella occurrences (associated with 2022-2026 MSP objectives).

### Condition Thresholds:

- **Good:** ≤25 percent of conserved willowy monardella occurrences have one or more threats (≥25 percent of mapped extent).
- **Caution:** 26-50 percent of conserved willowy monardella occurrences have one or more serious threats (≥25 percent of mapped extent).
- **Concern:** 51-75 percent of conserved willowy monardella occurrences have one or more serious threats (≥25 percent of mapped extent).
- **Significant Concern:** >75 percent of conserved willowy monardella occurrences have one or more serious threats (≥25 percent of mapped extent).

### Current Condition: Concern

In 2020, four of six (67 percent) occurrences were affected by one or more serious threats encompassing ≥25 percent of their maximum extent (fig. MOLIV3.1). Nonnative grasses were a serious threat to willowy monardella at 67 percent of occurrences in a year of above average rainfall. Other serious threats at these occurrences included nonnative forbs, altered hydrology, erosion, and urban runoff.

### Trend (2014-2020): No Change

Threat levels have fluctuated annually from 2014 to 2020, especially invasion by nonnative annual grasses and forbs (fig. MOLIV4.1). Threat levels have ranged from 50 percent of occurrences impacted in 2014 to 20 percent in 2015 and 67 percent in 2020. Erosion and altered hydrology are also serious threats to a subset of monitored occurrences. Given these fluctuations, there is no apparent trend in serious threats over time.

**Confidence: High**

Regional Rare Plant Inspect and Manage data are collected with a standardized protocol and accurate at categorizing threats to conserved willowy monardella occurrences.

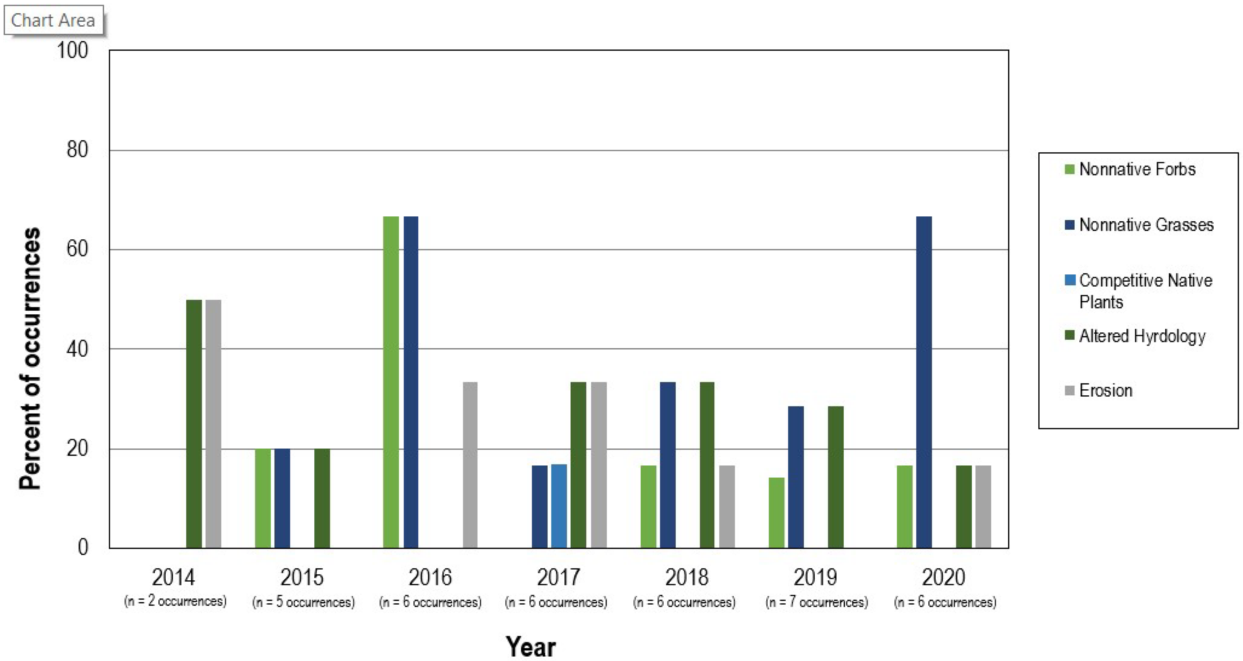


**Figure MOLIV3.1.** Percent of willowy monardella occurrences with ≥25 percent of mapped extent affected by various threats from 2014 to 2020.

This bar graph shows the percent of occurrences with serious threats including nonnative forbs (light green), nonnative grasses (dark blue), competitive native plants (blue), altered hydrology (dark green), and erosion (gray).

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# Hermes Copper – Species Indicator (Rare and Specialist Species)


### Why Is This Indicator Included?

Hermes copper (*Lycaena hermes*) is a rare butterfly endemic to San Diego County and northern Baja California, Mexico (Marschalek and Klein 2010). Hermes copper has been declining for several decades and was recently listed as threatened by USFWS (USFWS 2021).

Hermes copper was selected as an indicator to assess how well the regional preserve system is protecting a rare endemic species of high conservation concern and limited distribution. This species is representative of some butterflies that specialize on a single host plant, have limited annual reproductive output, and are vulnerable to fire and changing climate.

Hermes copper occurs in coastal sage scrub and mixed chaparral habitats and is restricted to a single host plant, spiny redberry (*Rhamnus crocea*), for larval development. Adults nectar primarily on flat-topped buckwheat (*Eriogonum fasciculatum*). This butterfly has low annual productivity and produces one brood per season. Eggs are laid singly on stems of spiny redberry and overwinter until larvae emerge in the spring (Marschalek and Deutschman 2008).

### Stressors

Hermes copper populations started disappearing after the 1960s because of habitat loss and fragmentation from urban development (Marschalek and Klein 2010). Population extirpations accelerated in 2003 and 2007 with large-scale wildfires (Marschalek and Klein 2010) and, in more recent years, with intense and prolonged drought (Marschalek and Deutschman 2008; Marschalek 2020).

- **Climate Vulnerability:** Increasing frequency, intensity, and duration of droughts is associated with decline in Hermes copper abundance and population extirpations (Marschalek 2020).
- **Invasive Plants:** Nonnative, annual forbs and grasses are increasing in distribution and abundance and can degrade Hermes copper habitat by reducing important nectar shrubs (Marschalek and Deutschman 2017). Invasive plant species are an indirect threat if they promote fire. Redberry appears to be relatively robust against nonnative plants following fire, whereas flat-topped buckwheat is more impacted (Marschalek and Klein 2010; see also text box).
- **Fire:** Extremely large and catastrophic wildfires in 2003 and 2007 caused the loss of 13 populations (Marschalek and Klein 2010).
- **Urbanization:** Urban development and the resulting habitat fragmentation caused considerable habitat loss and degradation and the extirpation of Hermes copper occurrences (Marschalek 2020).
- **Connectivity:** Habitat loss and fragmentation has isolated populations so that small populations lack a nearby source of butterflies for demographic rescue (Strahm and others 2012; Marschalek and others 2013).

### Desired Condition

MSP Road Map Goal (SDMMP and TNC 2017):

*Protect, enhance, and restore Hermes copper occupied habitats, historically occupied habitats, and the landscape connections between them to create resilient, self-sustaining populations that provide for persistence over the long-term (>100 years).*

### Current Condition Status

Many sites supporting Hermes copper have been conserved, but the butterfly continues to decline. Currently there are only four known extant populations in the eastern portion of the species range (Marschalek 2020; D. Marschalek, personnel communication, September 7, 2021). The locations of these populations are Roberts Ranch South, Boulder Creek, Potrero Bureau of Land Management (BLM) (northwest of Potrero), and a private property northeast of Potrero. However, there is only one population that appears to have reasonable numbers. Wildfires caused the extirpation of 11 of 18 populations in 2003 and two of four populations in 2007 (Marschalek and Klein 2010). Only one site was re-colonized from adjacent unburned habitat. Most other burned sites had no source populations close enough to re-establish the extirpated population (Marschalek and Klein 2010; Marschalek and Deutschman 2017). Distance to a source depends on the actual distance but also the landscape matrix and behavior of the species. Extreme drought is associated with population declines in 2002, 2007, 2014, 2015, and 2018 and extirpations in 2014, 2015, and 2018 (Marschalek and Deutschman 2008; Marschalek 2020).

The overall condition for the Hermes Copper Species Indicator is Significant Concern based on consideration of the two metrics (table HERM0.1). In 2020, Hermes copper populations had disappeared from all but three sites (Metric 1) and dwindled to small numbers (Metric 2) (Marschalek 2020). Additional metrics will be developed in the future as more information becomes available.

**Table HERM0.1**. Current overall condition status for Hermes Copper Species Indicator and period of baseline to current years comparison for metric conditions, trends, and confidence levels.

| Indicator/metric (baseline – current years) | Condition | Trend | Confidence |
|---|---|---|---|
| Hermes copper overall condition status | Significant Concern | Declining | High |
| Metric 1: occupied sites (2010-2020) | Significant Concern | Declining | High |
| Metric 2: population status (2010-2020) | Significant Concern | Declining | High |

## Metric 1: Occupied Sites

**Overview:** Hermes copper populations have been surveyed from 2003 to 2020 at many sites via walking transects (Marschalek and Deutschman 2017, 2018a,b, 2019, 2020). Survey effort varies by year with different sites monitored over time. In years with low survey effort the primary focus was to visit sentinel sites (that is, sites designated for periodic surveys to monitor abundance using standardized protocols). In years with higher levels of effort, the intent was to monitor sentinel sites and conduct surveys of recently extant sites, historically occupied sites, and new sites with suitable habitat but no previous Hermes copper detections. We only included years with surveys of at least 20 sites to look for trends. Most sites were surveyed in multiple years.

**Metric Evaluation Period:** 2010-2020 (Baseline 2010; Current: 2020)

**Baseline:** The baseline year is 2010, when 31 sites were surveyed, and Hermes copper was detected at 19 (61 percent) sites on Conserved Lands (fig. HERM1.1; Marschalek and Deutschman 2017). Surveys were conducted in 2003-2009, but survey effort was less than 20 sites. Large-scale wildfires in 2003 and 2007 caused extirpation at seven of these sites prior to 2010. One site in a large block of contiguous U.S. Forest Service (USFS) habitat recolonized in 2010 after the 2003 fires (Marschalek and Deutschman 2017).

**2027 Progress Towards Desired Condition:** Restore, enhance, and maintain ≥5 conserved, extant occurrences of Hermes copper (associated with 2022-2026 MSP objectives).

### Condition Thresholds:

- **Good:** ≥15 conserved sites supporting Hermes copper.
- **Caution:** 10-14 conserved sites supporting Hermes copper.
- **Concern:** 5-9 conserved sites supporting Hermes copper.

- **Significant Concern:** <5 conserved sites supporting Hermes copper.

### Current Condition: Significant Concern

In 2020, Hermes copper butterflies were detected at a total of three (9 percent) of 35 sites surveyed on Conserved Lands (Marschalek 2020). Hermes copper is now known from one site on private property northeast of Potrero and three conserved sites: Roberts Ranch South, Boulder Creek, and Potrero BLM (Marschalek 2020).

### Trend (2010-2020): Declining

Hermes copper began to decline in the 1960s and has disappeared from many sites since surveys were initiated in 2001(figs. HERM1.1 and 1.2). During 2010, butterflies were detected at 19 (61 percent) of 31 surveyed sites (Marschalek and Deutschman 2017). By 2020, butterflies were present at only three (9 percent) of 35 sites. Population extirpations since the 2003 and 2007 wildfires are attributed to intense and prolonged drought (fig. HERM1.1; Marschalek 2021).

### Confidence: High

Annual monitoring at sentinel sites, exploratory surveys, and repeated visits to previously surveyed sites provide a comprehensive database of Hermes copper detections.

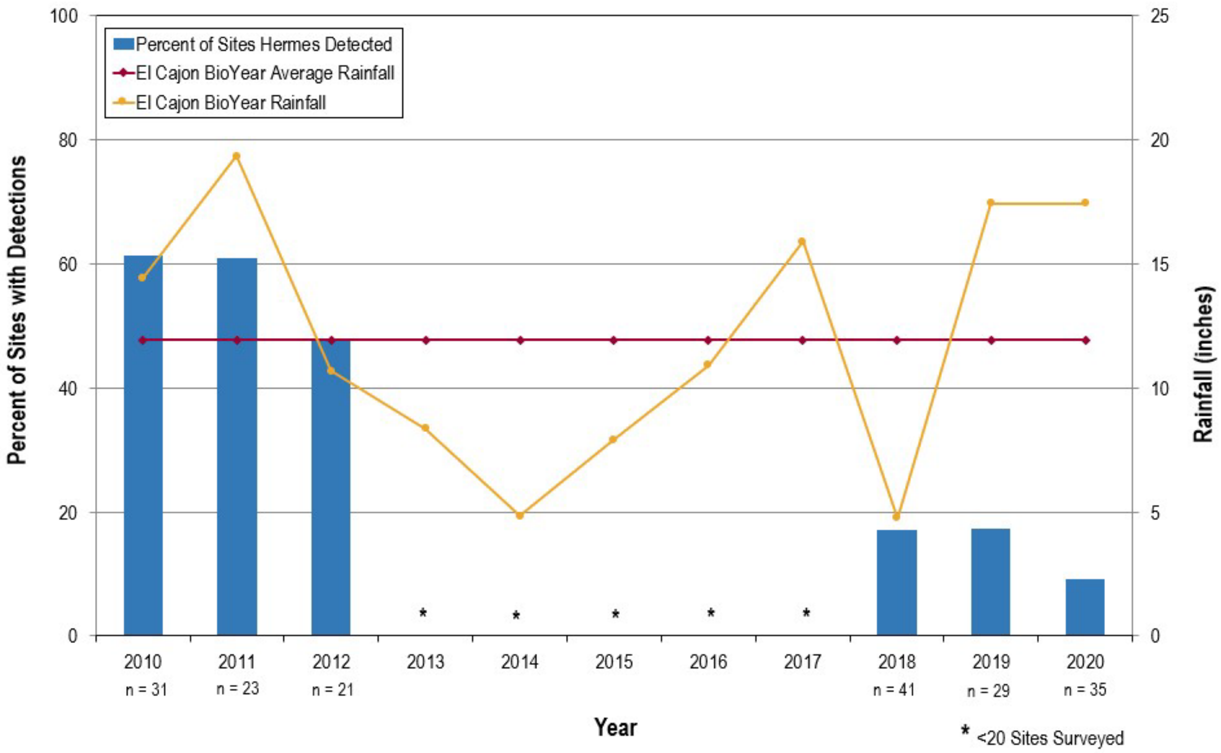


**Figure HERM1.1.** Bioyear rainfall and percent of sites with Hermes copper detections from 2010 to 2020. This graph shows the percent of sites with Hermes detection in blue bars. Average annual bioyear rainfall (growing season rainfall October 1 to September 30) is depicted in the red line for the El Cajon weather station in the vicinity of monitored sites. Bioyear rainfall from 2010 to 2020 represented by the gold line shows much of the survey period had below average rainfall coinciding with the recent decline in butterfly detections. Years with <20 surveyed sites are excluded as survey effort is not considered representative.

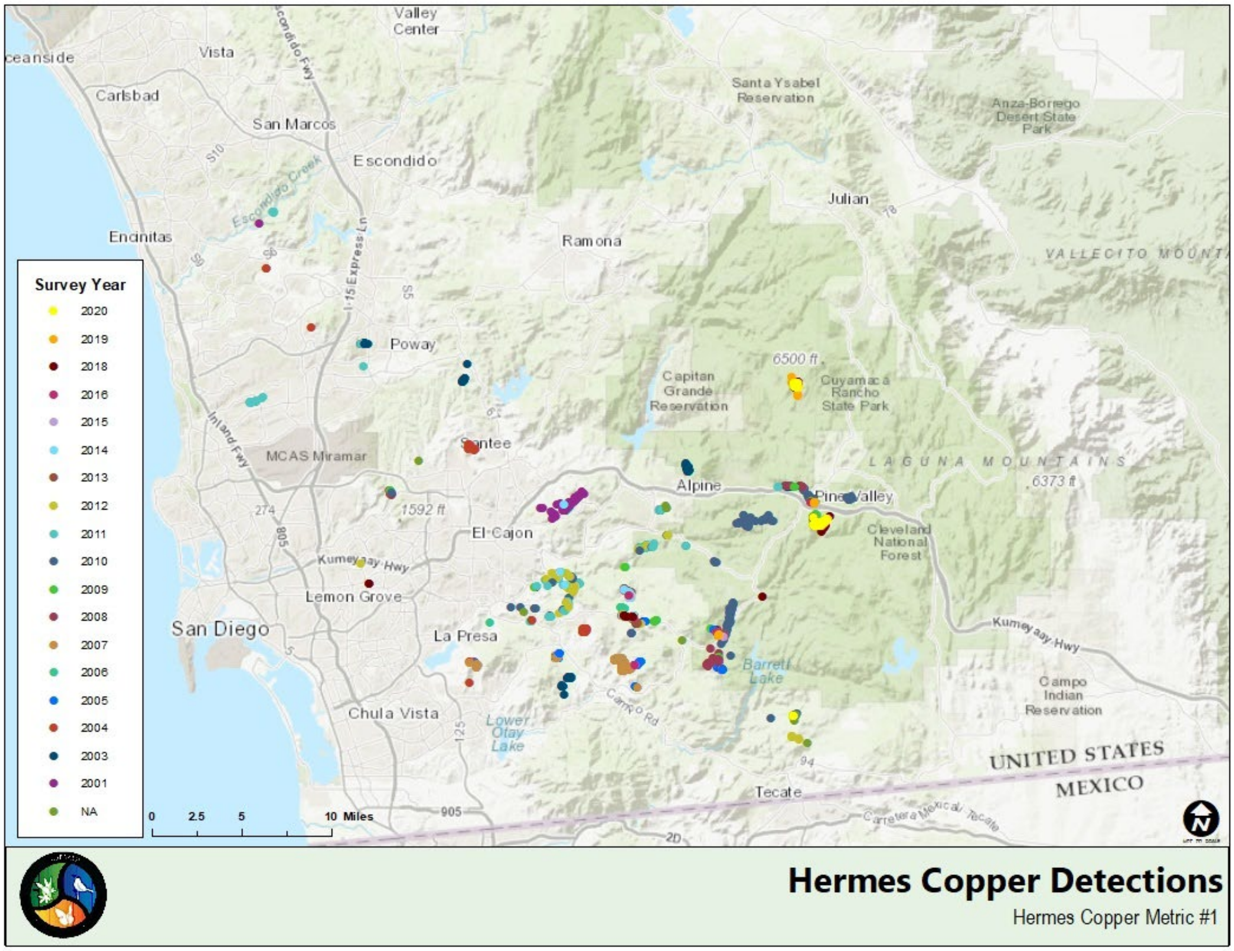


**Figure HERM1.2.** Hermes copper detections by survey year from 2001 to 2020.
Surveys conducted over much of the Hermes copper geographic range show that Hermes copper current distribution has contracted and is now restricted to the eastern portion of the range (yellow circles represent 2020 detections).

## Metric 2: Population Status

**Overview:** Sentinel site surveys were conducted annually from 2010 to 2020. Following a set route, butterflies are counted on a walking transect of variable length. Sentinel USFS sites include Boulder Creek Loop, Lawson Peak, Roberts Ranch North, Sycuan Peak, and, since 2018, Roberts Ranch South (Marschalek and Deutschman 2017, 2018a,b, 2019; Marschalek 2020). These surveys help to track population abundance over time.

**Metric Evaluation Period:** 2010-2020 (Baseline: 2010; Current: 2020)

**Baseline:** In 2010, four sentinel sites were surveyed with small numbers of butterflies detected (≤12) at all sites (fig. HERM2.1; Marschalek and Deutschman 2017).

**2027 Progress Towards Desired Condition:** Manage the two sentinel sites still supporting butterflies to reduce risk of extirpation from fire or other threats (associated with 2022-2026 MSP objectives).

### Condition Thresholds:

- **Good:** Five sentinel sites support butterflies with more than ≥50 individuals at ≥50 percent of the five sites.
- **Caution:** Five sentinel sites support butterflies, but ≥50 individuals are counted at only one site.
- **Concern:** Four sentinel sites support butterflies, but ≥50 individuals are counted at only one site.
- **Significant Concern:** Three or fewer sentinel sites support butterflies, regardless of the number of butterflies counted.

### Current Condition: Significant Concern

In 2020, only two sentinel sites supported butterflies (fig. HERM2.1, Marschalek 2020). Five butterflies were detected at Boulder Creek Loop, and 45 were detected at Roberts Ranch South.

### Trend (2010-2020): Declining

Hermes copper populations have disappeared from three of five sentinel sites between 2010 and 2020 (fig. HERM2.1). Numbers had been low throughout the survey period until the Roberts Ranch South population was discovered in 2018 and added to the sentinel site rotation. This site supported over two times as many butterflies in 2019 than any other site during the 11-year survey period. While butterflies are relatively abundant at this site, the overall trend for the remaining sites is Declining, which is attributed in recent years to prolonged and intense drought (fig. HERM2.1).

### Confidence: High

The data set is reliable as there is a standardized protocol with experienced biologists conducting the surveys. There may be some small uncertainty in counts due to weather effects on phenology and the difficulty of detecting individuals in small numbers. Multiple visits during the season help to reduce this uncertainty.

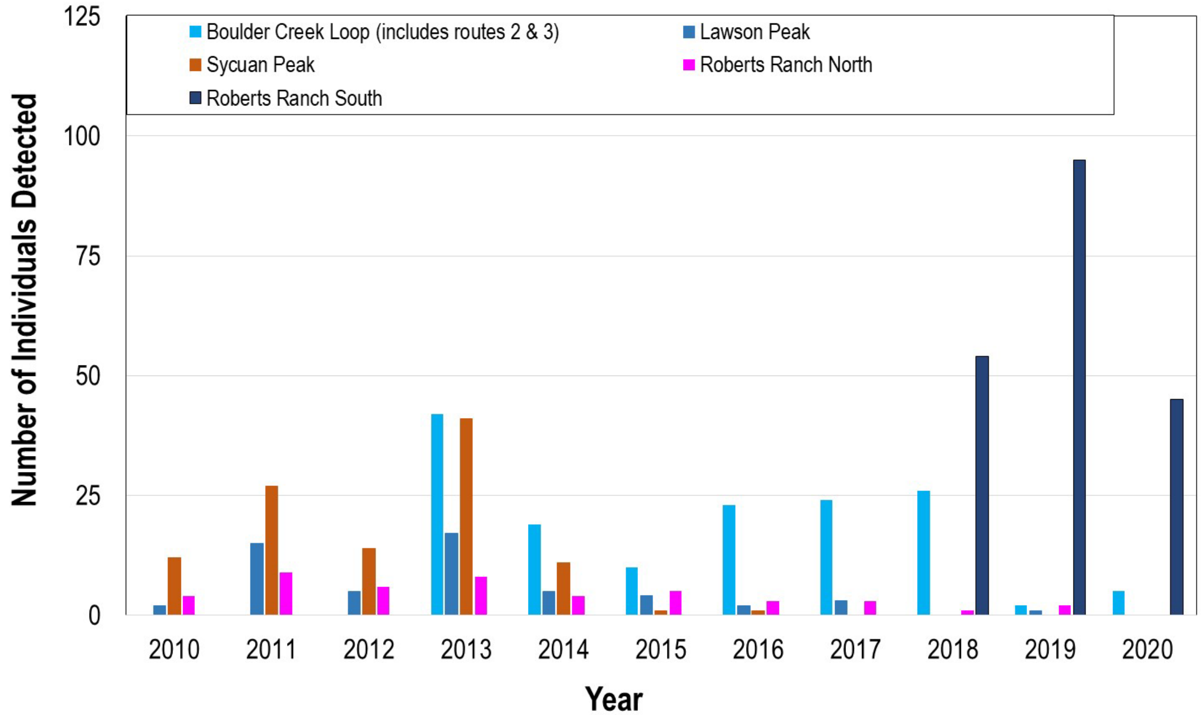


**Figure HERM2.1.** Number of individuals detected during surveys of four sentinel sites between 2010 and 2020. A fifth site (Robertson Ranch South) was discovered in 2018 and monitored in 2019 and 2020. The number of individuals detected has declined at all sites with the exception of newly discovered Robertson Ranch South. In 2020, Hermes copper was detected at only two of the five sentinel sites.

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## Southwestern Pond Turtle – Species Indicator (Rare and Specialist Species)


### Why Is This Indicator Included?

The southwestern pond turtle (*Actinemys* [*Emys]* *pallida*) is the only freshwater turtle native to coastal southern California. Impacts such as urban development, introduced species, and altered hydrology have caused a decline in this taxon (Clark and others 2010; Thomson and others 2016; Brehme and others 2018; Brown and others 2020; Turtle Taxonomy Working Group 2021). Once widespread, pond turtles are now rare in San Diego County, with only a few stable populations in the upper portions of the watersheds (Stephenson and Calcarone 1999).

Until 2014, the western pond turtle was considered one species and referred to as *Actinemys (Emys) marmorata* (Spinks and others 2014). Recently, the species has undergone taxonomic revisions with different agencies using variations of the taxonomy for the southern clade. The USFWS recognizes the southern group as *Actinemys marmorata pallida,* and the California Department of Fish and Wildlife (CDFW) recognizes it as *Emys marmorata*. Following the taxonomic revision to recognize two distinct

The pond turtle, a member of the Emydidae family, is the only freshwater turtle native to coastal California. Pond turtles once occupied coastal streams, ponds, and marshes throughout southern California.

They are cryptically colored and vary from brown to olive-brown to dark brown. The scutes on their carapace have a radiating, marbled pattern that is sometimes only visible in sunlight, and their heads and bodies have a mottled appearance. Males and females have slight morphological differences. Males tend to have thicker tails and concave plastrons while females tend to have flat or convex plastrons and taller carapaces (Bury and Germano 2008).

species, this report will refer to it as the southwestern pond turtle (*Actinemys [Emys] pallida*; hereafter referred to as pond turtle) (Turtle Taxonomy Working Group 2021).

*Actinemys (Emys) marmorata* (western pond turtle) is identified as a Species of Special Concern by CDFW (Jennings and Hayes 1994, Thomson et al. 2016). It was petitioned for listing under the federal Endangered Species Act in 1992 and again in 2012 (Center for Biological Diversity 2012); the 2012 proposal for listing is under review by the USFWS. *Actinemys pallida* was formerly considered a subspecies of *A. marmorata*. In 1997, *Clemmys (Actinemys) marmorata pallida* was included as one of the 75 species that the MSCP aims to conserve within coastal San Diego County (City of San Diego 1998). The pond turtle has been the focus of many monitoring and restoration efforts in western San Diego County (Madden -Smith and others 2005; Brown and others 2015, 2020).

The southwestern pond turtle was selected as an indicator of how well the regional preserve system is protecting a species of high conservation priority in riparian and wetland habitats. Because this species requires permanent or semi-permanent water with little human impact and free of nonnative predators, it can be used as an indicator of healthy aquatic communities (Thomson and others 2016).

### Stressors

The southwestern pond turtle has been declining for decades and faces many threats across western San Diego County (Stephenson and Calcarone 1999; Thomson and others 2016; Brown and others 2020a).

- **Invasive Animals:** Invasive aquatic predators including bullfrogs, crayfish, and largemouth bass inhibit recruitment by preying upon juvenile pond turtles (Clark and others 2010; Thomson and others 2016; Brown and others 2020).
- **Climate Vulnerability:** Extreme or prolonged drought can have a severe impact on pond turtle populations by reducing or eliminating surface water for foraging and refugia (Madden-Smith and others 2005; Brown and others 2015, 2020; Purcell and others 2017).
- **Urbanization:** Impacts from fragmentation, loss of habitat, and road mortality can shift population demographics and affect recruitment (Griffen and others 2020). Fragmentation also reduces the pond turtle's ability to recover from local extirpation events (for example, fire, drought, or temporary human impacts) (Thomson and others 2016).
- **Altered Hydrology:** Altered hydrology impacts the pond turtle through reduction of habitat in upper portions of the watershed (for example, water removal or impoundment, sedimentation, reduced water temperatures below dams) as well as facilitation of invasive species in lower watersheds through aseasonal flow (Madden-Smith and others 2005; Brown and others 2015, 2020; Thomson and others 2016)

- **Fire:** Fire impacts the pond turtle through both direct mortality and indirect habitat alteration. Large, watershed-level wildfires can increase sedimentation, which reduces the amount of available surface water habitat (Wohlgemuth and Hubbert 2008; Thomson and others 2016).

### Desired Condition

MSP Roadmap Goal (SDMMP and TNC 2017):

*Protect and enhance existing sites with southwestern pond turtle to self-sustaining levels (that is, 200+ individuals, even sex ratio, evidence of recruitment) in areas that meet the conditions for long-term management (low human access; high naturalness) and create new self-sustaining occurrences to ensure persistence over the long-term (>100 years).*

### Current Condition Status

The initial MSCP pond turtle assessment (2003-2005) indicated that no populations within the preserve system were recruiting (that is, having natural offspring in the wild). Restoration efforts and property acquisitions have brought more pond turtles into conservation and facilitated recruitment (successful production and survival of young to adulthood) in the wild. However, there are still very few locations that have stable or increasing populations of pond turtles on Conserved Lands in San Diego. This indicator is being tracked across the HUC12 watersheds, which are the most local sub-watersheds capturing the tributary systems (fig. SWPT0.1; USGS 2013). The HUC12 watershed can be used as a meaningful management unit. The current condition consists of 24 HUC12 watershed units with at least a single pond turtle detection; only six of these have detectable recruitment.

The overall current condition status for the Southwestern Pond Turtle Species Indicator is derived by considering the scores across the four metrics (table SWPT0.1), yielding an overall condition in the Concern category. However, the two metrics with highest confidence have improving trends (Metrics 1 and 4). While there are still very few populations in conservation, restoration and translocation efforts have increased occupancy and recruitment within the preserve. More metrics will be added for future analyses.

Over the last 20 years, SDMMP has coordinated with partners to investigate, monitor, and restore southwestern pond turtle populations (Madden-Smith and others 2005; Brown and others 2015, 2020). The number of conserved populations is low but has been growing since the initiation of SANDAG and the MSCP conservation and restoration efforts. Invasive species removal efforts help bolster southwestern pond turtle populations (for example, at Sycuan Peak Ecological Reserve, Escondido Creek), but invasive species continue to make inroads elsewhere in the preserve system. Drought has also impacted pond turtles in many locations, but current efforts to restore the turtle to Conserved Lands with permanent water resources are providing this species with climate resiliency (Brown and others 2015, 2020; Purcell and others 2017).

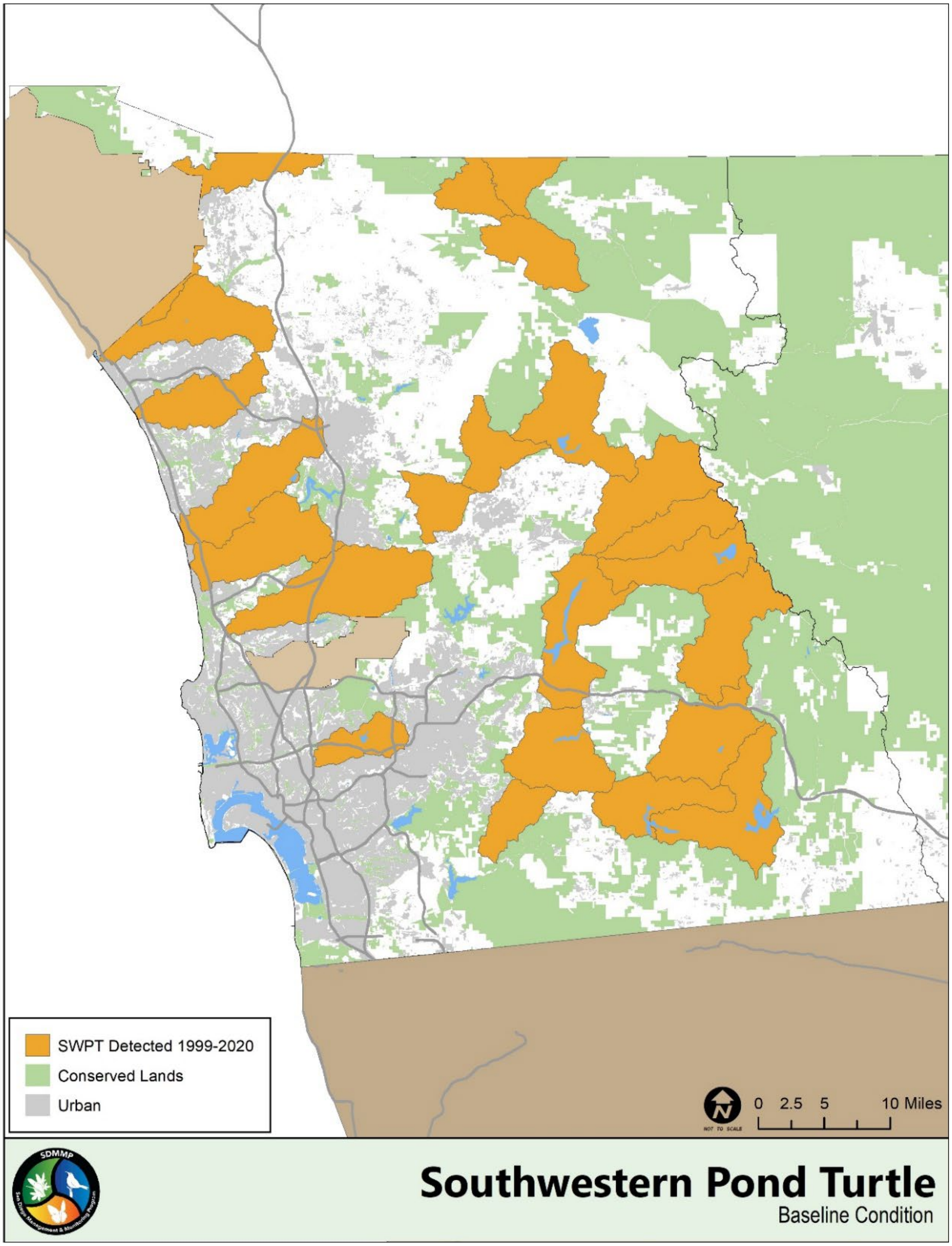


**Figure SWPT0.1.** HUC12 watersheds with recent pond turtle detections in Western San Diego County. This map shows orange polygons that represent HUC12 watersheds where one or more pond turtles were observed during 1999 to 2020 surveys.

**Table SWPT0.1.** Current overall condition status for the Southwestern Pond Turtle Species Indicator and period of baseline to current years comparison for metric conditions, trends, and confidence levels.

| Indicator/metric | Condition | Trend | Confidence |
|---|---|---|---|
| Southwestern pond turtle overall condition status | Concern | Improving | Moderate |
| Metric 1: presence of adult versus juvenile pond turtles (2000-2020) | Significant Concern | Improving | High |
| Metric 2: invasive aquatic species impact score (2000-2020) | Concern | No Change | Moderate |
| Metric 3: water availability score (2000-2020) | Concern | Unknown | Moderate |
| Metric 4. managed occurrences on Conserved Lands (2000-2020) | Significant Concern | Improving | High |

## Metric 1: Presence of Adult versus Juvenile Pond Turtles

**Overview:** This metric focuses on viable populations of pond turtles within the regional preserve system. It includes populations that are natural, restored or enhanced natural, and newly created. Examples of these include Pine Valley Creek (natural), Sycuan Peak Ecological Reserve and Escondido Creek (restored natural), and The Nature Conservancy's Wheatley Preserve (newly created).

The first component of this metric is presence of pond turtles of any sex or age class. The baseline data were collected from 2000 to 2005 and are compared with data from more current studies. This metric can easily utilize data collected by USGS, local jurisdictions, consultants, and citizen scientists (that is, iNaturalist, BioBlitz).

The second component of this metric, the presence of pond turtles, measures successful reproduction in each HUC12 watershed. Utilizing capture data from USGS, San Diego County, and USFS, this metric compares population status at HUC12s by calculating quantitative scores (see text box below). Potential for successful production of offspring was scored based on sex ratio and detection of juveniles. Juveniles were identified by small carapace lengths. A small mean carapace length in a HUC12 watershed represents the presence of juvenile and adult age classes. This indicates a successfully reproducing population at a HUC12 with diverse population structure (Nicholson and others 2020) and received the highest score. The overall score for this metric is the sum of scores for each HUC12 watershed unit (see text box).

HUC stands for Hydrologic Unit Code. A hydrologic unit describes the area of land upstream from a specific point on the stream (generally the mouth or outlet) that contributes surface water runoff directly to this outlet point.

HUC12 watersheds are the most local sub-watershed unit. These include the tributaries to the creek and streams as individual units (USGS 2013). This makes them suitable for management actions such as invasive species eradication and for monitoring threats and stressors.

Interbreeding pond turtle populations may span one or more adjacent HUC12 watersheds, although this has not yet been documented for San Diego County. Alternatively, barriers to movement may prevent interbreeding among populations.

**Metric Evaluation Period:** 2000-2020 (Baseline: 2000-2005; Current: 2015-2020)

> Metric scoring: Each HUC12 was given a score of 1 (single sex adults only), 3 (both sexes present), or 10 (juveniles and adults present). The individual scores were summed to give the overall metric score. The maximum score possible across the 24 HUC12s is 240.

**Baseline:** During the baseline time period (2000-2005), pond turtles were detected in 24 of 56 (43 percent) HUC12 watersheds examined. Information on sex and age (adult or juvenile) of pond turtles was collected at nine of the 24 HUC12s (Madden-Smith and others 2005, Fisher and others 2014). Of these nine HUC12s, both sexes were detected with no juveniles at three HUC12s (33 percent), and a single sex was detected at the other six (67 percent). The score for the nine HUC12s with age and sex information in 2000-2005 was 15 (fig. SWPT1.1; Madden-Smith and others 2005; SDMMP and TNC 2017). The remaining 15 of 24 HUC12s were not scored because, while there were verified observations of pond turtles, no information on the sex of adults or the presence of juveniles was available.

**2027 Progress Towards Desired Condition:** Maintain or restore production of juvenile/young pond turtles in the six HUC12s with currently managed pond turtle populations. This could be accomplished through removal of nonnative predators at the six HUC12s, continued pond turtle reintroductions in the two new HUC12s on Conserved Lands, and management actions to mitigate impacts of prolonged drought (associated with 2022-2026 MSP objectives).

#### Condition Thresholds:

- **Good:** Minimum metric score of 180 out of 240. This range of scores indicates pond turtles could be producing young in 18 or more of the 24 HUC12s. It could also be achieved through a combination of young being produced at fewer HUC12s combined with HUC12s where both sexes are present.
- **Caution:** Metric score between 120 and 179 out of 240. This range of scores indicates pond turtles could be producing young in 12 to 17 HUC12s. It could also be achieved with a combination of HUC12s with juveniles and HUC12s without juveniles where both sexes are present.
- **Concern:** Metric score between 80 and 119 out of 240. This range of scores indicates pond turtles could be producing young in eight to 11 HUC12s. It could also be achieved with a combination of HUC12s with juveniles and HUC12s without juveniles where both sexes are present.

- **Significant Concern:** Metric score < 80 out of 240. This range of scores indicates pond turtles could be producing young in fewer than eight HUC12s. It could also be achieved with a combination of HUC12s with juveniles and HUC12s without juveniles where both sexes are present.

### Current Condition: Significant Concern

The current metric score measured from 2015 to 2020 is 74 out of 240 points possible. We now have survey information for a total of 80 HUC12s in the MSPA, including pond turtle population information (age and sex class) at the 24 baseline HUC12s occupied in 2000-2005. Of these 24 baseline HUC12s, 11 (46 percent) are currently occupied by pond turtles on Conserved Lands. Of the 11 occupied HUC12s, juvenile turtles have been detected at six (55 percent), both sexes without juveniles at three (27 percent), and two (18 percent) are currently occupied by only one sex (male only).

Thirteen of the 24 HUC12s (54 percent) occupied in the baseline period now have no detectable pond turtles on Conserved Lands (fig. SWPT1.2).

### Trend (2005-2020): Improving

The number of occupied HUC12s with juvenile pond turtles is Improving since 2005, resulting in the metric score going from 15 to 74. As of 2020, six HUC12s have juveniles, whereas the nine HUC12s for which there were baseline (2000-2005) age and sex information had no juveniles. Since most of the HUC12s had only one sex detected, this indicates pond turtles could have been functionally extirpated at these HUC12s during the time of the baseline surveys (Madden-Smith and others 2005; Nicholson and others 2020).

Assessment of this metric requires information on age and sex class that was not available for most (15 of 24) of the HUC12s in 2000-2005. However, it’s noted that there are fewer occupied HUC12s in 2015-2020 than there were in 2000-2005. Fifteen of the original 24 HUC12s where pond turtles were detected in 2000 to 2005 now have no detectable turtles on Conserved Lands. Perhaps, in the 15 HUC12s lacking age and sex information, occupancy was based on the presence of a single individual which subsequently died.

### Confidence: High

For 20 years, research efforts have focused on monitoring the status of and restoration methods for pond turtles within the MSPA. All currently occupied sites have been studied for a minimum of 7 years, and surveys have been conducted in 80 HUC12s throughout the MSPA. Most potential locations where status is unknown are on private or inaccessible lands.

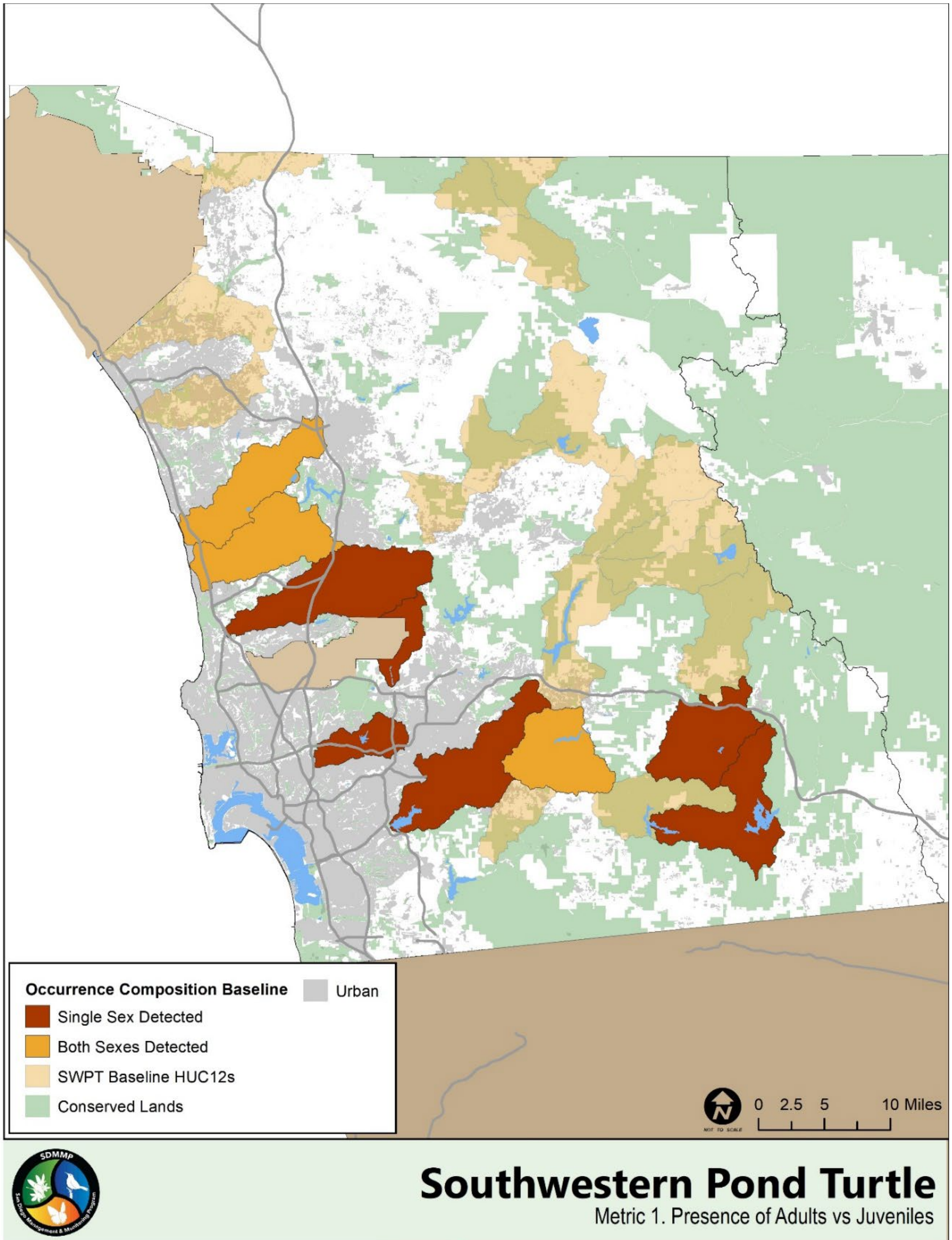


**Figure SWPT1.1.** Southwestern pond turtle juvenile detections and potential to have juveniles (that is, adults of both sexes present) by HUC12 watershed during the baseline monitoring period (2000 to 2005). Rust polygons are HUC12 watersheds where only male turtles were detected, and orange polygons are where both sexes were detected. This map also includes baseline HUC12s with unknown status where age class and sex could not be determined (transparent polygons).

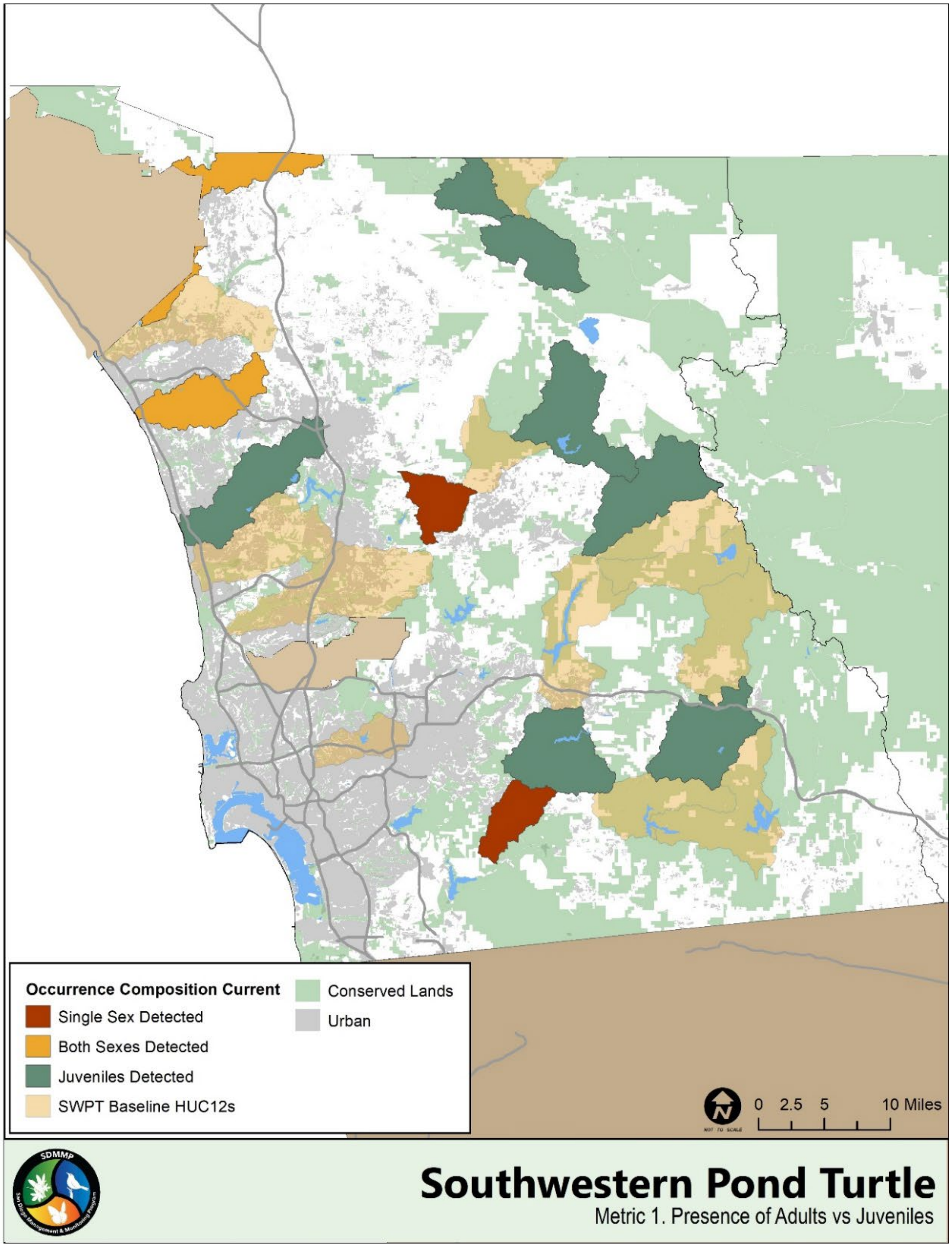


**Figure SWPT1.2.** Southwestern pond turtle juvenile detections and potential to have juveniles (having adults of both sexes) by HUC12 watershed in the current period (2015 to 2020). Rust polygons are HUC12 watersheds where only male turtles were detected, orange polygons are where both sexes were detected, and dark green polygons are where juveniles were detected. This map also includes baseline HUC12s with unknown status where age class and sex could not be determined (transparent polygons).

## Metric 2: Invasive Aquatic Species Impact Score

**Overview:** Invasive aquatic species (IAS) can have severe direct and indirect effects on pond turtle productivity (Clark and others 2010; Brown and others 2015; Nicholson and others 2020). The IAS Impact Score assesses, in one value, the presence and relative impact of IAS at HUC12 watersheds occupied by pond turtles.

The HUC12 watersheds with pond turtle detections in 2000-2005 (that is, the 24 HUC12s, identified as occupied by pond turtles in the baseline period) are individually scored based on detections of IAS. Each IAS is given a point value based on its impact on pond turtle recruitment. Predatory species are given a higher impact score than competitive IAS which eat the same food as pond turtles. Competitive IAS have higher scores than IAS which could affect the resources that a pond turtle eats (that is, trophic IAS). For example, mosquito fish (*Gambusia affinis*) do not eat the same food as pond turtles but compete with dragonfly larvae and other macroinvertebrates that are eaten by pond turtles.

Within predatory, competitive, and trophic groups of IAS, different scores are assigned based on potential level of impact to pond turtles. For example, scores of -10 are assigned for bullfrogs (*Lithobates catesbeianus*), while -5 points are assigned for bass (*Micropterus* sp.) and crayfish (*Procambarus clarkii*). Competitive IAS are scored -2 points and include invasive turtles like sliders (*Trachemys* sp.). IAS affecting only trophic interactions are given a weight of -1 point and include mosquitofish and sunfish (*Lepomis* sp.). The total IAS score is added up for each HUC ranging from 0 to -55. A score of 0 means there are no IAS in that HUC12, while a score of between 0 and -10 indicates there are no high impact IAS present. A score of -55 indicates all currently known IAS are present. The scores are then averaged across the HUC12 watersheds to calculate the overall IAS Impact Score. The total IAS score is added up for each HUC ranging from 0 to -55. A score of 0 means there are no IAS in that HUC12 while a score of between 0 and -10 indicates there are no high impact IAS present. A score of -55 indicates all currently known IAS are present. The scores are then averaged across the HUC12 watersheds to calculate the overall IAS Impact Score. This metric is also used for the Arroyo Toad Species Indicator.

**Metric Evaluation Period:** 2000-2020 (Baseline: 2000-2005; Current: 2015-2020)

**Baseline:** USGS, City of San Diego, County of San Diego, CDFW, and partners have been collecting data on nonnative aquatic species in streams throughout the MSPA since 2000 (Hathaway and others 2002, Madden-Smith 2005). The baseline value for this metric is a snapshot of invasive species impacts on Conserved Lands associated with southwestern pond turtle habitat during 2000 to 2005. The 24 HUC12s in which pond turtles were detected between 2000 and 2005 are evaluated as part of the baseline and are considered in the current condition and threshold condition categories. Invasive species records were compiled to give a numerical score by HUC12 as described above. The baseline condition follows Madden-Smith and others (2005), incorporating data collected from previous studies (2000 to 2005). The baseline IAS Impact Score for this metric is -29.95. Fourteen of the 24 HUC12s had the two high impact predatory IAS (crayfish, bullfrogs), and nine of the remaining 10 HUC12s had at least one of the high impact predatory IAS.

**2027 Progress Towards Desired Condition:** Projects are underway to remove invasive aquatic predators from sites with pond turtles to increase the IAS Impact Score (reduce impact) to greater than -20. This means that on average, less than two high impact predatory IAS would be present in the 24 HUC12s. This is consistent with MSP objectives (SDMMP and TNC 2017). To achieve this goal, it will be necessary to remove IAS from the upper portions of the watersheds to keep IAS from moving downstream.

### Condition Thresholds:

- **Good:** An average IAS Impact Score > -10 for the 24 HUC12s with pond turtle detections in 2000-2005.
- **Caution:** An average IAS Impact Score between -10 and -20 for the 24 HUC12s with pond turtle detections in 2000-2005.
- **Concern:** An average IAS Impact Score between -21 and -30 for the 24 HUC12s with pond turtle detections in 2000-2005.
- **Significant Concern:** An average IAS Impact Score < -30 for the 24 HUC12s with pond turtle detections in 2000-2005.

### Current Condition: Concern

The current IAS Impact Score is -25.5 for the 24 HUC12s with pond turtle detections in 2000-2005. Over 80 percent of the historic pond turtle HUC12s are severely impacted by IAS (fig. SWPT2.1). IAS can impact pond turtle reproduction, and efforts to remove these species started in 2008. This management helped to restore pond turtle populations at specific locations within a HUC12 (for example, Sycuan Peak Ecological Reserve within the Loveland Reservoir HUC12 or Scholder Creek within the Sutherland Lake HUC12). However, these efforts have not yet been scaled up to the entire HUC12 watershed.

### Trend (2005-2020): No Change

The IAS Impact Score has improved very slightly from -29.95 to -25.5, but the condition remains in the Concern category. Local and regional resource partners are having success removing IAS at individual sites within a HUC12. In addition, newly acquired and conserved lands higher in the watersheds are less impacted by IAS. However, to date, there have been no efforts focused on an entire HUC12, so little change is being made at the HUC12 level, and new IAS are still being introduced in the County.

### Confidence: Moderate

The inventory and monitoring data span 20 years. However, many pond turtle monitoring sites are visited once in 3 to 5 years because of the pond turtle's relatively long lifespan and low fecundity. Therefore, there is variability between surveys and potential for IAS to move into a

HUC12 undetected. The widespread use of rapid assessment protocols to detect IAS in the future could increase confidence in this metric.

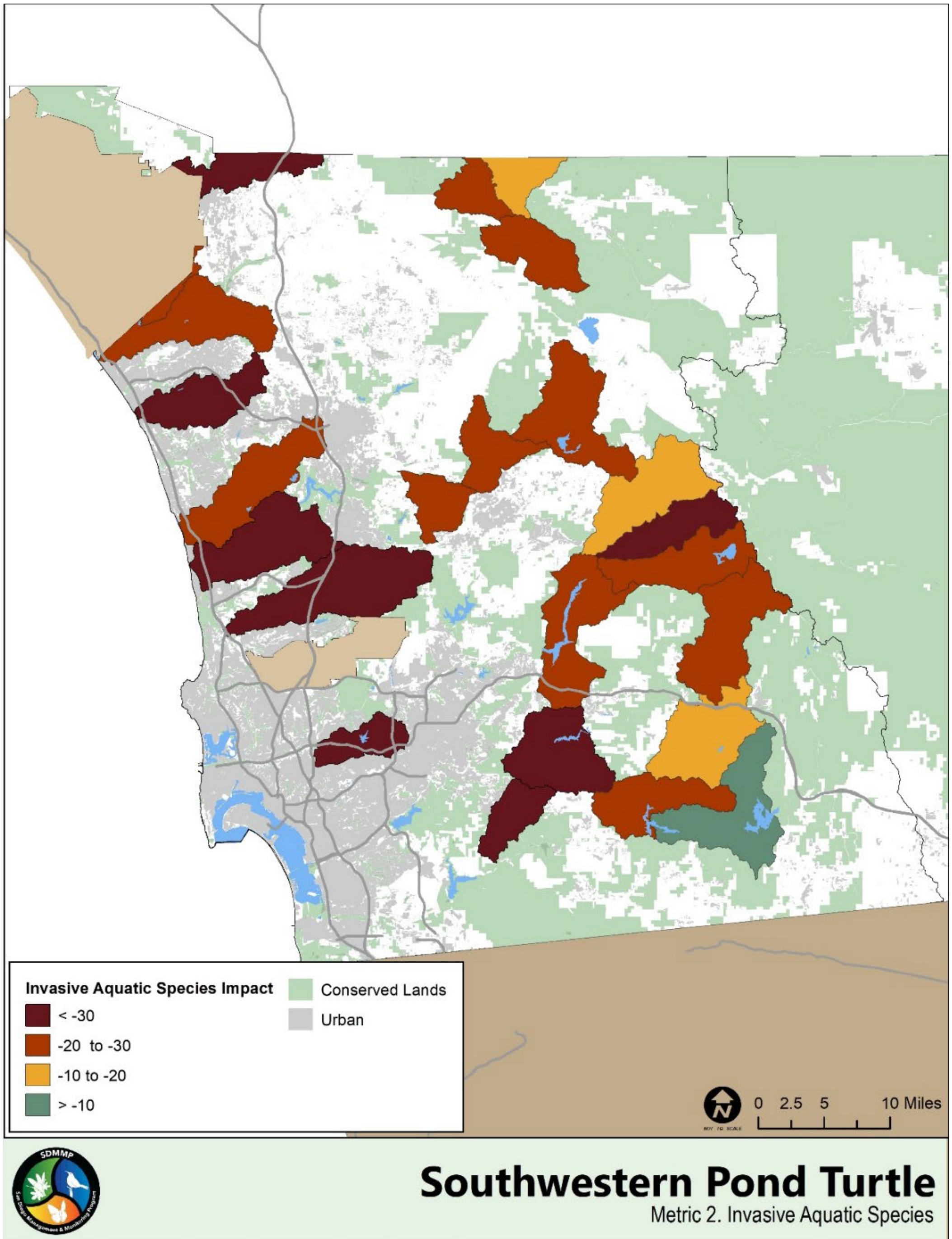


**Figure SWPT2.1.** Invasive aquatic species score by HUC12 watershed as of 2020.
Higher scores indicate HUC12 watersheds with more impacts from IAS. Dark brown polygons represent HUC12 watersheds that are most impacted by IAS and fall within the Significant Concern condition category. Rust colored HUC12 watersheds are categorized as a condition of Concern, orange as Caution, and dark green as Good.

## Metric 3: Water Availability Score

**Overview:** With drought, large-scale wildfire, and hydrologic impairment (dams and diversions), suitable aquatic habitat is a major concern for persistence of the pond turtle. Pond turtles require streams and ponds that are permanent or semi-permanent in most years. These systems need to have sufficient water to allow for foraging and escape (Madden-Smith and others 2005; Brown and others 2015). Available surface water in the local streams and ponds is in large part affected by two components: water level and stream/pond bottom depth.

Water availability is a product of rainfall, ground water depletion, diversion, and runoff. The geomorphology or depth of ponds and streams is affected by sedimentation and debris flows. Increased sedimentation can be caused by hydrologic impairment that moderates flow events and does not allow sediment mobilization (Taniguchi and Biggs 2015). Debris flows are products of large amounts of upland sediment being mobilized after stochastic events such as large-scale wildfire (Wohlgemuth and Hubbert 2008; Moody and Martin 2009).

The Water Availability Score is assessed for the 24 HUC12 watersheds where turtles were detected during 2000 to 2005. The score is based on hydrologic impairments (dams, diversions, etc.) and field-collected surface water data from visual encounter surveys conducted from 2015 to 2020. HUC12 watersheds with turtles detected during 2000 to 2005 are scored for Water Availability in 2015-2020. Water Availability Scores range from 0 (unimpaired) to 7 (highly impaired). Presence of dams within the HUC12 watershed is scored 0 (not present) or 1 (present). Ground water wells are scored 0 (not present), 1 (one to 34 wells) or 2 (more than 34 wells) per HUC12 watershed. Artificial channels and diversions are scored according to density (length of channel/diversion in kilometers divided by area of HUC12 in square kilometers) as 0 (no artificial channels), 1 (less than 0.146 $km/km^2$), or 2 (greater than 0.146 $km/km^2$). Field data are scored as 0 (no dry survey visits), 1 (one dry survey visit), or 2 (more than one dry survey visit). The individual scores for the watersheds, ranging from 1 to 7, are averaged to give an overall Water Availability Score.

**Metric Evaluation Period:** 2015-2020 (Baseline: 2015-2020; Current: 2015-2020)

**Baseline:** The baseline (2015 to 2020) for the Water Availability Score is the current condition with a calculated value of 4.4 for the 24 HUC12 watersheds occupied by turtles during the 2000 to 2005 sampling period. Field collected species and habitat survey data for this period document that 24 HUC12s had available water to support pond turtle populations in 2000 to 2005 (Brown and others 2020). However, a Water Availability Score cannot be calculated for 2000 to 2005 as GIS data layers and Stream Temperature, Intermittency, and Conductivity data loggers (STICs) measurements are unavailable for that time period.

**2027 Progress Towards Desired Condition:** Use riparian and upland habitat restoration to restore natural processes within streams. Conserve and restore natural lands in watersheds to reduce the impact of hydrologic impairment and restore natural lands in HUC12 watersheds (associated with 2022-2026 MSP objectives) to a Water Availability Score of 4.3 or less.

### Condition Thresholds:

- **Good:** Water Availability Score <1.7 for 24 HUC12s with pond turtle detections in 2000-2005.
- **Caution:** Water Availability Score between 1.7 and 3.5 for 24 HUC12s with pond turtle detections in 2000-2005.
- **Concern:** Water Availability Score between 3.6 and 5.3 for 24 HUC12s with pond turtle detections in 2000-2005.
- **Significant Concern:** Water Availability Score >5.3 for 24 HUC12s with pond turtle detections in 2000-2005.

### Current Condition: Concern

The current period (2015-2020) Water Availability Score is 4.4, placing it in the Concern condition category (fig. SWPT3.1). During the last part of the field data collection period (2018-2020), prolonged drought severely impacted habitat in stream systems and ponds in the upper portions of the watersheds where pond turtles had previously been stable (Brown and others 2020). As a result, fewer HUC12 watersheds had suitable water available for pond turtles during the 2018-2020 period.

### Trend (2015-2020): Unknown

During our field sampling baseline period (2015-2020), we identified some improvements for pond turtles (for example, pond turtles were established in permanent ponds as refugia from drought at Wheatley Preserve and Rancho Jamul Ecological Reserve). However, many occupied streams were impacted by drought and had less surface water available for the species than they did during 2000 to 2005 surveys (Sweetwater River, Santa Ysabel Creek, Black Canyon, Pine Creek). More data are needed to determine if this is a long-term trend.

### Confidence: Moderate

Pond turtle sites are monitored on a rotating basis, and year-to-year rainfall variation may not be captured at a given site.

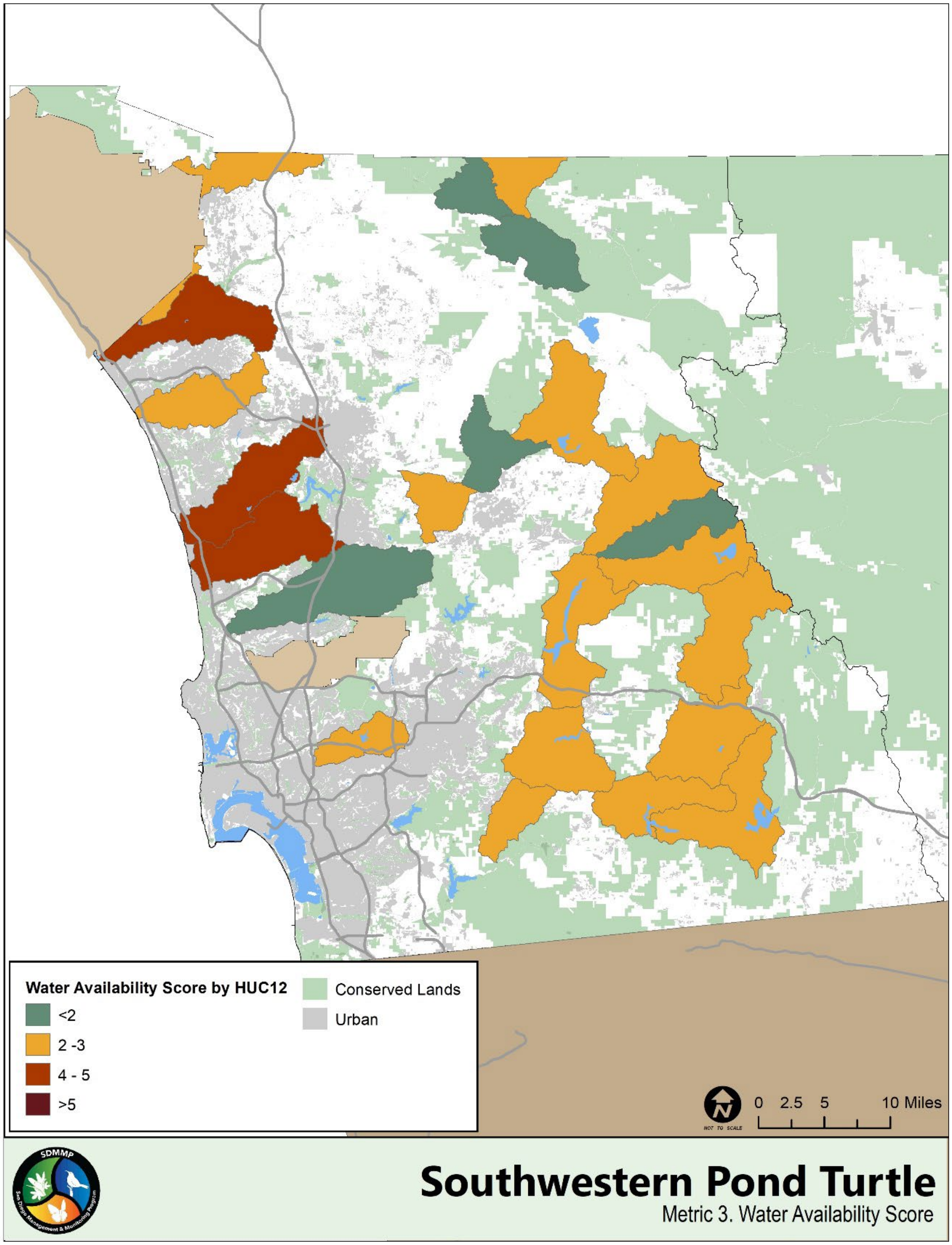


**Figure SWPT3.1**. Water Availability Score for individual HUC12 watersheds.
This figure shows the 24 HUC12 watersheds occupied by pond turtles during 2000 to 2005 (baseline and current). Dark brown polygons represent HUC12 watersheds that are most impacted for Water Availability and fall within the Significant Concern condition category. Rust colored HUC12 watersheds are categorized as a condition of Concern, orange as Caution, and dark green as Good.

## Metric 4: Managed Occurrences on Conserved Lands

**Overview:** The lack of pond turtle occurrences producing juveniles on Conserved Lands during baseline surveys in 2000 to 2005 (Madden-Smith and others 2005) spurred efforts to enhance, restore, or create locations to conserve pond turtles in the MSPA (SDMMP and TNC 2017). Regional management actions are being taken to increase the number and success of reproducing pond turtle occurrences (Brown and others 2020). This management at existing occurrences on Conserved Lands takes the form of restoration (that is, decreasing threats such as invasive species) and/or enhancement (that is, adding new turtles through captive rearing or translocation). New occurrences are also being established in suitable habitat on Conserved Lands where no turtles were recently present. The Managed Occurrences on Conserved Lands metric tracks the number of pond turtle occurrences where restoration or enhancement is taking place or where new occurrences are being established on Conserved Lands.

Each of the 24 HUC12s occupied in 2000 to 2005 is given a Managed Occurrences on Conserved Lands score of 0 to 5 based on the level of management and the outcomes of that management. HUC12s with restored natural pond turtle occurrences that are producing juveniles on Conserved Lands are given a score of 5. HUC12s with newly created pond turtle occurrences that are producing juveniles on Conserved Lands are given a score of 4. HUC12s with natural pond turtle occurrences that are being managed on Conserved Lands but still not producing juveniles are given a score of 2. HUC12s with newly created pond turtle occurrences on Conserved Lands that are being managed but still not producing juveniles are given a score of 1. HUC12s that have no turtle occurrences on Conserved Lands but are being managed to improve habitat for pond turtles are given a score of 0. The individual HUC12 scores are summed across the 24 HUC12s to give a final Managed Occurrences on Conserved Lands score from 0 to 120.

**Metric Evaluation Period:** 2000-2020 (Baseline: 2000-2005; Current: 2015-2020)

**Baseline:** The score for Managed Occurrences on Conserved Lands is 0 based on survey data collected during the baseline period (2000-2005; Madden-Smith and others 2015). No pond turtle occurrences were managed or being restored at this time.

**2027 Progress Towards Desired Condition:** Restored or enhanced turtle occurrences on Conserved Lands in six (25 percent; Managed Occurrences on Conserved Lands score of greater than 30) of the 24 HUC12 watersheds occupied by turtles in 2000 to 2005 (associated with 2022-2026 MSP objectives).

### Condition Thresholds:

- **Good:** Managed Occurrences on Conserved Lands score >90. This threshold requires a combination of natural or new occurrences managed on Conserved Lands and occurrences producing offspring at 20 or more sites within the 24 HUC12 watersheds with pond turtles during 2000 to 2005.

- **Caution:** Managed Occurrences on Conserved Lands score from 60 to 90. This threshold requires a combination of natural or new occurrences managed on Conserved Lands and occurrences producing offspring at 10 to 19 sites within the 24 HUC12 watersheds with pond turtles during 2000 to 2005.
- **Concern:** Managed Occurrences on Conserved Lands score from 30 to 59. This threshold can be met if all currently managed occurrences on Conserved Lands produce offspring or by adding nine new occurrences to the regional preserve system.
- **Significant Concern:** Managed Occurrences on Conserved Lands metric score <30.

#### Current Condition: Significant Concern

The current Managed Occurrences on Conserved Lands score of 21 is based on data collected from 2015 to 2020 and falls within the Significant Concern category. This score is a result of conserved and managed pond turtle occurrences in seven HUC12s, with three of these occurrences producing offspring (fig. SWPT4.1). There is one site with successful reproduction that has had both habitat restoration and enhancement through captive rearing of juveniles from eggs collected at the site. At this site, Sycuan Peak Ecological Reserve, the pond turtle numbers have more than doubled since management efforts were initiated. There are two occurrences where habitat has been restored that have produced juvenile turtles (that is, Escondido Creek and the west fork of the San Luis Rey River). Two other occurrences have had habitat restored, but no juvenile turtles have been detected as of 2020. Finally, two new turtle occurrences have been established by translocation and, as of 2020, had not produced young.

#### Trend (2000-2020): Improving

There are currently pond turtle management projects on Conserved Lands within seven HUC12s. These include two newly established occurrences and five restored and/or enhanced occurrences, of which three show successful reproduction. This is marked improvement over having no managed occurrences on Conserved Lands in the baseline period (2000-2005).

#### Confidence: High

USGS, in collaboration with SDMMP, CDFW, USFWS, USFS, San Diego Zoo, City of San Diego, Center for Natural Lands Management, and County of San Diego, has been studying potential methods for enhancement of and restoration for pond turtles since 2008 (Brown and others 2015). The restoration and translocation efforts within the County have been closely monitored for successes. Successes include shifts in demography of pond turtle occurrences from primarily older adults to younger, healthier turtles at restoration sites (Molden and others 2022). Results of these efforts have been presented to the Wildlife Agencies and included in publications.

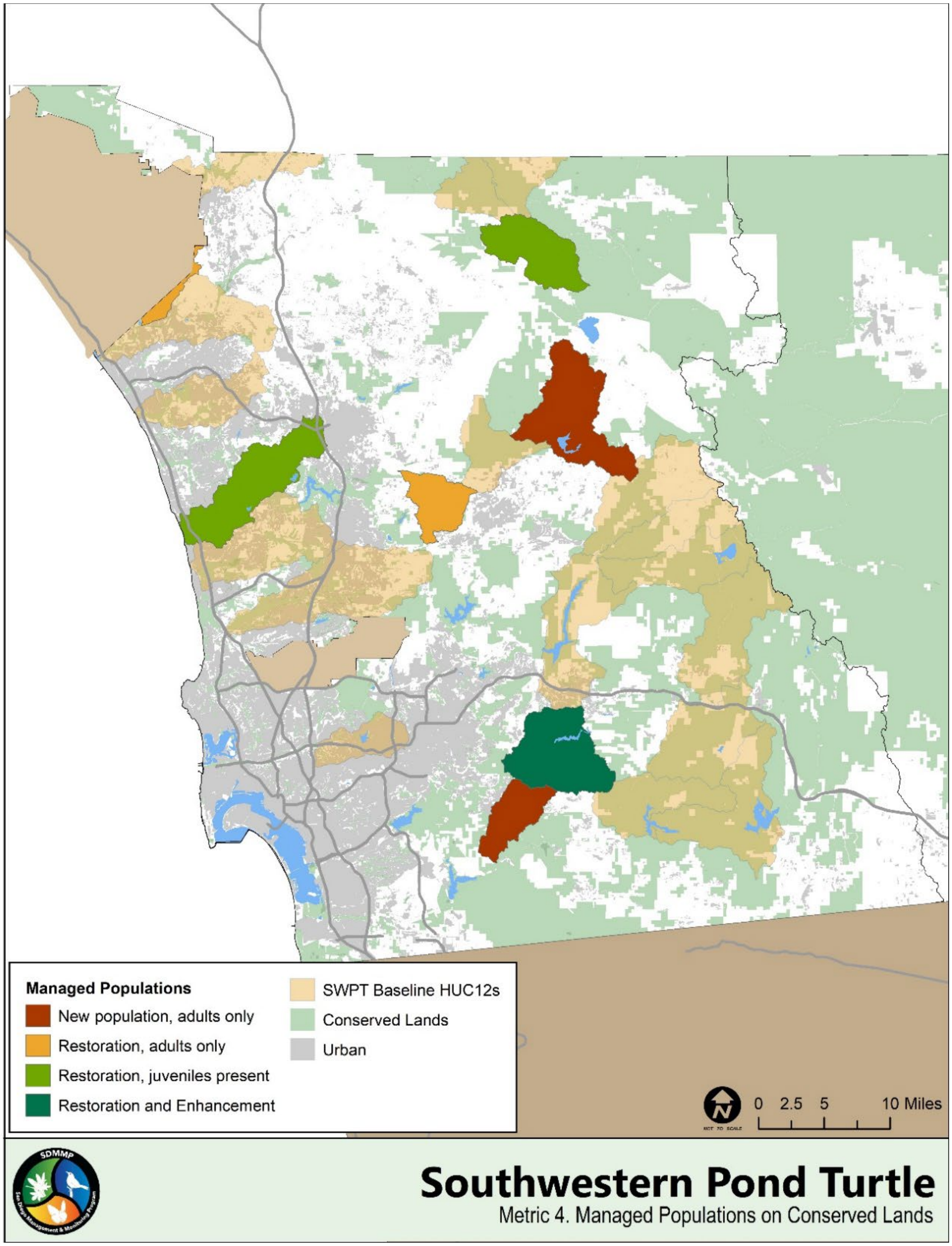


**Figure SWPT4.1.** Managed Occurrences on Conserved Lands by HUC12 in the current period (2015 to 2020). In this figure, rust colored HUC12 watersheds have new occurrences of adults, orange HUC12 watersheds have restored occurrences but with no juveniles present, light green HUC12 watersheds have restored occurrences with detections of juveniles, and dark green HUC12 watersheds have restored and enhanced occurrences where juveniles are present.

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## Coastal Cactus Wren - Species Indicator (Vegetation Community Species)


**Why Is This Indicator Included?**

Cactus wren inhabit deserts throughout southwestern United States and northern and central Mexico. Coastal cactus wren is an ecologically distinct subpopulation found in coastal sage scrub containing cacti in coastal southern California (see box). Desert cactus wrens are abundant, whereas coastal cactus wrens started declining in the 1920s in southern California and have decreased dramatically since the 1980s (Rea and Weaver 1990; Proudfoot and others 2000; Hamilton and others 2011). The coastal cactus wren is a focus of multiple species conservation plans in southern California.

> Subspecies taxonomic status is uncertain, and the relationship between coastal and desert wrens is being investigated with genetic methods. Coastal wrens share song characteristics and have a similar ecology but appear isolated from desert wrens (Atwood and Lerman 2007).

The coastal cactus wren is included as an indicator of the condition of cactus scrub, a rare habitat in coastal southern California and northern Baja California, Mexico. Cactus scrub has a unique plant community composition and provides important habitat for many species, especially those that nest in cacti for protection from predators. Coastal cactus wren is also a flagship species for multiple species conservation planning in southern California and has been selected as an indicator of how well the regional preserve system is achieving conservation of a species of very high conservation priority.

## Stressors

Coastal cactus wrens have been declining for 100 years in coastal southern California, largely due to habitat loss, fragmentation, and degradation from urban and agricultural development that has resulted in clusters of populations genetically isolated from one another (Rea and Weaver 1990; Barr and others 2015). In the last two decades, large-scale wildfires and frequent and intense droughts have contributed to declines in San Diego County (Hamilton 2009; TNC and SDMMP 2015). Other threats include invasive, nonnative plants, human subsidized predators (for example, cats [*Felis catus*] and corvids), and urban edge impacts to remnant cactus patches.

- **Loss of Genetic Diversity:** A recent study found 20 distinct genetic clusters in southern California (Barr and others 2015), with five of these clusters found in San Diego County: at central Orange County/Marine Corps Base Camp Pendleton; San Pasqual Valley/Lake Hodges; Lake Jennings; Sweetwater/Encanto; and Otay. Small populations are vulnerable to loss of genetic diversity from higher levels of breeding among closely related individuals. Inbreeding can lead to inbreeding depression, characterized by reduced reproductive success and survival. One measure of genetic diversity is effective population size or the number of individuals contributing genes to a generation. An effective population size of ≥50 individuals is considered the minimum to prevent inbreeding depression over five generations in the wild (Franklin 1980). Recent research indicates this minimum threshold should be increased to 100 individuals (Frankham and others 2014). All five genetic clusters in San Diego County have effective population sizes below 100, and three range from 19 to 29 (Barr and others 2015).
- **Climate Vulnerability:** Increasing frequency, intensity, and duration of droughts with a changing climate negatively affect cactus wren populations (TNC and SDMMP 2015). Plant and insect productivity in semi-arid regions is correlated with rainfall (Polis and others 1997; Wenninger and Inouye 2008). Drought and a reduction in insect food availability can lower avian productivity in semi-arid regions (Rotenberry and Wiens 1991; Morrison and Bolger 2002; Bolger and others 2005; Preston and Rotenberry 2006; Preston and Kamada 2012).
- **Invasive Plants:** Invasive, nonnative annual forbs and grasses degrade cactus scrub habitat (Preston and Kamada 2012). Cactus wrens frequently forage on the ground, and dense grass and forb cover can interfere with foraging and potentially reduce arthropod food availability (Hamilton and others 2011; Preston and Kamada 2012).
- **Connectivity**: Habitat loss and fragmentation have led to small, isolated cactus wren populations (Barr and others 2015). Small populations are vulnerable to loss of genetic diversity and to demographic and environmental stochasticity (Lacy 2000; Melbourne and Hastings 2008).
- **Fire**: Increasing frequency of large-scale wildfires in shrublands has led to direct loss of wren populations and cactus scrub habitat. Indirectly, fire can lead to an increase of invasive,

nonnative annual grasses and forbs and poor cactus scrub recovery (Mitrovich and Hamilton 2006; Hamilton 2008).

- **Urbanization:** Habitat loss and fragmentation caused the extirpation and decline of wren populations (Rea and Weaver 1990; Proudfoot and others 2000). Remnant populations bordering urbanized and rural residential areas are at risk from edge effects such as increased fire, human disturbance, invasive plants, and human subsidized predators such as cats, corvids, and Cooper's hawk (*Accipiter cooperii*) (Solek and Szijj 2004; Preston and Kamada 2012).

### Desired Condition

MSP Roadmap Goal (SDMMP and TNC 2017):

*Protect, enhance, and restore suitable cactus scrub habitat for coastal cactus wrens to increase effective population size in each genetic cluster at a short-term sustainable level (for example 50-100 wrens), rehabilitate habitat destroyed by wildfire, improve habitat quality to maintain populations during drought, enhance connectivity within and between genetic clusters to increase genetic diversity and rescue small populations, and manage human subsidized predators to ensure the long-term persistence (>100 years) of cactus wrens on Conserved Lands in the MSPA.*

### Current Condition Status

The current overall condition status of the Coastal Cactus Wren Species Indicator is Concern based on assessment of the two metric conditions (table CACW0.1). Coastal cactus wrens are sparsely distributed in available habitat in small populations vulnerable to local extinction from stochastic processes and stressors such as drought (Metric 1) (Lynn and Kus 2021), putting their condition in the Caution category. Habitat quality (Metric 2) fell in the Concern category. Additional metrics will be added as more information becomes available.

**Table CACW0.1**. Current overall condition status for Coastal Cactus Wren Species Indicator and period of baseline to current year comparison for metric conditions, trends, and confidence levels.

| Indicator/metric (baseline – current year) | Condition | Trend | Confidence |
|---|---|---|---|
| Coastal cactus wren overall condition status | Concern | No Change | High |
| Metric 1: occupied plots (2009-2020) | Caution | No Change | High |
| Metric 2: habitat quality (2015-2020) | Concern | No Change | High |

## Metric 1: Occupied Plots

**Overview:** In 2014, cactus wrens were documented declining in south San Diego County compared with results from 2009 and 2011 surveys (USFWS 2011; TNC and SDMMP 2015). This decline coincided with an intense and prolonged drought and reflected a decrease in cactus wren detections in both the number of sites and number of cactus plots within sites. From 2015 through 2020, USGS monitored the same USFWS cactus scrub plots in south San Diego County (Lynn and Kus 2021). Plots were surveyed twice each breeding season to detect wrens in mapped cactus patches and to assess habitat quality.

Small populations are vulnerable to local extinction and decline due to decreasing genetic diversity and demographic and environmental stochasticity (Lacy 2000; Melbourne and Hastings 2008). Sites with <5 cactus wren territories are vulnerable to local extirpation (TNC and SDMMP 2015).

**Metric Evaluation Period:** 2009-2020 (Baseline: 2009-2011; Current: 2015-2020)

**Baseline:** USFWS conducted surveys in 2009 and 2011 for coastal cactus wren in mapped cactus scrub in the regional preserve system in western San Diego County (USFWS 2011; TNC and SDMMP 2015). Of 155 cactus scrub plots surveyed in south San Diego County, 51 (33 percent) and 46 (30 percent) were occupied in 2009 and 2011, respectively.

**2027 Progress Towards Desired Condition:** Enhance, restore, and create new cactus scrub to increase coastal cactus wren occupied plots to 40 percent of plots surveyed in cactus scrub on Conserved Lands in south San Diego County (associated with 2022-2026 MSP objectives).

### Condition Thresholds:

- **Good:** Coastal cactus wren occupy >40 percent of surveyed cactus plots on Conserved Lands in south San Diego County.
- **Caution:** Coastal cactus wrens occupy 31-40 percent of surveyed cactus plots on Conserved Lands in south San Diego County.
- **Concern:** Coastal cactus wrens occupy 21-30 percent of surveyed cactus plots on Conserved Lands in south San Diego County.
- **Significant Concern:** Coastal cactus wrens occupy ≤20 percent of surveyed cactus plots on Conserved Lands in south San Diego County.

### Current Condition: Caution

In 2020, the current condition category is Caution as cactus wrens occupied 35 percent of 378 survey plots (Lynn and Kus 2021).

### Trend (2009-2015): No Change

USGS cactus wren plots (surveyed and occupied) on Conserved Lands in south San Diego County from 2015 to 2020 are shown in figs. CACW1.1-CACW1.6. There were no surveys in

2016. In 2015, coastal cactus wrens occupied only 18 percent of cactus scrub plots, but this increased annually and by 2020, 35 percent of plots were occupied (table CACW1.1.; Lynn and Kus 2021). By 2020, the percent of occupied plots was slightly higher than in 2009 and 2011 levels. The number of occupied plots fluctuated between 2009 and 2020, in association with annual precipitation, including extreme drought in 2014 and 2018. Despite these fluctuations, the percent of occupied plots in 2020 (35 percent) was similar to 2009 (33 percent) and 2011 (30 percent).

### Confidence: High

Monitoring data collected from 2009 to 2020 is of high quality as a result of consistent sampling of plots and the use of a well-defined protocol by biologists experienced with surveying for cactus wren (USFWS 2011; Lynn and Kus 2021).

**Table CACW1.1**. Number of cactus scrub patches surveyed in the current period (2015 through 2020) and percent of cactus wren occupied plots.

| Year | Number of plots surveyed | Number of plots occupied | Percent of plots occupied |
|---|---|---|---|
| 2015 | 318 | 58 | 18 percent |
| 2016 | 0 | NA | NA |
| 2017 | 362 | 81 | 22 percent |
| 2018 | 360 | 100 | 28 percent |
| 2019 | 382 | 126 | 33 percent |
| 2020 | 378 | 131 | 35 percent |

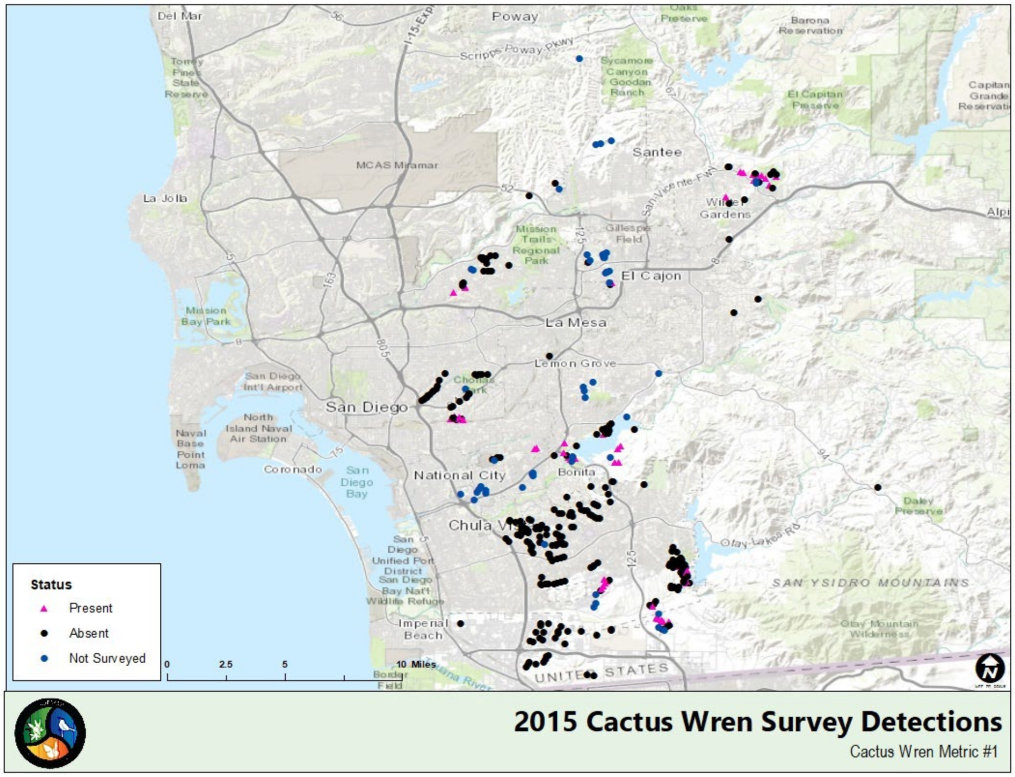


**Figure CACW1.1.** Cactus scrub patches surveyed in 2015 and cactus wren occupied plots.

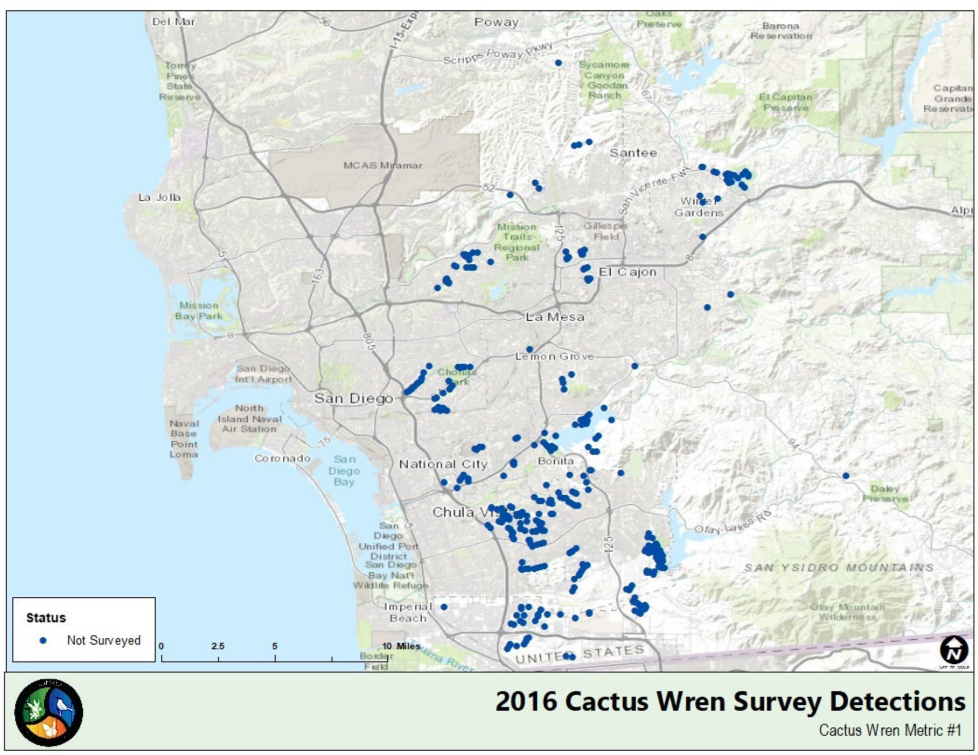


**Figure CACW1.2.** Cactus scrub patches surveyed in 2016 and cactus wren occupied plots.

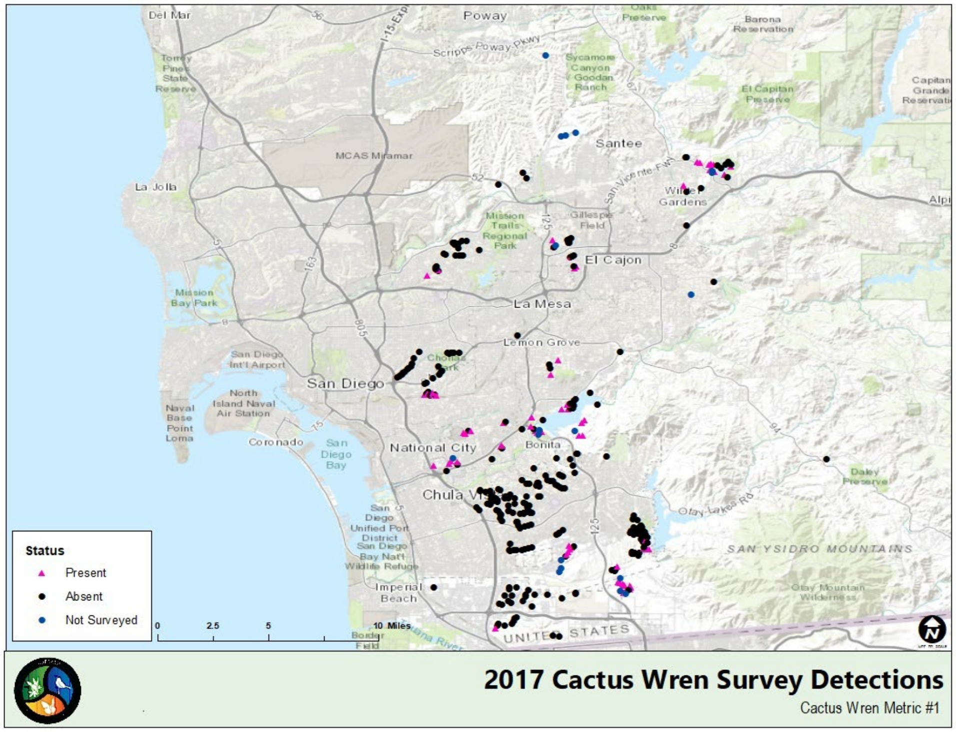


**Figure CACW1.3.** Cactus scrub patches surveyed in 2017 and cactus wren occupied plots.

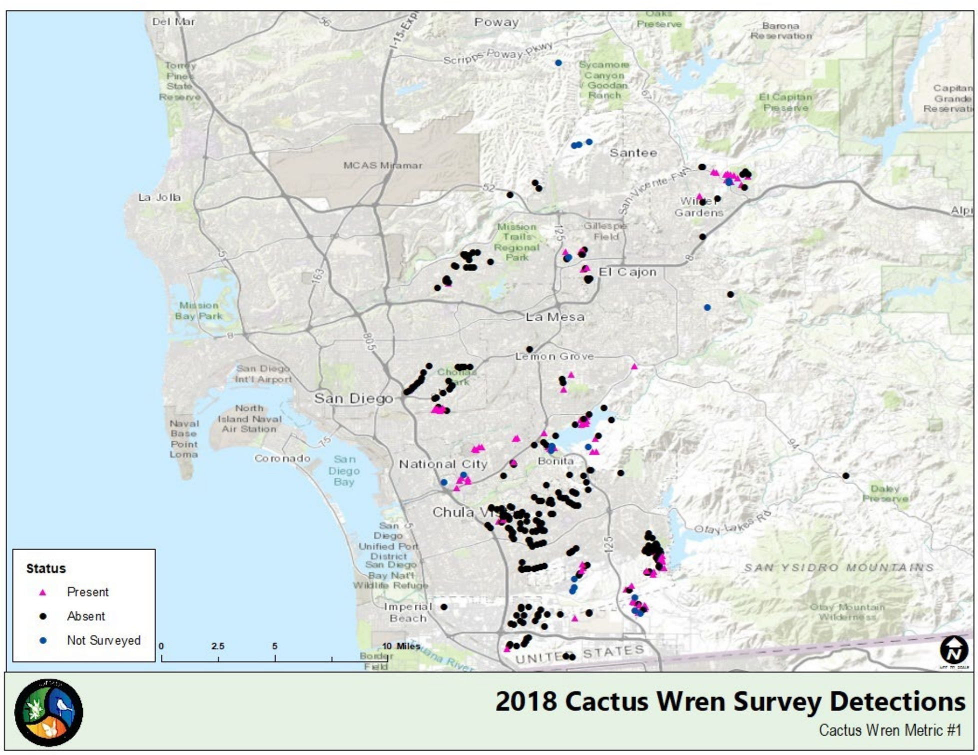


**Figure CACW1.4.** Cactus scrub patches surveyed in 2018 and cactus wren occupied plots.

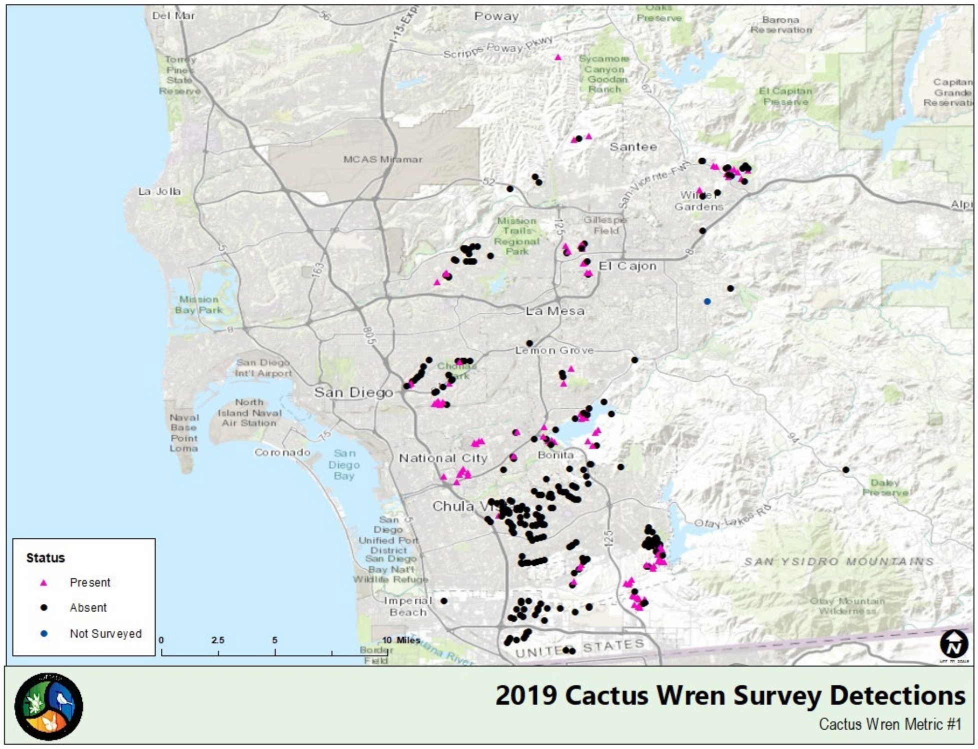


**Figure CACW1.5.** Cactus scrub patches surveyed in 2019 and cactus wren occupied plots.

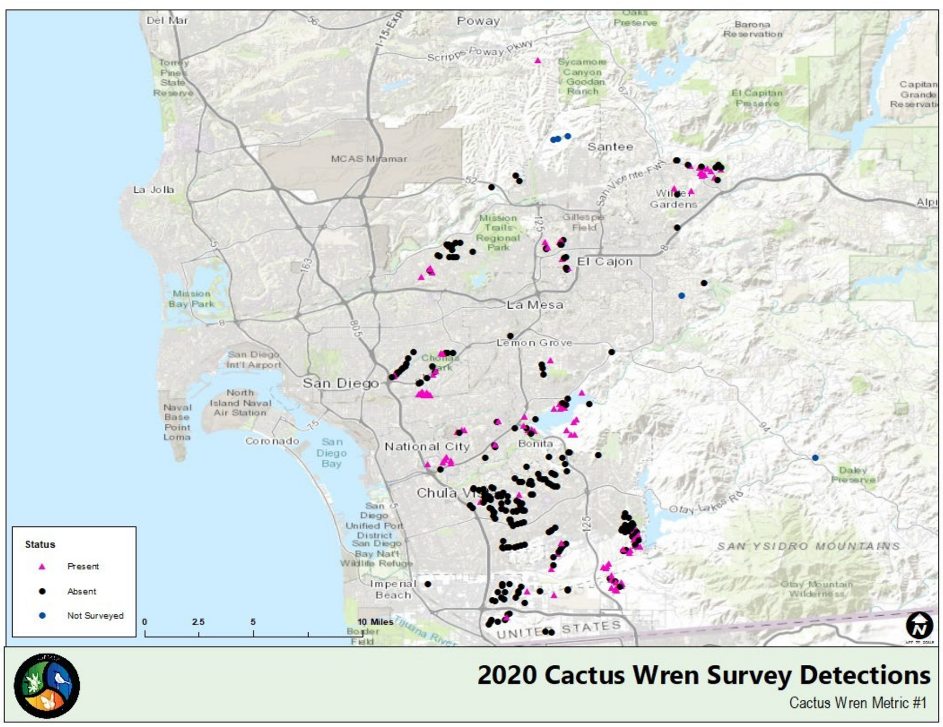


**Figure CACW1.6.** Cactus scrub patches surveyed in 2020 and cactus wren occupied plots.

## Metric 2: Habitat Quality

**Overview:** Habitat quality was assessed during the 2015 and 2017 to 2020 coastal cactus wren surveys in south San Diego County (Lynn and Kus 2021). Habitat attributes measured included cactus crowding/overtopping by shrubs and vines, percent of dead cactus, and cover of invasive, nonnative annual forbs and grasses. Threat levels for a survey plot are categorized based on the percent of the cactus (dead, overcrowded) or plot (cover of invasives) affected by a threat. Threat levels are:

1 = 0 percent is impacted by a threat.

2 = <1 percent is impacted by a threat.

3 = 1-5 percent is impacted by a threat.

4 = >5-25 percent is impacted by a threat.

5 = >25-50 percent is impacted by a threat.

6 = >50-75 percent is impacted by a threat.

7 = >75 percent is impacted by a threat.

Threat levels of 5 to 7 (>25 percent) are considered a serious threat and suggest that management intervention could be beneficial.

**Metric Evaluation Period:** 2015-2020 (Baseline: 2015; Current: 2020)

**Baseline:** The first year of habitat assessments was 2015, a drought year preceded by an extreme drought year. Of the 318 plots surveyed, 187 (59 percent) had one or more serious threats (>25 percent impact). Shrubs crowded and overtopped >25 percent of the cactus at 141 out of 318 (44 percent) survey plots (fig. CACW2.1; Lynn and Kus 2021). Over 25 percent of cactus was dead in 53 of 318 plots (17 percent; fig. CACW2.2). Cover of nonnative annual plants exceeded 25 percent in 54 of 318 plots (17 percent; fig. CACW2.3).

**2027 Progress Towards Desired Condition:** <25 percent of conserved cactus scrub survey plots have threat levels of 5 to 7 for one or more threats (associated with 2022-2026 MSP objectives).

### Condition Thresholds:

- **Good:** ≤20 percent of conserved cactus scrub survey plots are ≥25 percent impacted by one or more threats.
- **Caution:** 21–39 percent of conserved cactus scrub survey plots are ≥25 percent impacted by one or more threats.
- **Concern:** 40–59 percent of conserved cactus scrub survey plots are ≥25 percent impacted by one or more threats.

- **Significant Concern:** ≥60 percent of conserved cactus scrub survey plots are ≥25 percent impacted by one or more threats.

### Current Condition: Concern

In 2020, 215 (57 percent) of 378 survey plots had ≥1 threat that was considered a serious level (≥25 percent impacted). Threat levels with >25 percent impact in cactus scrub survey plots included cactus crowding/overtopping at 144 (38 percent) plots (fig. CACW2.1; Lynch and Kus 2021), dead cactus at seven (2 percent) plots (fig. CACW2.2), and invasive nonnative annual plants at 133 (35 percent) plots (fig. CACW2.3).

### Trend (2015-2020): No Change

After the initial survey in 2015 during an intense and extended drought, the threat level of nonnative annual plants fluctuated with rainfall levels, and shrub crowding/overtopping of cactus followed a similar pattern while dead cactus declined (figs. CACW2.1 - 2.3; Lynn and Kus 2021). The overall percent of occupied plots with ≥1 serious threat did not change from 2015 (59 percent) to 2020 (57 percent).

### Confidence: High

Monitoring data collected in 2015 and 2017 to 2020 are of high quality due to consistent sampling of plots and the use of a well-defined protocol by biologists experienced with surveying for cactus wren and assessing habitat attributes (Lynn and Kus 2021).

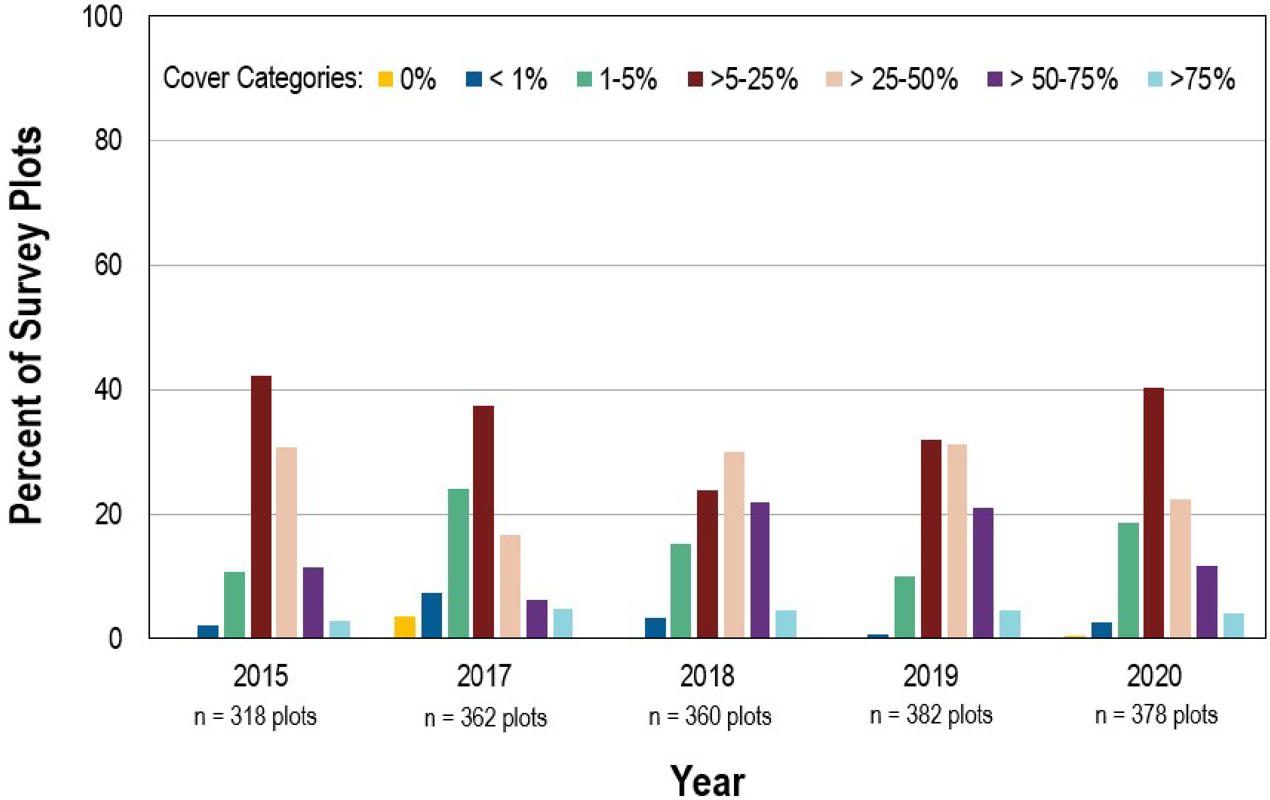


**Figure CACW2.1.** Percent of cactus crowded or over-topped by shrubs in cactus scrub survey plots from 2015 to 2020, excluding 2016 when surveys were not conducted (Source: Lynn and Kus 2021).

This bar graph shows percent of survey plots falling into different threat intensity categories defined by the percent of cactus affected within a survey plot. Bars representing low level threats are: 0 percent cactus affected = yellow, <1 percent = blue, 1-5 percent = green, and >5-25 percent = dark brown. Bars representing serious threats are: >25-50 percent of cactus affected = salmon, >50-75 percent = purple, and >75 percent = light blue.

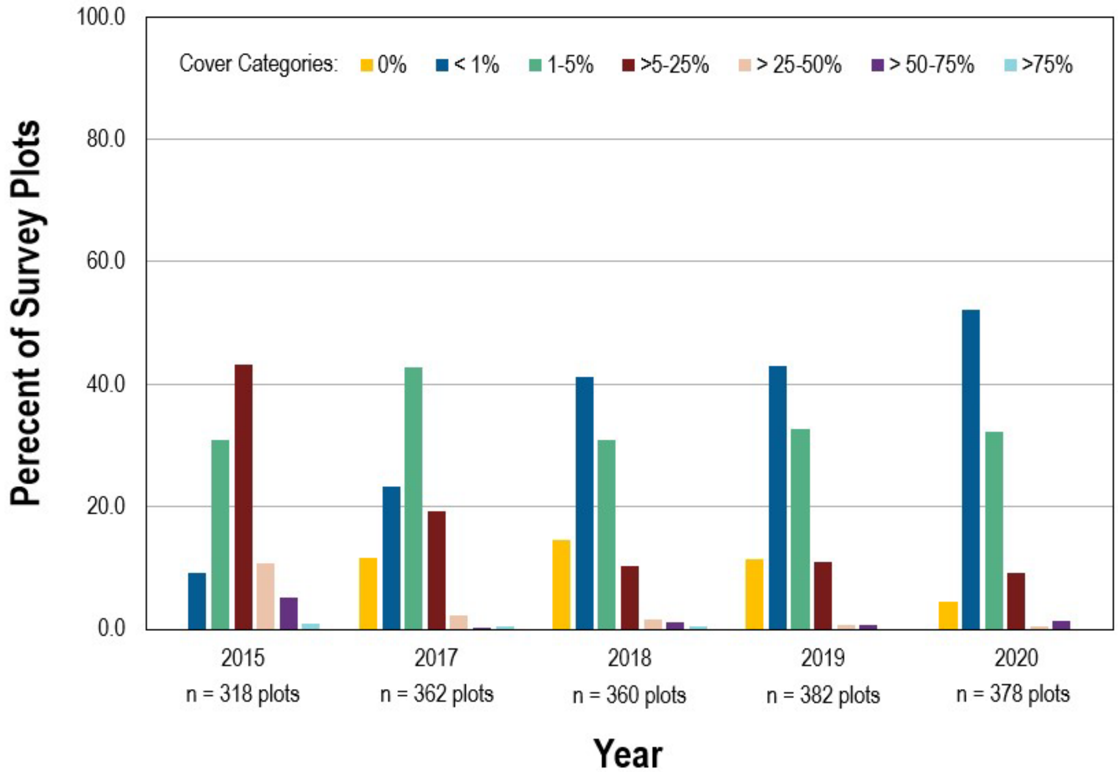


**Figure CACW2.2.** Percent of cactus that was dead at cactus scrub survey plots from 2015 to 2020, excluding 2016 when surveys were not conducted (Source: Lynn and Kus 2021).

This bar graph shows percent of survey plots falling into different threat intensity categories defined by the percent of cactus affected within a survey plot. Bars representing low level threats are: 0 percent cactus affected = yellow, <1 percent = blue, 1-5 percent = green, and >5-25 percent = dark brown. Bars representing serious threats are: >25-50 percent of cactus affected = salmon, >50-75 percent = purple, and >75 percent = light blue.

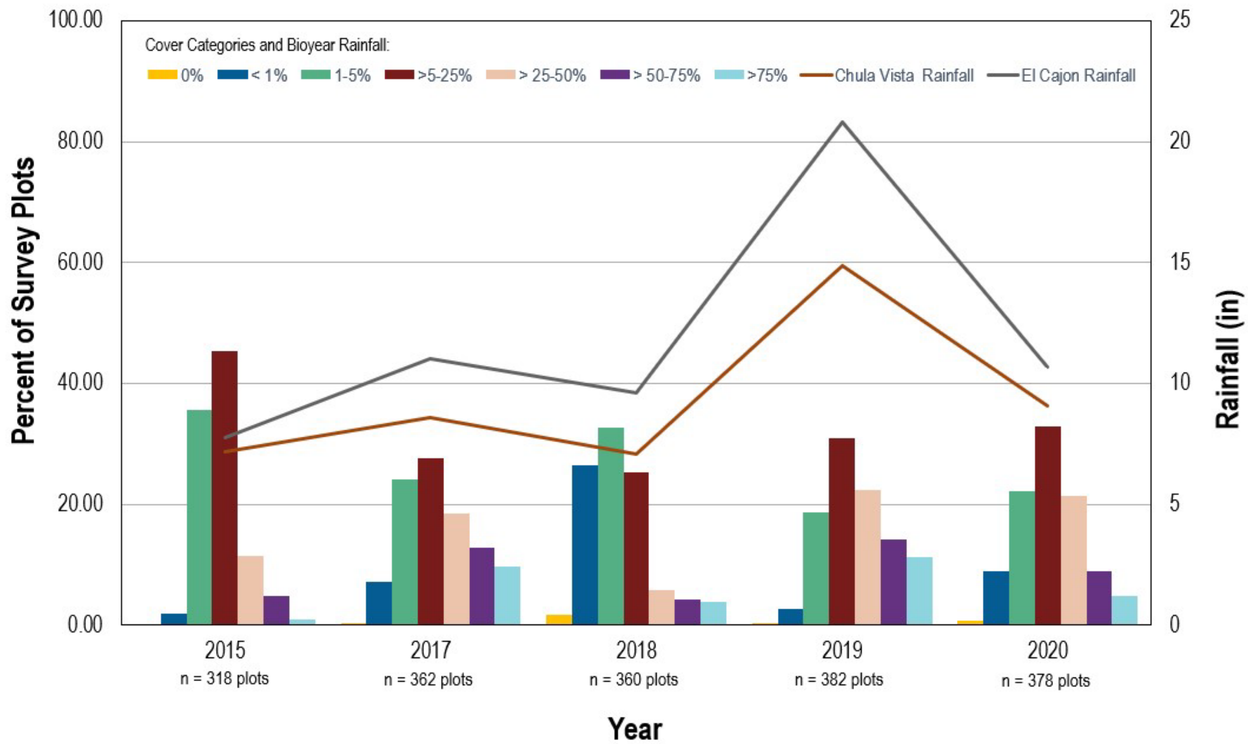


**Figure CACW2.3.** Percent cover of invasive, nonnative annual forbs and grasses at cactus scrub survey plots from 2015 to 2020, excluding 2016 when surveys were not conducted (Source: Lynn and Kus 2021). This bar graph shows the percent of survey plots falling into different threat intensity categories defined by the percent cover of nonnative grasses and forbs in a survey plot. Bars representing low level threats are: 0 percent cactus affected = yellow, <1 percent = blue, 1-5 percent = green, and >5-25 percent = dark brown. Bars representing serious threats are: >25-50 percent of cactus affected = salmon, >50-75 percent = purple, and >75 percent = light blue. Bioyear rainfall (October 1- September 30) for two weather stations near cactus wren occurrences show that in drier years (2015 and 2018), the cover of nonnative annual plants is predominantly in the low threat intensities compared to the other years when more plots are in the serious threat level categories,

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## Coastal California Gnatcatcher – Species Indicator (Vegetation Community Species)


### Why Is This Indicator Included?

Coastal California gnatcatcher is the northernmost subspecies of California gnatcatcher, occurring in coastal southern California and northwestern Baja California, Mexico (Atwood 1991). It is restricted to CSS vegetation. The gnatcatcher is a small (5-6 gram) songbird that forages on insects, forms long-term pair bonds, and maintains a year-round territory (USFWS 1993; Preston and others 1998).

Habitat loss, fragmentation, and degradation resulting from urban and agricultural development and large-scale wildfires have led to the decline of coastal California gnatcatchers (USFWS 1993; Winchell and Doherty 2014; Kus and Houston 2021). Habitat loss was recorded as early as the 1940s, with gnatcatchers reported as significantly declining by the 1960s (USFWS 1993). In 1992, it was estimated that the coastal California gnatcatcher in the US numbered 1,811 to 2,291 pairs (Atwood

The gnatcatcher was listed as federally threatened in 1993 and is a California Species of Special Concern. In 1991, in response to a petition to list the gnatcatcher as a state endangered species, the state of California created the NCCP Act. This act provides for regional protection of plants, animals, and their habitats, while allowing for compatible economic development. Coastal California gnatcatcher is considered the "flag-ship" species for the NCCP Act and the development of multiple species conservation plans in southern California by federal and state wildlife agencies and local jurisdictions (USFWS 1993; Winchell and Doherty 2006).

1992). The bulk of the birds were in San Diego County followed by Riverside and Orange counties, with small numbers in Los Angeles County. Since the 1990s, gnatcatchers have been found in San Bernardino and Ventura counties (USFWS 2010).

The coastal California gnatcatcher is included as an indicator of the condition of CSS, a declining habitat in coastal southern California and northern Baja California, Mexico (see also CSS Indicator section). CSS has unique plant community composition and provides important habitat for many species. Coastal California gnatcatcher is also a flagship species for multiple species conservation planning in southern California and has been selected as an indicator for how well the regional preserve system is achieving conservation of a species of highest conservation priority.

### Stressors

There are many threats to coastal California gnatcatchers, including intense and extended drought, large-scale wildfires, and invasion of CSS by nonnative annual grasses and forbs.

- **Climate Vulnerability:** Increasing frequency, intensity, and duration of droughts with a changing climate can adversely affect bird populations. Plant and insect productivity in semi-arid regions is correlated with rainfall and, in turn, affects breeding bird productivity (Rotenberry and Weins 1991; Bolger and others 2005; Wenninger and Inouye 2008). Drought can limit insects available as food for breeding birds in CSS (Bolger and others 2005). The amount of rainfall during egg production is positively associated with California gnatcatcher clutch size (Patten and Rotenberry 2009). A reduction in food availability has been shown to reduce bird productivity in southern California shrublands (Bolger and others 2005; Preston and Rotenberry 2006).
- **Invasive Plants:** Invasive, nonnative annual forbs and grasses degrade CSS habitat (D'Antonio and Vitousek 1992; Minnich and Dezzani 1998; Talluto and Suding 2008). Coastal California gnatcatchers are insectivores and forage in shrubs. CSS shrubs can be crowded by invasive, nonnative annual plants, which have been shown to reduce arthropod diversity (Burger and others 2003; Longcore 2003). This could affect food availability for insectivorous birds, such as the gnatcatcher (Longcore 2003).
- **Connectivity:** Although coastal California gnatcatchers can disperse relatively long distances (Vandergast and others 2019), habitat fragmentation is leading to isolation in some parts of the range. Small, isolated populations are vulnerable to loss of genetic diversity and to demographic and environmental stochasticity (Lacy 2000; Melbourne and Hastings 2008). The US population forms one genetic cluster with signs of emerging genetic differentiation at the northern end of the range, where populations are more isolated by urban development. Vandergast and others (2019) found that there is a loss of genetic diversity when cover of suitable habitat within 30 km (mean gnatcatcher dispersal distance) of a population falls below 10 percent.

- **Fire:** Increasing frequency of large-scale wildfires in shrublands has led to direct loss of gnatcatchers and CSS habitat (Winchell and Doherty 2014; Kus and Houston 2021). Indirectly, fire can lead to invasion by nonnative annual grasses and forbs and degraded CSS that can affect gnatcatcher occupancy (Minnich and Dezzani 1998; Talluto and Suding 2008; Winchell and Doherty 2014).

- **Urbanization:** Habitat loss and fragmentation caused the extirpation and decline of some coastal California gnatcatcher populations (Atwood 1992; USFWS 1993). Populations bordering urbanized areas are at risk from edge effects like increased fire frequency, invasive plants, and human-subsidized nest predators such as corvids (USFWS 1993, 2010).

### Desired Condition

MSP Roadmap Goal (SDMMP and TNC 2017):

*Protect, maintain, enhance, and restore CSS habitat to high ecological integrity for coastal California gnatcatcher in order to support a large, stable gnatcatcher population with genetic connectivity and resilience to drought, wildfire, and invasive nonnative plants to ensure persistence of gnatcatchers and to incidentally benefit other CSS species over the long term (>100 years).*

### Current Condition Status

The current overall condition status of the Coastal California Gnatcatcher Species Indicator is Concern based on the two metric condition values of Concern (table CAGN0.1). The Proportion Area Occupied (PAO) in San Diego County is low (Metric 1), and wildfires have reduced PAO relative to unburned areas. There are insufficient data to determine a trend in PAO for subregional monitoring of gnatcatcher in San Diego County, whereas post-fire recovery is progressing overall. Additional metrics on habitat quality and management will be added to future reports as more information becomes available.

**Table CAGN0.1**. Current overall condition status for Coastal California gnatcatcher Indicator and period of baseline to current years comparison for metric conditions, trends, and confidence levels.

| Indicator/metric (baseline – current year) | Condition | Trend | Confidence |
|---|---|---|---|
| Coastal California gnatcatcher overall condition status | Concern | Improving | High |
| Metric 1: proportion area occupied (2016-2020) | Concern | Unknown | High |
| Metric 2: recovery from fire (2015-2020) | Concern | Improving | High |

## Metric 1: Proportion Area Occupied

**Overview:** USGS, SDMMP, USFWS, and CDFW, working with many partners, developed a regional monitoring program for coastal California gnatcatcher in southern California, encompassing the US portion of the species' range. The goals of monitoring are to:

1) Determine population status of coastal California gnatcatchers in southern California on Conserved and Military Lands;

2) Track trends in gnatcatcher habitat occupancy over time to identify when thresholds have been met that trigger management actions; and

3) Identify habitat attributes and threats associated with gnatcatcher occupancy to develop specific, habitat-based management criteria and recommendations.

The regional gnatcatcher monitoring protocol was developed based on previous USFWS monitoring and testing of methods (Miller and Winchell 2016). USGS and SDMMP created a habitat model to define the sampling frame (Preston and others 2020) and developed a spatially balanced sampling design with power to detect at least a 30 percent change in PAO. USGS and SDMMP developed a vegetation data collection protocol and refined it with testing.

In addition to the regional monitoring to track trends for southern California, subregional monitoring sampling designs were developed to determine gnatcatcher PAO for Orange County and for San Diego County. The first round of regional and subregional monitoring began in 2016 and was repeated in 2020.

**Metric Evaluation Period:** 2016-2020 (Baseline: 2016; Current: 2020)

**Baseline:** In 2016, regional coastal California gnatcatcher monitoring of southern California (San Diego, Orange, Los Angeles, Ventura, Riverside, and San Bernardino counties) estimated a PAO of 0.24 (fig. CAGN1.1; Kus and Houston 2021). The subregional PAO for San Diego County was 0.20, lower than that of 0.30 for Orange County (figs. CAGN1.1 and CAGN1.2).

**2027 Progress Towards Desired Condition:** Increase coastal California gnatcatcher San Diego subregional PAO to ≥0.30 through natural successional post-fire recovery of CSS and targeted management to improve habitat quality (associated with 2022-2026 MSP objectives).

### Condition Thresholds:

- **Good:** Coastal California gnatcatcher PAO ≥0.40 for Conserved Lands in San Diego County.
- **Caution:** Coastal California gnatcatcher PAO 0.30-0.39 for Conserved Lands in San Diego County.
- **Concern:** Coastal California gnatcatcher PAO 0.20-0.29 for Conserved Lands in San Diego County.
- **Significant Concern:** Coastal California gnatcatcher PAO <0.20 for Conserved Lands in San Diego County.

#### Current Condition: Concern

In 2020, coastal California gnatcatcher regional PAO was 0.28 (fig. CAGN1.1; Kus and Houston 2021). For San Diego County, the subregional PAO was 0.24, compared to 0.36 for Orange County (figs. CAGN 1.1 and CAGN1.3). This places the current status of gnatcatcher PAO in the Concern category.

#### Trend (2016-2020): Unknown

There are currently only two points in time with regional monitoring for southern California and San Diego County subregional monitoring. One more round of monitoring is needed to determine if there is a trend.

#### Confidence: High

Monitoring data collected in 2016 and 2020 are of high quality due to consistent sampling of plots and the use of a well-defined protocol by biologists experienced with surveying for coastal California gnatcatchers (Kus and Houston 2021).

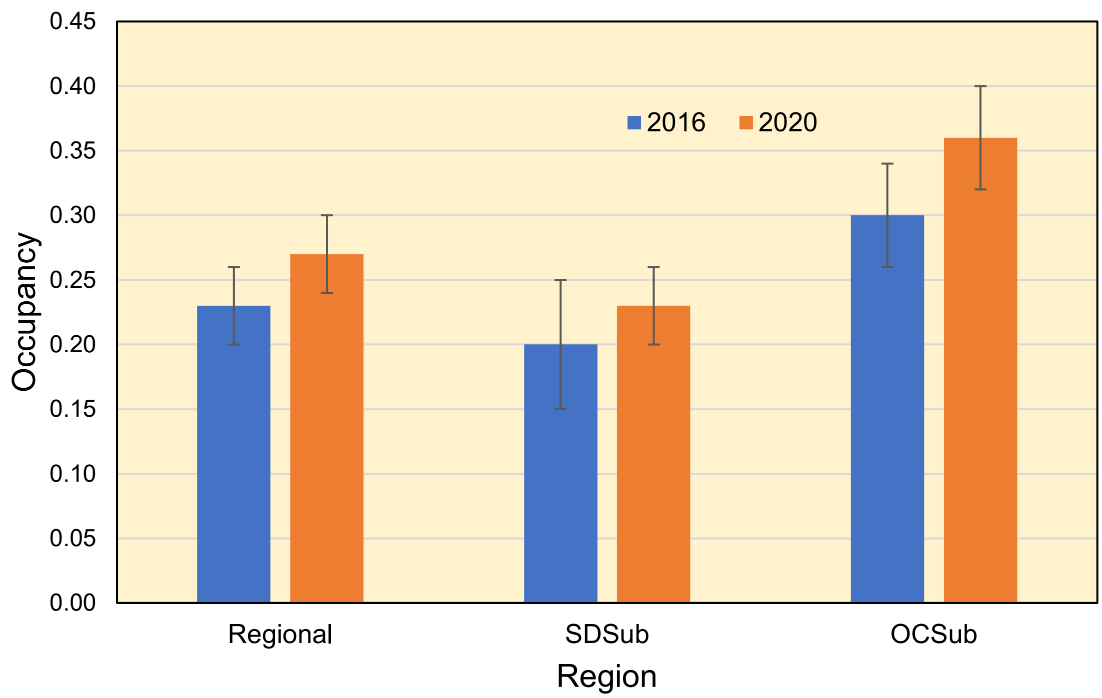


**Figure CAGN1.1.** Coastal California gnatcatcher PAO in 2016 and 2020 for southern California region (Regional) and San Diego (SDSub) and Orange County (OCSub) subregions.

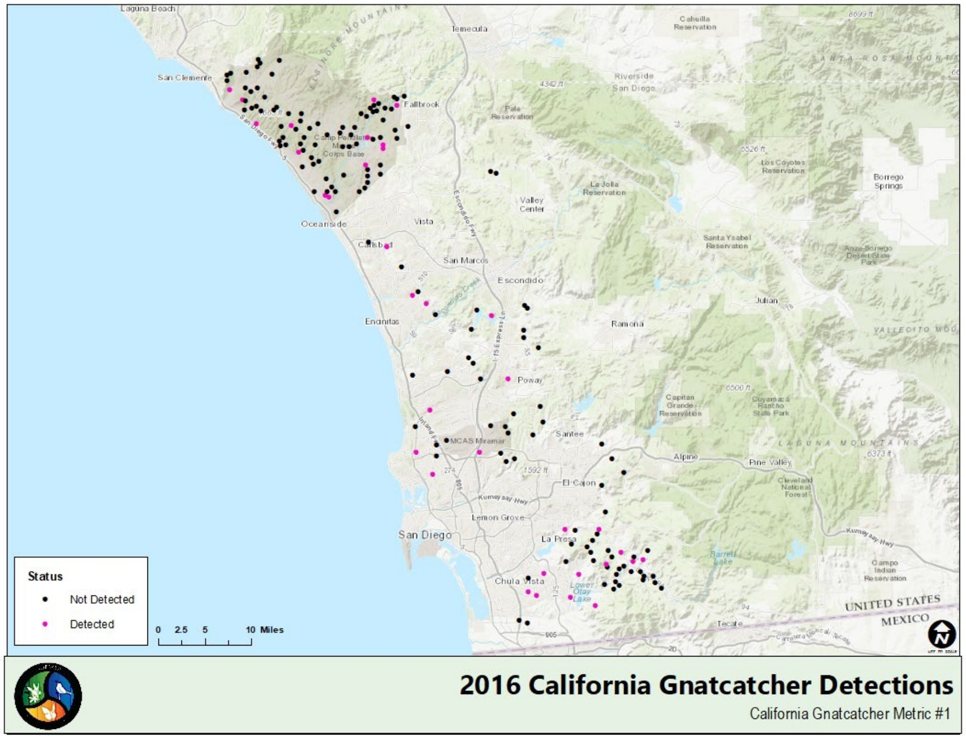


**Figure CAGN1.2.** San Diego County 2016 subregional sample plots and occupancy by coastal California gnatcatchers (Source Kus and Houston 2021).

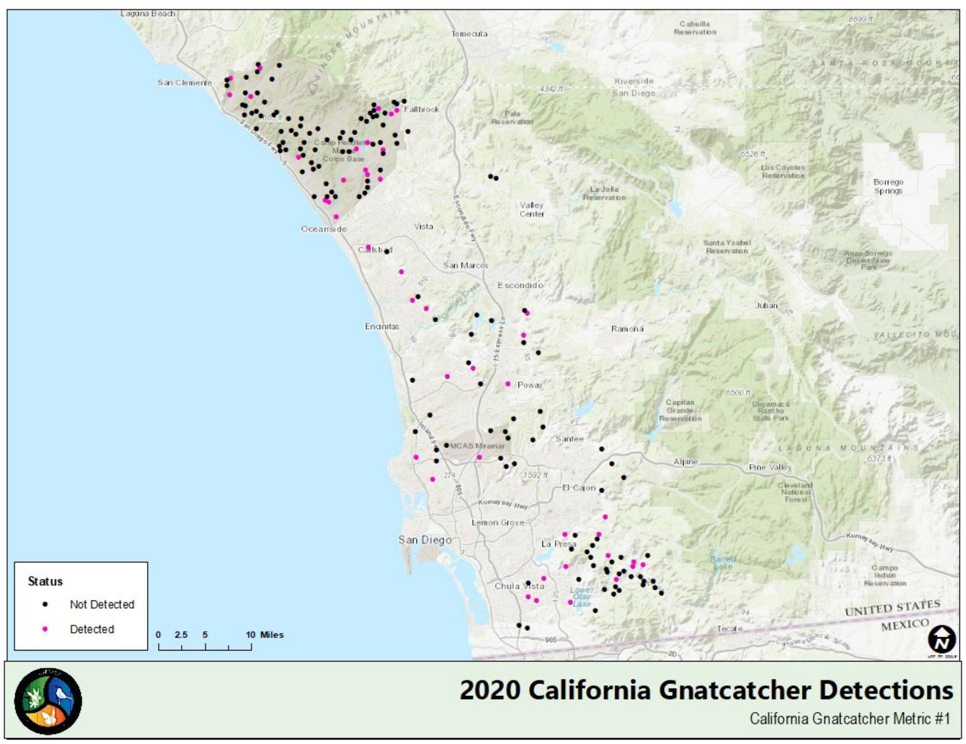


**Figure CAGN1.3.** San Diego County 2020 subregional sample plots and occupancy by coastal California gnatcatchers (Source Kus and Houston 2021).

## Metric 2: Recovery from Fire

**Overview:** USGS is conducting a coastal California gnatcatcher post-fire recovery study in San Diego County. The purpose is to evaluate change in gnatcatcher PAO over time for four fire history categories:

- Unburned, no fire since 2002
- Burned 2003 – 2006
- Burned 2007 – 2010
- Burned 2011 – 2014

The objectives of the Post-Fire Recovery Study are:

1) Determine whether there has been further recovery of gnatcatchers in areas burned in 2003 (that is, PAO >0.10).
2) Determine if there is a difference in gnatcatcher PAO between areas burned in 2003, 2007, and 2014.
3) Determine relationships between gnatcatcher PAO and vegetation composition, cover, and structure.

In 2015, USGS sampled points in areas representing the three burned categories on Conserved Lands in San Diego County. In 2016 and 2020, monitoring was conducted at unburned plots, in addition to the areas representing the three burned categories. The surveys were conducted using the regional gnatcatcher and vegetation monitoring protocols. The post-fire recovery study included plots used in regional and subregional modeling with additional plots added to balance sampling effort between all fire histories (Kus and Houston 2021).

**Metric Evaluation Period:** 2015-2020 (Baseline: 2015; Current: 2016 and 2020)

**Baseline:** In 2015, coastal California gnatcatcher PAO was highest at 0.23 in the Burned 2003-2006 category, intermediate at 0.15 in the Burned 2007-2010 category, and lowest at 0.02 in the Burned 2011-2014 category (figs. CAGN2.1 and CAGN2.2; Kus and Houston 2021). There were no Unburned category plots sampled in 2015.

**2027 Progress Towards Desired Condition:** Increase coastal California gnatcatcher PAO to ≥0.30 for plots in the Burned 2003-2006 and 2007-2010 categories and to ≥0.20 for plots in the Burned 2011 to 2014 category through natural successional post-fire recovery of CSS and targeted management to improve habitat quality (associated with 2022-2026 MSP objectives).

### Condition Thresholds:

- **Good:** Coastal California gnatcatcher PAO increases by a value of ≥0.10 over 4-year monitoring intervals for all burn categories, or all burn categories combined have a PAO of ≥0.30.
- **Caution:** Coastal California gnatcatcher PAO increases by a value ≥0.10 over 4-year monitoring intervals for at least one, but not all, burn categories.
- **Concern:** Coastal California gnatcatcher PAO increases by ≥0.05 and <0.10 over 4-year monitoring intervals for at least one burn category.
- **Significant Concern:** Coastal California gnatcatcher PAO increases by <0.05 over 4-year monitoring intervals in all burned category plots.

### Current Condition: Concern

In 2020, coastal California gnatcatcher PAO for plots burned since 2003 was highest at 0.26 in the Burned 2007-2010 category, intermediate at 0.18 in the Burned 2003-2006 category, and lowest at 0.13 in the Burned 2007-2014 category (figs. CAGN2.1 and CAGN2.3; Kus and Houston 2021). This represents a small decrease of 0.01in gnatcatcher PAO for the Burned 2007-2010 plots since 2016, an increase of 0.08 in the Burned 2011-2014 plots, and a decline of 0.06 in the Burned 2003-2006 plots. Unburned areas had a substantially higher PAO of 0.51, an increase in PAO of 0.08 since 2016.

Gnatcatcher recovery from fire falls within the Concern category as there has been no increase ≥0.10 between 2015 and 2020 for any of the postfire recovery categories. Although the Burned 2011-2014 category is close with an increase in PAO of 0.08, the Burned 2003-2006 category declined by a similar amount, and there was a small decline in the Burned 2007-2010 category.

### Trend (2015-2020): Improving

There are three monitoring periods (2015, 2016, 2020) for the burned categories in the post-fire recovery study. The 2007 and 2014 burn categories show an increase in PAO over time (figs. CAGN2.1-CAGN2.4), although the 2003 burn shows an increase from 2015 to 2016 and then unexpected decrease in PAO in 2020. Overall, there is a gradual increasing trend in PAO for burned plots over time, although the current status of the burned category is 50 percent or less than unburned habitat. A trend in PAO cannot be determined for unburned plots, which were only sampled in 2016 and 2020.

### Confidence: High

Monitoring data collected in 2015, 2016, and 2020 are of high quality due to consistent sampling of plots and the use of a well-defined protocol by biologists experienced with surveying for coastal California gnatcatchers (Kus and Houston 2021).

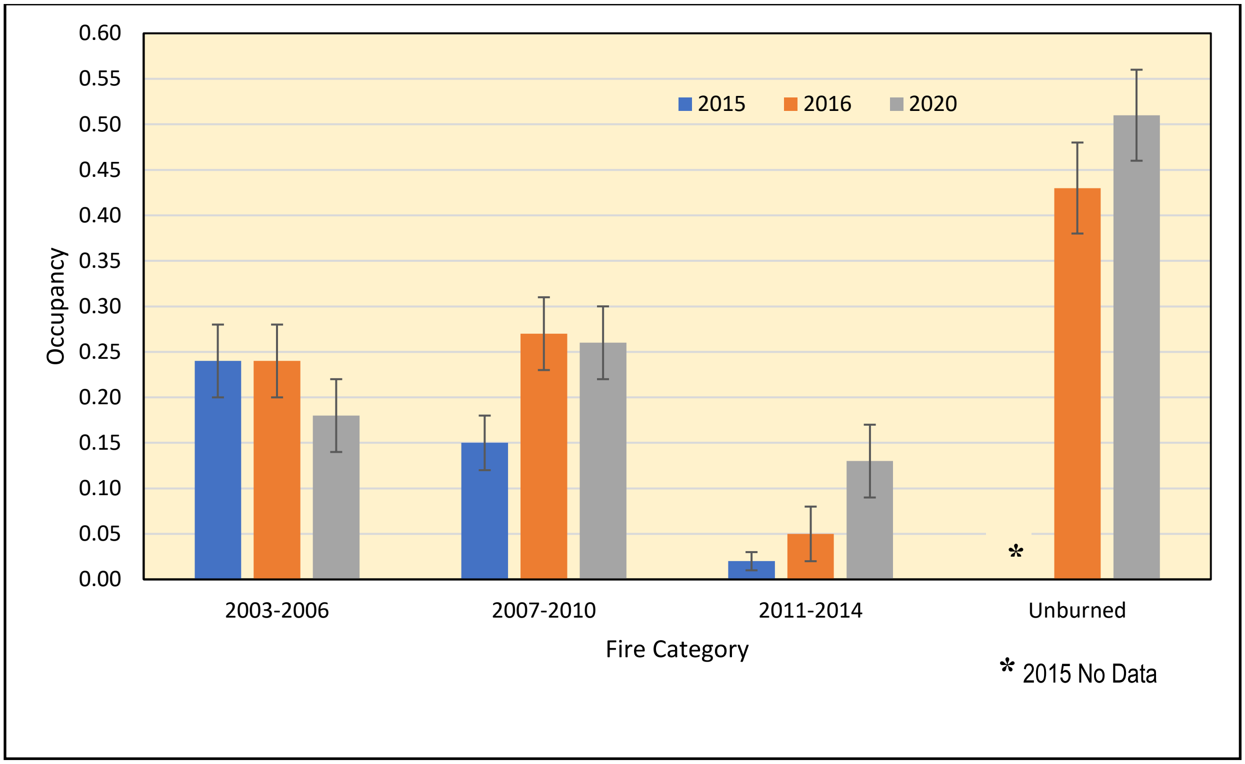


**Figure CAGN2.1.** Coastal California gnatcatcher PAO for burned and unburned plots monitored in 2015, 2016, and 2020. The fire categories are Burned 2003-2006, Burned 2007-2010, and Burned 2011-2014. There was no data collected in 2015 for unburned plots (Kus and Houston 2021).

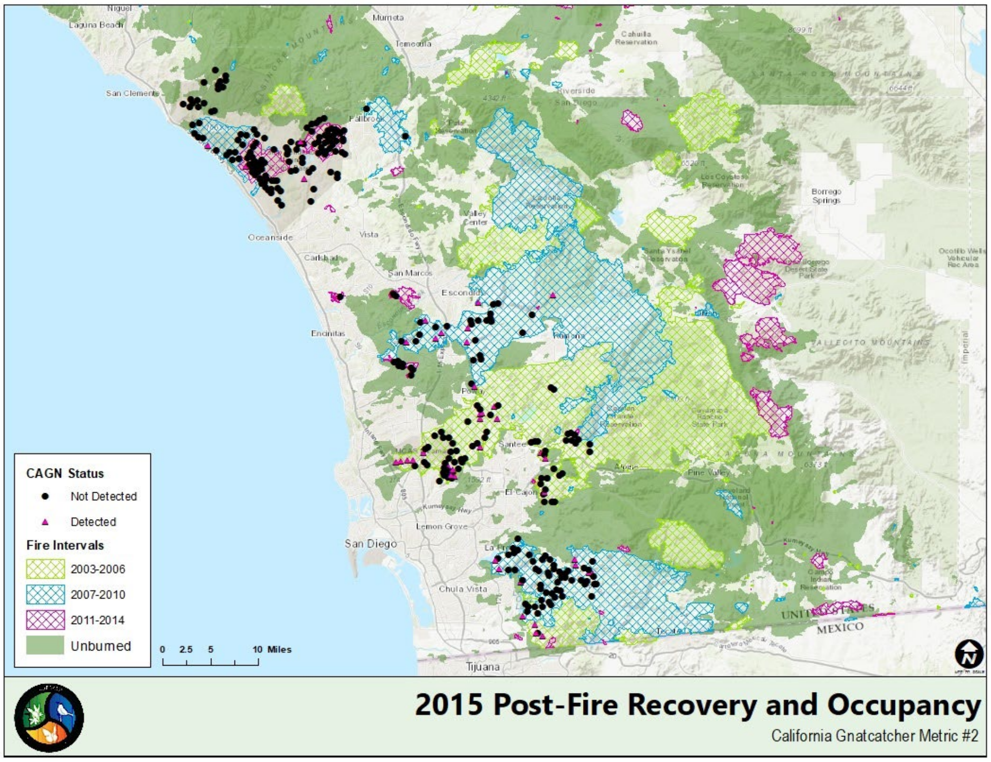


**Figure CAGN2.2.** San Diego County 2015 (baseline) post-fire recovery plots and occupancy by coastal California gnatcatchers (Source Kus and Houston 2021).

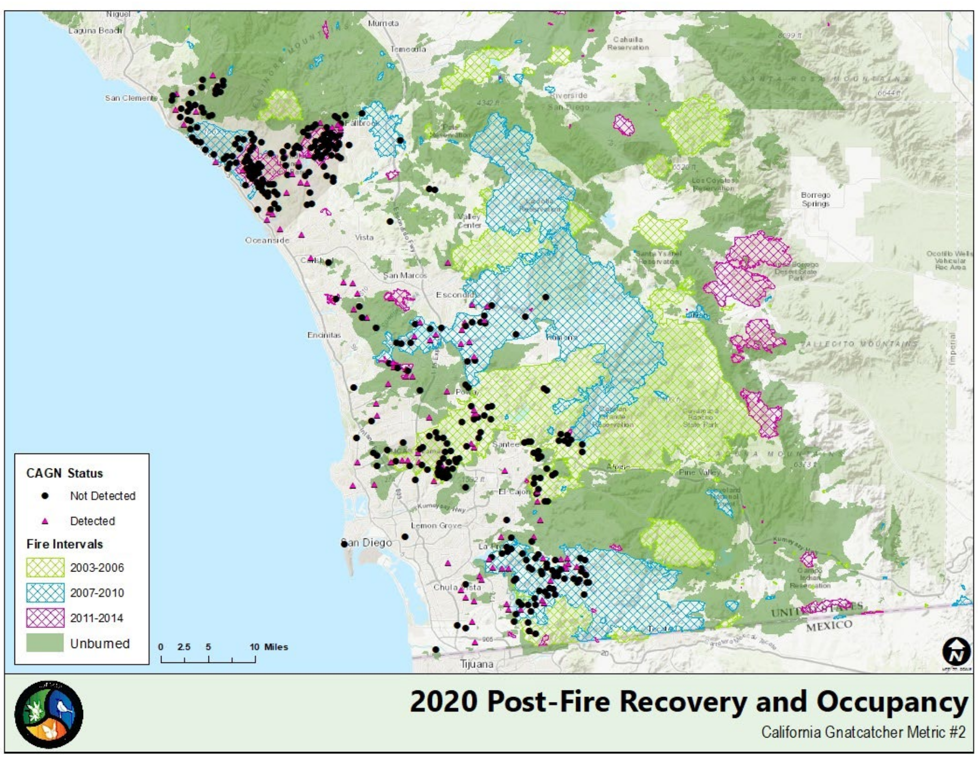


**Figure CAGN2.3.** San Diego County 2020 (current) post-fire recovery plots and occupancy by coastal California gnatcatchers (Source Kus and Houston 2021).

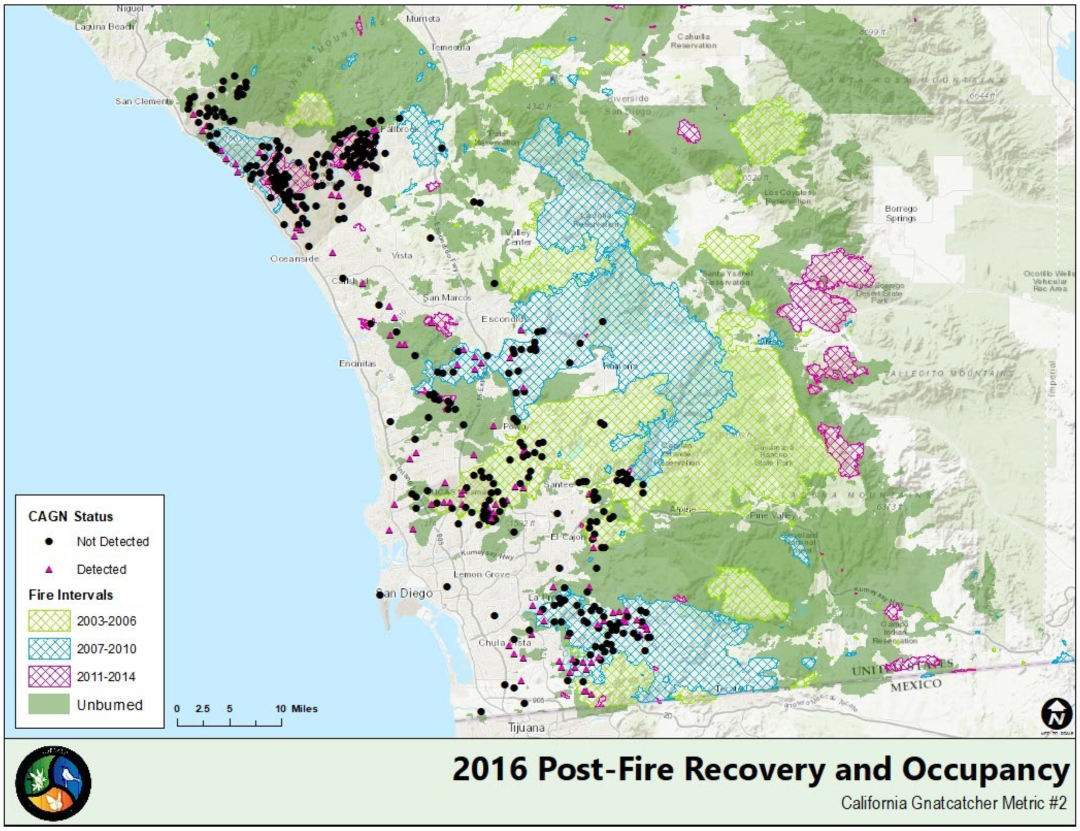


**Figure CAGN2.4.** San Diego County 2016 post-fire recovery plots and occupancy by coastal California gnatcatchers (Source Kus and Houston 2021).

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## Arroyo Toad – Species Indicator
## (Vegetation Community Species)


**Why Is This Indicator Included?**

The arroyo toad is a medium sized toad, with large adults reaching 3 inches in length. This species has horizontal pupils and lacks a prominent dorsal stripe (Sweet and Sullivan 2005).

Arroyo toad preferred breeding habitat includes streams with slow-flowing shallow water and a sandy bottom. Much of this habitat in southern California has been impacted by habitat loss and fragmentation, drought, and hydrologic impairments. This species is also affected by predation from invasive bullfrogs and predatory fishes (Miller and others 2012; Brehme and others 2018; Brown and others 2020).

The arroyo toad utilizes large sandy wash habitats once common in coastal San Diego County (Sweet and Sullivan 2005). The warm, shallow water and sunny banks allow the arroyo toad larvae and juveniles to develop quickly, and the ephemeral systems preclude invasive predators (Miller and others 2012). In predator-free upper watersheds, arroyo toads also persist in riparian habitats along major rivers with deep pools. Arroyo toads once occurred lower in large river drainages, but with changes in hydrology that favor invasive, nonnative aquatic species, they have disappeared from these riparian habitats.

With loss of habitat to development and reservoirs, and impacts from altered hydrology and invasive species, the arroyo toad requires active management and restoration to be successful on Conserved Lands within San Diego County (White and Greer 2006; USFWS 2011; SDMMP and TNC 2017). As a result, several riparian restoration, research, and monitoring efforts have focused on the arroyo toad within the MSPA (SDMMP and TNC 2017). The arroyo toad was listed as federally endangered in 1994 (USFWS 1994) and is a State of California Species of Special Concern (Thomson and others 2016).

Arroyo toad is included as an indicator of riparian habitat health. The species provides a gauge of how well riparian habitats of southern California coastal rivers are functioning within its historic range. Periodic disturbances in these rivers and streams create alluvial stream reaches with shallow, low flow and provide breeding habitat for the arroyo toad. The arroyo toad also reflects how well the regional preserve system is protecting a species of high conservation priority.

### Stressors

Threats to arroyo toad populations include loss of habitat and fragmentation due to urban development and impacts from altered hydrology, changing climate, and invasive, nonnative aquatic animal species.

- **Altered Hydrology:** Altered hydrology, resulting from biotic (for example, *Arundo donax*, fan palms [*Washingtonia robusta*]) and abiotic (for example, dams, diversions, urban aseasonal flow) factors, can reduce or degrade surface water required for breeding in upper watersheds or facilitate the introduction of invasive predators in lower watersheds (Miller and others 2012; Brown and others 2020).
- **Climate Vulnerability:** Extended and severe drought reduces potential breeding habitat. Droughts extending for multiple years can impact populations and threaten loss of persistence. Adults may be unable to breed due to lack of water and may die before reproducing (Miller and others 2012).
- **Invasive Aquatic Species:** Predation of adult, juvenile, and larval arroyo toads by invasive, nonnative species like bullfrogs and predatory fishes threatens population stability and persistence (Sweet and Sullivan 2005; Miller and others 2012). Indirect impacts from invasive species can include reduction in breeding habitat, degradation of water quality, and competition for resources (Thomson and others 2017; Weber and others 2017).

### Desired Condition

MSP Roadmap Goal (SDMMP and TNC 2017):

*Manage threats and protect and enhance existing significant occurrences of arroyo toad to self-sustaining levels and re-establish occurrences in locations where they previously existed to ensure persistence over the long-term (>100 years).*

### Current Condition Status

Arroyo toad has been in decline in San Diego from anthropogenic impacts such as habitat loss and fragmentation, water impoundment and diversion, and invasive species for over 20 years (Madden-Smith and others 2005). The recent prolonged drought has exacerbated these impacts, reducing the arroyo toad's ability to reproduce and maintain or expand populations even after restoration and land acquisition for conservation (Brown and others 2020). Only 15 populations/distinct locations currently have evidence of reproduction (USFWS 2015, Brown and others 2020).

The current overall condition status of the Arroyo Toad Species Indicator is Significant Concern based on the three metric condition values (table ARTO0.1). The HUC12 watershed is the highest resolution sub-watershed, making it suitable for monitoring. The metrics for the arroyo toad utilize the 28 HUC12s where arroyo toads were detected at any life stage during the MSCP baseline studies during 2000 to 2005 (Madden-Smith and others 2005). As part of a declining trend, there were only 15 HUC12s occupied by arroyo toads in 2020 (Metric 1); this is attributed to an increase in drought and aseasonal flows (Metric 2). The invasive aquatic species impact score (Metric 3) is of concern as predatory invasive animals are found in eight of the 15 occupied watersheds. Additional metrics will be added as more information becomes available.

**Table ARTO0.1**. Current overall condition status for the Arroyo Toad Species Indicator and period of baseline to current year comparison for metric conditions, trends, and confidence levels.

| Indicator/metric (baseline – current year) | Condition | Trend | Confidence |
|---|---|---|---|
| Arroyo toad overall condition status | Significant Concern | Declining | Moderate |
| Metric 1: number of sites occupied by young of the year (2008-2020) | Significant Concern | Declining | Moderate |
| Metric 2: water availability score (2008-2020) | Concern | Unknown | High |
| Metric 3: invasive aquatic species impact score (2000-2020) | Concern | No Change | Moderate |

## Metric 1: Number of Sites Occupied by Young of the Year

**Overview:** This metric is the number of HUC12s with suitable habitat that are occupied by arroyo toad young of the year. Within a HUC12, data are collected at sites with one or more contiguous 250-m stream reaches with suitable habitat. There may be multiple sites within a HUC12 that are separated by unsuitable habitat. If any one site is occupied by arroyo toad young of the year, then the HUC12 is considered occupied.

Metric 1 evaluates the ability of the arroyo toad to successfully reproduce in suitable habitat at a given HUC12 that supported arroyo toads in 2000 to 2008. This metric is calculated based on data collected for the 28 HUC12s supporting arroyo toads during 2000 to 2005 surveys (Madden-Smith and others 2005). It also uses data collected from 2000 to 2008 from skeletochronology studies of the arroyo toad (Fisher and others 2018), surveys by local water districts (USGS and TAIC 2002), surveys following the 2004 wildfires in the County (Mendelsohn and others 2005), and initial surveys on Conserved Lands following the Witch and Harris Fires of 2007 (Brown and others 2020). If a stream reach is dry in a particular year, then it is not included in this calculation. The intent is to measure the proportion of habitat with water and that is suitable for reproduction that supports young of the year (Miller and others 2012).

This metric is being measured across HUC12 watersheds which capture the smallest sub-watersheds within the tributary systems. The HUC12 watershed is a meaningful unit as it is at a scale that can be managed, such that an invasive species may be removed or water inputs or outputs may be controlled (Mangiante and others 2018). The condition thresholds for this metric tells us how well arroyo toad populations are persisting in the 28 HUC12 watersheds where they were detected during 2000 to 2008 surveys (USGS 2013; USFWS 2015).

**Metric Evaluation Period:** 2000-2020 (Baseline: 2000-2008; Current: 2018-2020)

**Baseline:** The baseline condition for the number of sites occupied by young of the year metric is based upon 2008, the first year in which arroyo toad daytime tadpole surveys were conducted within the MSPA. These surveys found that 22 of the 28 HUC12 watersheds supporting toads during 2000 to 2008 surveys had detectable young of the year in 2008 (fig. ARTO1.1; Brown and others 2020).

**2027 Progress Towards Desired Condition:** No short-term progress milestone for this objective.

### Condition Thresholds:

- **Good:** Young of the year detected at >20 of the 28 HUC12 watersheds that supported arroyo toads during 2000 to 2008.
- **Caution:** Young of the year detected at 14 to 20 of the 28 HUC12 watersheds that supported arroyo toads during 2000 to 2008.
- **Concern:** Young of the year detected at 7 to 13 of the 28 HUC12 watersheds that supported arroyo toads during 2000 to 2008.
- **Significant Concern:** Young of the year detected at <7 of the 28 HUC12 watersheds that supported arroyo toads during 2000 to 2008.

### Current Condition: Significant Concern

Arroyo toads have been impacted over recent decades by low water flows causing a lack of suitable breeding habitat related to water impoundment and prolonged drought. Surveys in 2018 to 2020 detected young of the year at only four HUC12s (15 sites) (fig. ARTO1.1; USFWS 2015, Brown and others 2020). The current condition for number of sites occupied by young of the year metric is Significant Concern.

**Trend (2008-2020): Declining**

The number of sites occupied by young of the year in San Diego during the current period (2018 to 2020) is lower by 18 HUC12s than during the baseline period (2000 to 2008; Brown and others 2020). Data collected in other years support a pattern of a Declining trend for this metric.

**Confidence: Moderate**

Raw or naïve data showing lack of young of the year are available for 2020. However, PAO has not been calculated or reported for the region as of this writing. PAO accounts for habitat that is no longer suitable due to physical conditions (water availability, stream morphology, etc.) (Miller and others 2012).

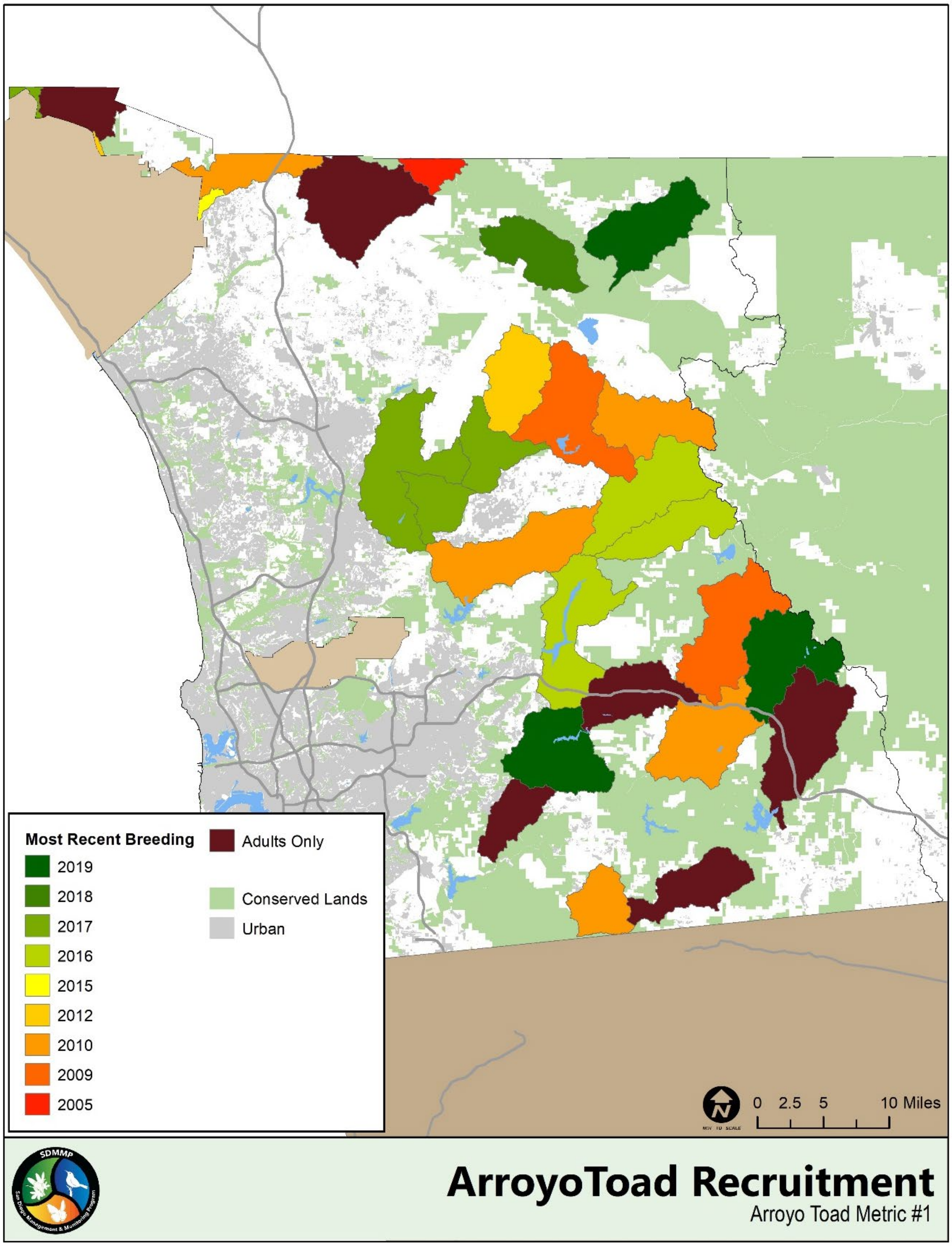


**Figure ARTO1.1.** Arroyo toad young of the year by HUC12 watershed. Most recent breeding year indicates the last year that young of the year were detected for the watershed.

## Metric 2: Water Availability Score

**Overview:**

The Water Availability Score examines the amount of time surface water is available (that is, hydroperiod), making a site conducive to successful arroyo toad reproduction. Arroyo toads require at least 90 continuous days of surface water during the breeding season to successfully breed, lay eggs, and have those eggs hatch and mature to metamorphosis (Miller and others 2012). This metric also measures the presence of surface water all year round, which could negatively impact toad populations (White and Greer 2004; Miller and others 2012). Altered hydrology, impervious surfaces, and urban aseasonal flow can cause occupied habitat to remain wet for over 300 days and facilitate invasion of nonnative aquatic predators (White and Greer 2004). Stochastic events such as large-scale wildfire or prolonged periods of drought can reduce the hydroperiod below the 90 continuous days threshold (Wohlgemuth and Hubbert 2008).

The overall Water Availability Score is a categorical score from 1 through 7 assigned for each HUC12 watershed and then averaged across the 28 HUC12 watersheds with arroyo toads during 2000 to 2008. It is based on an evaluation of water presence at visual encounter arroyo toad monitoring surveys through the breeding season, Stream Temperature, Intermittency, and Conductivity data loggers with annual visual surveys, and GIS layers quantifying hydrologic impact and impervious surfaces. A Water Availability Score of 1 is closest to the expected natural hydroperiod suitable for reproduction, and 7 is the greatest deviation (either too short or too long of a hydroperiod) from this suitable hydroperiod.

Each HUC12 with arroyo toad detections in 2000-2008 is given a score from 1 to 7. Presence of dams within the HUC12 watershed is scored 0 (not present) or 1 (present). Ground water wells are scored 0 (not present), 1 (1 to 34 wells), or 2 (more than 34 wells) per HUC12 watershed. Artificial channels and diversions are scored according to density (length of channel/diversion in kilometers divided by area of HUC12 in square kilometers) as 0 (no artificial channels), 1 (less than 0.146 $km/km^2$), or 2 (greater than 0.146 $km/km^2$). Field surveys are scored as 0 (wet) or 1 (dry) for presence of water suitable for breeding. STIC data are scored as 0 (not permanent) or 1 (permanent) for presence of water suitable for invasive fish and bullfrogs. Examples of artificially permanent water within the potentially suitable arroyo toad habitat include effluent-based discharge increasing the hydroperiod in the Santa Margarita River where toads were present historically and streambed alterations which cause pooling surface water in Santa Ysabel Creek downstream of occupied arroyo toad habitat. Both examples harbor bullfrogs and largemouth bass in historically season streams. This does not include naturally pooling water in bedrock swales such as those found in upper San Diego River or Roblar Creek. The final score is based upon the average score for 28 HUC12s that supported arroyo toads in 2000 to 2008.

**Metric Evaluation Period:** 2015 to 2020 (Baseline: 2015 to 2020; Current: 2015 to 2020)

**Baseline:** The baseline for the Water Availability Score is the current condition (2015 to 2020) with a calculated value of 4.2. Field-collected species and habitat survey data for this period document that 22 HUC12s had available water to support successful arroyo toad reproduction in 2008 (Brown and others 2020). However, a Water Availability Score cannot be calculated for 2008 as GIS data layers and STICs measurements are unavailable from 2000 to 2008.

**2027 Progress Towards Desired Condition:** Restoration of natural flows and riparian habitat with reductions of urban aseasonal flows as needed to provide suitable arroyo toad breeding habitat at five sites on Conserved Lands (associated with 2022-2026 MSP objectives).

#### Condition Thresholds:

- **Good:** Water Availability Score of <1.7 averaged across the 28 HUC12s with arroyo toad detections in 2000 to 2008.
- **Caution:** Water Availability Score between 1.7 and 3.5 averaged across the 28 HUC12s with arroyo toad detections in 2000 to 2008.
- **Concern:** Water Availability Score between 3.6 and 5.3 averaged across the 28 HUC12s with arroyo toad detections in 2000 to 2008.
- **Significant Concern:** Water Availability Score >5.3 averaged across the 28 HUC12s with arroyo toad detections in 2000 to 2008.

#### Current Condition: Concern

The current Water Availability Score for 2020 is 4.2 (baseline and current are the same), which places it in the Concern category (fig. ARTO2.1). During this time, water availability in only 11 of the HUC12s with arroyo toad detections in 2000 to 2008 was sufficient to provide suitable breeding habitat during the breeding season, while not being artificially long in duration and promoting predatory species. The prolonged drought has caused several sites, particularly in the higher, more undeveloped watersheds, to have insufficient surface flow for breeding (for example, lower Cottonwood Creek and portions of San Diego River). Also, urban aseasonal flows have caused several sites to have hydroperiods that are too long, allowing invasive predators to persist (for example, lower Santa Ysabel Creek, lower San Luis Rey, middle Santa Margarita River all maintained permanent flow during drought conditions and supported bullfrogs and bass).

#### Trend (2008-2020): Unknown

The trend in condition is Unknown since the baseline period and the current condition period are the same. However, during the 2008 field surveys, 22 HUC12s had sufficient water for reproduction based on regional monitoring efforts by SDMMP partners (USFWS 2015; Brown and others 2020). During 2015 to 2018 surveys, suitable hydroperiods for successful breeding declined to 10 of the 28 HUC12s with arroyo toad detections in 2000-2008 (Brown and others 2020). However, conservation and riparian habitat restoration has the potential to offset some impacts that shorten hydroperiods. Recent restoration efforts in the lower San Luis Rey Watershed by the California Department of Transportation and in the Otay Watershed by CDFW and County of San Diego are also trying to offset lengthened hydroperiods from aseasonal flow by creating habitat with wider, braided channels that would not support permanent surface flow and invasive species.

### Confidence: High

Confidence is High for calculating the Water Availability Score for 2015 through 2020. Water availability has been a component of habitat suitability surveys (Madden-Smith and others 2005; Fisher and others 2018), and STICs and GIS data provide reliable information.

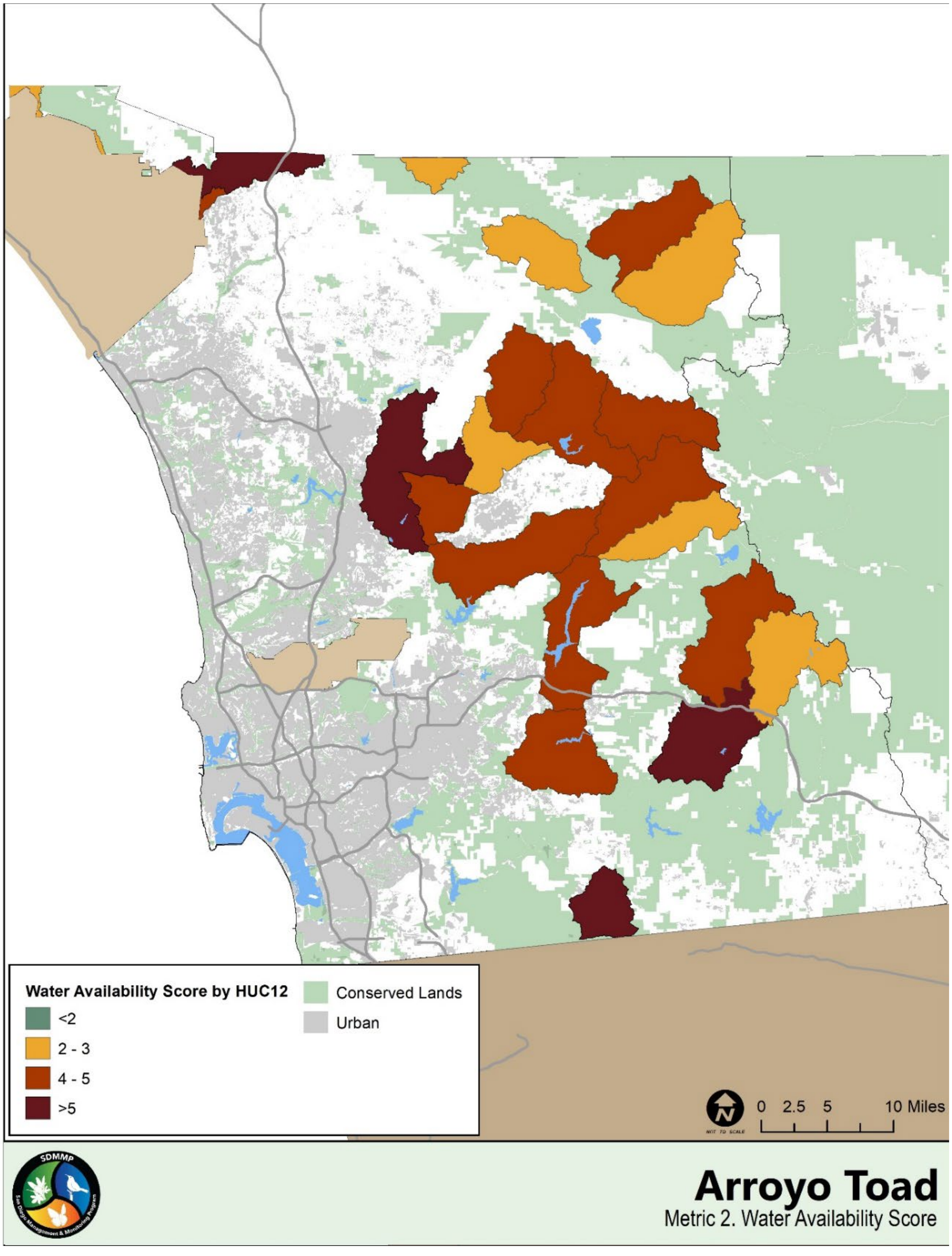


**Figure ARTO2.1.** Water Availability Scores for individual HUC12 watersheds in 2020 that were occupied by arroyo toads in 2000 to 2008. Dark brown polygons represent HUC12 watersheds that are most impacted for Water Availability and fall within the Significant Concern condition category. Rust colored HUC12 watersheds are categorized as a condition of Concern, orange as Caution, and dark green as Good.

### Metric 3: Invasive Aquatic Species Impact Score

**Overview:** This metric examines the presence and potential impact of invasive aquatic animal species in arroyo toad habitat.

Arroyo toad can be reduced in abundance or even eliminated by high impact IAS, such as bullfrogs, bass, and crayfish that prey upon the toads (Miller and others 2012; Brown and others 2020). Stream reaches or features with urban aseasonal flows and permanent surface water can facilitate expansion and persistence of these nonnative aquatic predators (White and Greer 2006). In particular, the invasive bullfrog can have devastating impacts on adult arroyo toad populations, frequently leading to local extirpation (Miller and others 2012). Other IAS have a lower impact through competition for resources, such as mosquito fish, shiners (*Notemigonus* sp.), and mollusks like the Asian clam (*Corbicula fluminea*; Sweet and Sullivan 2005).

Within predatory, competitive, and trophic groups of IAS, different scores are assigned based on potential level of impact to arroyo toad. For example, scores of -10 are assigned for bullfrogs (*Lithobates catesbeianus*), while -5 points are assigned for bass (*Micropterus* sp.) and crayfish (*Procambarus clarkii*). Competitive IAS are scored -2 points and include invasive turtles like sliders (*Trachemys* sp.). IAS affecting only trophic interactions are given a weight of -1 point. For example, mosquito fish do not eat the same food as arroyo toads but compete with macroinvertebrates eaten by arroyo toads. The total IAS score is added up for each HUC ranging from 0 to -55. A score of 0 means there are no IAS in that HUC12, while a score of between 0 and -10 indicates there are no high impact IAS present. A score of -55 indicates all currently known IAS are present. The scores are then averaged across the HUC12 watersheds to calculate the overall IAS Impact Score. This metric is also used for the Southwestern Pond Turtle Species Indicator.

**Metric Evaluation Period:** 2000 to 2020 (Baseline: 2008; Current: 2020)

**Baseline:** The 2000 to 2008 baseline IAS Impact Score is -22.5 and is derived from biodiversity studies for the MSCP (Hathaway and others 2002, 2004; Madden-Smith and others 2005), surveys for local water districts (USGS and TAIC 2002), and initial surveys on Conserved Lands following the Witch and Harris Fires of 2007 (Brown and others 2020). Invasive, aquatic predators were present in large numbers in all watersheds, with the most significant species (crayfish, bullfrogs, bass, etc.) present in eight of the 15 (53 percent) occupied watersheds.

**2027 Progress Towards Desired Condition:** Reduce urban aseasonal flows, incised channels, and deep pools supporting IAS to more natural stream morphology and flows suitable for successful arroyo toad reproduction at five sites on Conserved Lands (associated with 2022-2026 MSP objectives).

#### Condition Thresholds:

- **Good:** An average IAS Impact Score >-10 for the 28 HUC12s with arroyo toad detections in 2000-2008.

- **Caution:** An average IAS Impact Score between -10 and -20 for the 28 HUC12s with arroyo toad detections in 2000-2008.
- **Concern:** An average IAS Impact Score between -21 and -30 for the 28 HUC12s with arroyo toad detections in 2000-2008.
- **Significant Concern:** An average IAS Impact Score <-30 for the 28 HUC12s with arroyo toad detections in 2000-2008.

### Current Condition: Concern

Currently (2020), the average IAS Impact Score is -21.9 for the 28 HUC12s with arroyo toad detections in 2000-2008 (fig. ARTO3.1).

### Trend (2005-2020): No Change

The IAS Impact Score improved very slightly from baseline (-22.5 to -21.9) but remains in the Concern category. Therefore, the trend is No Change. Continued regional monitoring of the arroyo toad should help detect if there are changes in the future. Programs for removing invasive aquatic species are in place in arroyo toad habitat in the Santa Margarita, San Luis Rey, San Dieguito, San Diego, Sweetwater, and Otay watersheds. This trend has implications for successful arroyo toad conservation as sites heavily impacted by invasive species in these watersheds have few to no arroyo toad detections in recent years (Miller and others 2012; USFWS 2015; Clark and others 2020; Brown and others 2020).

### Confidence: Moderate

USGS and partners have been monitoring and studying impacts to the arroyo toad in the region since 2003. Many of these efforts have been tied to stochastic events (large scale wildfires, purchase of new lands, etc.) without a regional framework. The addition of SDMMP's regional monitoring framework in 2020 will help increase confidence in this metric.

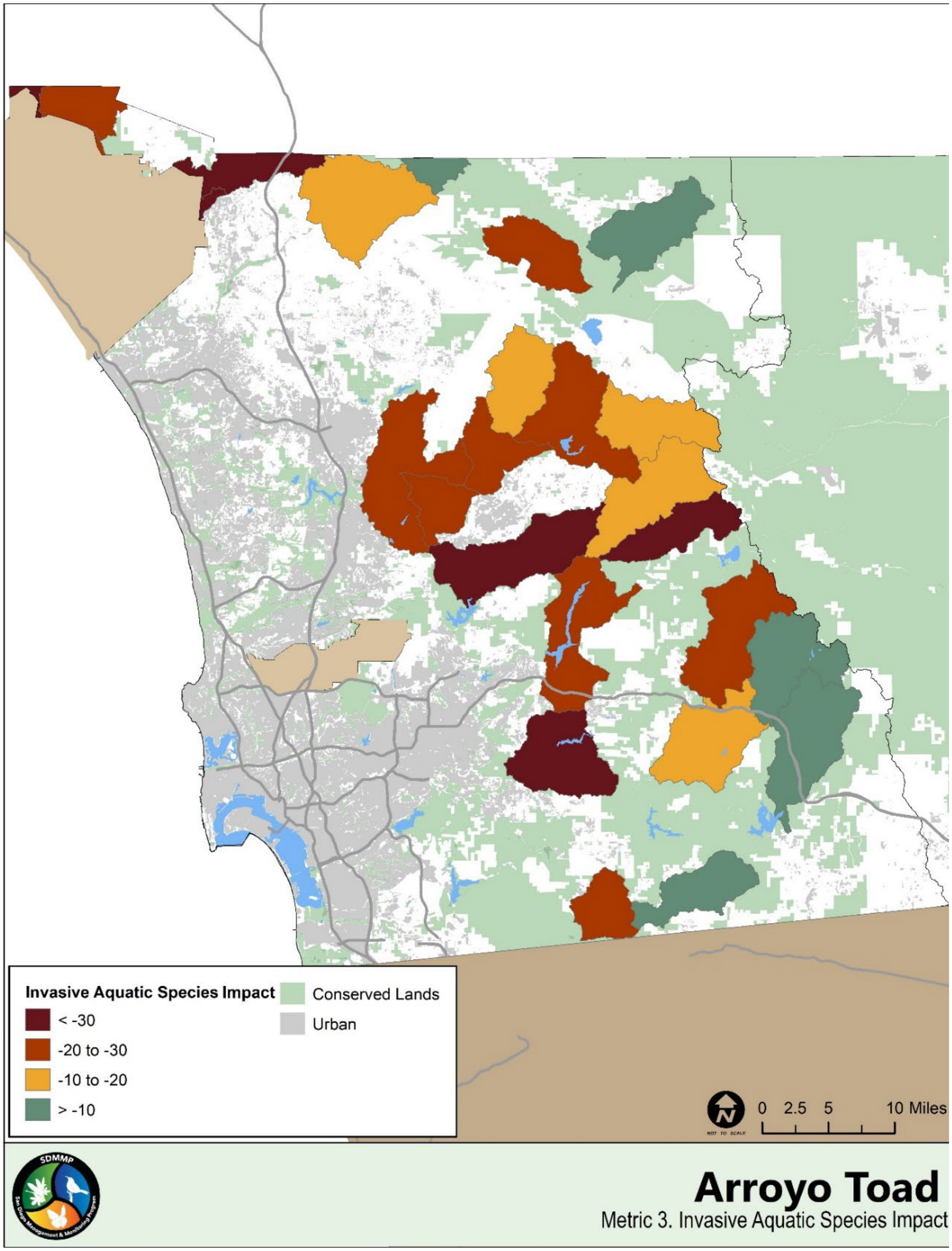


**Figure ARTO3.1.** Invasive aquatic species impact score by HUC12 watershed as of 2020. This map shows the IAS impact score for the 28 HUC12 with arroyo toad detections in 2000 to 2008.
Higher scores indicate HUC12 watersheds with more impacts from IAS. Dark brown polygons represent HUC12 watersheds that are most impacted by IAS and fall within the Significant Concern condition category. Rust colored HUC12 watersheds are categorized as a condition of Concern, orange as Caution, and dark green as Good.

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## Least Bell’s Vireo – Species Indicator (Vegetation Community Species)


**Why Is This Indicator Included?**

> Least Bell’s vireos forage for insects in trees and shrubs along streams, rivers, and floodplains. They prefer to nest in the dense understory, where predation is a main cause of nest failure (Kus and others 2008). This species prefers early successional riparian scrub and woodland and was once abundant in riparian lowlands throughout California (USFWS 1986).

Least Bell’s vireo (*Vireo bellii pusillus*) is a small migratory songbird currently restricted to breeding in willow-dominated and other riparian habitats in southern California and northern Baja California, Mexico (USFWS 1986). Vireos winter in the Cape region of the southern Baja peninsula. Starting in the 1930s, least Bell’s vireo declined more dramatically than any other California songbird species because of loss of riparian habitat and nest parasitism by brown-headed cowbirds (*Molothrus ater*). The species was listed by the State of California as endangered in 1980 and by the USFWS as endangered in 1986 (USFWS 1986). San Diego County supports the most predicted suitable habitat (Preston and others 2021) and largest numbers of vireos from time of listing to present (USFWS 2006; Kus and others 2021). Cowbird control, as well as habitat conservation and restoration efforts to recover least Bell’s vireo populations, have benefitted other riparian species in southern California.

Least Bell’s vireo is included as an indicator of riparian habitat health as the species provides an example of how well early successional riparian scrubland in lowland rivers and streams is functioning. Least Bell's vireo also reflects how well the regional preserve system is protecting a species of high conservation priority.

### Stressors

Least Bell's vireo populations face threats from habitat loss and degradation, cowbird parasitism, and changing climate.

- **Climate Vulnerability:** Increasing frequency, intensity, and duration of droughts with a changing climate can negatively affect least Bell's vireo reproduction. Plant and insect productivity in semi-arid regions are correlated with rainfall. (Polis and others 1997; Wenninger and Inouye 2008). Drought can limit insects available as food, which can lower productivity, although riparian habitats can partially ameliorate the effects of extreme drought (Selwood and others 2015; Nimmo and others 2016)
- **Invasive Plants:** Many nonnative plants, such as Arundo/giant reed (*Arundo donax*), have invaded riparian vegetation communities. These invasive plants can lead to the loss and degradation of vireo breeding habitat and impact recovery of vireo populations (USFWS 2006).
- **Invasive Animals:** Brown-headed cowbirds have spread throughout California, and these brood parasites impact vireo reproductive success and productivity. Cowbirds were a significant factor in the decline of vireo. Kuroshio and polyphagous shot hole borer beetles (*Euwallacea* spp.) in symbiosis with fungi (*Fusarium* spp.) have invaded coastal southern California (Eskalen and others 2013). The resulting shot hole borer/Fusarium dieback causes extensive tree mortality and is especially destructive to willows in riparian systems (Boland 2017). USGS monitored least Bell's vireos at the Tijuana River and found a shift in distribution in response to vegetation changes caused by the beetles, although the long-term impacts to vireo are unknown (Howell and Kus 2018).
- **Urbanization:** Habitat loss to urban and agricultural development is a major cause in the decline of vireo populations. Vireo populations adjacent to urban development are at risk from edge effects such as human disturbance, noise, invasive plants, and human subsidized predators such as California scrub-jays (*Aphelocoma californica*), raccoons (*Procyon lotor*), and opossums (*Didelphis virginiana*; Kus and others 2008).

### Desired Condition

MSP Roadmap Goal (SDMMP and TNC 2017):

*Protect, enhance, and restore least Bell's vireo occupied and suitable habitat to create resilient, self-sustaining populations that provide for persistence over the long-term (>100 years).*

### Current Condition Status

Historically, least Bell's vireos were distributed throughout the San Joaquin and Sacramento Valleys, the central coast, and southern California (USFWS 1986). The primary cause of the vireo's decline was large-scale loss and alteration of riparian habitats throughout California for agricultural and urban development, flood control projects, gravel extraction, and grazing (USFWS 1986, 1998; Kus and others 2020). Nest parasitism by brown-headed cowbirds is also an important factor in the vireo's decline (Kus and Whitfield 2005). Cowbirds are nest parasites that lay eggs in vireo nests and rely on the vireos to raise cowbird young at the expense of vireo offspring. Brown-headed cowbirds invaded California from the Great Plains in the early 1900s and rapidly increased in abundance, causing significant impacts to vireo populations (USFWS 2006). By the 1970s, least Bell's vireo had disappeared from most of its range, and by 1985 there were only 291 known territories in southwestern California (USFWS 1986). Riparian habitat conservation and restoration, along with brown-headed cowbird management, have increased least Bell's vireo populations and expanded the species' distribution since the 1980s (Kus and Whitfield 2005; USFWS 2006; Kus and others 2020).

The current overall condition status of the Least Bell's Vireo Species Indicator is Good based on the single metric of occupied grid cells surveyed along the San Luis Rey River, which is classified as Good condition and Improving (table LBVI0.1). Additional metrics will be added as more information becomes available, including expanding Metric 1 to encompass additional riparian systems beyond just the San Luis Rey River.

**Table LBVI0.1**. Current overall condition status for Least Bell's Vireo Species Indicator and period of baseline to current year comparison for metric conditions, trends, and confidence levels.

| Indicator/Metric (baseline – current year) | Condition | Trend | Confidence |
|---|---|---|---|
| Least Bell's vireo overall condition status | Good | Improving | High |
| Metric 1: occupied grid cells (1984-2020) | Good | Improving | High |

## Metric 1: Occupied Grid Cells

**Overview:** USGS compiled and maintains a database of least Bell's vireo survey data for southern California (Kus 2021). This database includes all USGS survey data as well as vireo records obtained from biological reports submitted to USFWS. The database includes surveyor name, survey date, area surveyed, whether vireos were detected, and breeding status (unknown, pair, transient). SDMMP created a grid of 300-foot x 300-foot (ft) cells over a long-term USGS monitoring area on the San Luis Rey River. The grid cell size represents slightly over 2 acres, about the average size of a least Bell's vireo territory. The grid was used to identify which cells were surveyed in a particular year and whether a vireo was detected in a surveyed cell.

Since 1984, USGS biologists have repeatedly surveyed the San Luis Rey River (Kus 2021). The survey area varied across years. The graphs and maps present a subset of the database, starting with 1984, the first year of surveys, and then including every decade after that (1990, 2000, 2010, 2020). In addition, 2 extra years were added when comprehensive surveys were conducted over all or most of the cumulative survey area (1994 and 2013).

**Metric Evaluation Period:** 1984-2020 (Baseline: 1984; Current: 2020)

**Baseline:** In 1984, there were 1,357 grid cells surveyed in the San Luis Rey River. Least Bell's vireos were detected in only 13 cells (1 percent) (figs. LBVI1.1 and LBVI1.2; Kus 2021).

**2027 Progress Towards Desired Condition**: The goal for 2027 is to continue documenting least Bell's vireo detections in riparian grid cells conserved in the San Luis Rey River (associated with 2022-2026 MSP objectives).

### Condition Thresholds:

- **Good:** Least Bell's vireos detected at ≥20 percent of grid cells in a standardized survey area of suitable habitat on Conserved Lands in the San Luis Rey River.
- **Caution:** Least Bell's vireos detected at 15-19 percent of grid cells in a standardized survey area of suitable habitat on Conserved Lands in the San Luis Rey River.
- **Concern:** Least Bell's vireos detected at 10-14 percent of grid cells in a standardized survey area of suitable habitat on Conserved Lands in the San Luis Rey River.
- **Significant Concern:** Least Bell's vireos detected <10 percent of grid cells in a standardized survey area of suitable habitat on Conserved Lands in the San Luis Rey River.

### Current Condition: Good

In 2020, least Bell's vireos were detected at 331 (24 percent) of 1,379 grid cells at the San Luis Rey River (figs. LBVI1.1 to LBVI1.8; Kus 2021).

### Trend (1984-2020): Improving

Least Bell's vireo detections have increased from 1 percent of grid cells surveyed in 1984 to 24 percent in 2020 (fig. LBVI1.2; Kus 2021). There have been some fluctuations (that is, 2013 with 13.5 percent) that may be associated with drought. However, the overall trend is Increasing.

### Confidence: High

Monitoring data collected from 1984 to 2020 are of high quality because of the use of a well-defined protocol by biologists experienced with surveying for least Bell's vireos (Kus 2021).

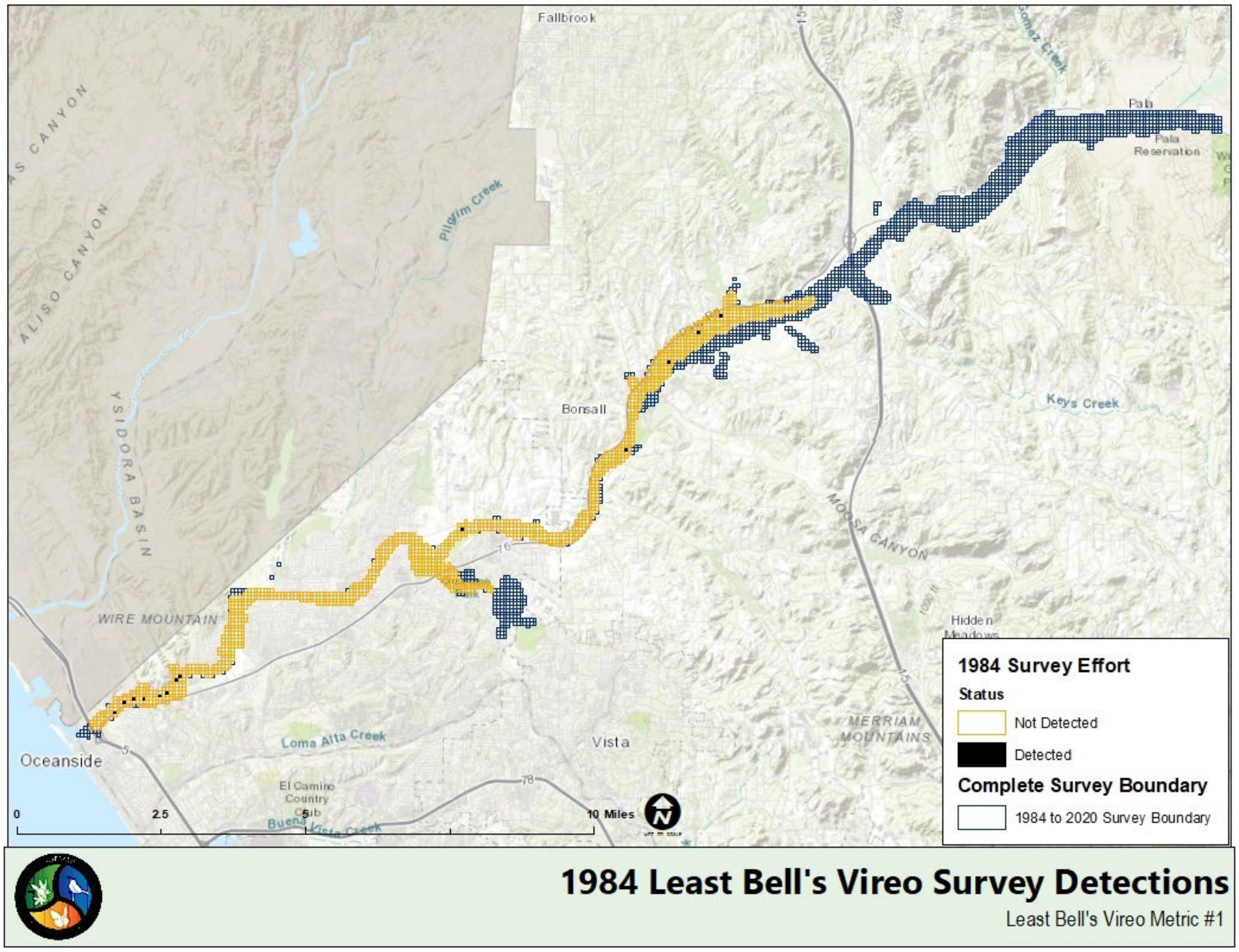


**Figure LBVI1.1.** San Luis Rey River riparian grid cells surveyed for least Bell's vireo (shown in yellow) in 1984 (baseline). This map shows the complete survey boundary for the 300-ft by 300-ft grid cells (in dark blue) where least Bell's vireo populations were surveyed on the San Luis Rey River between 1984 and 2020. The grids where least Bell's vireos were detected in 1984 are shown in black.

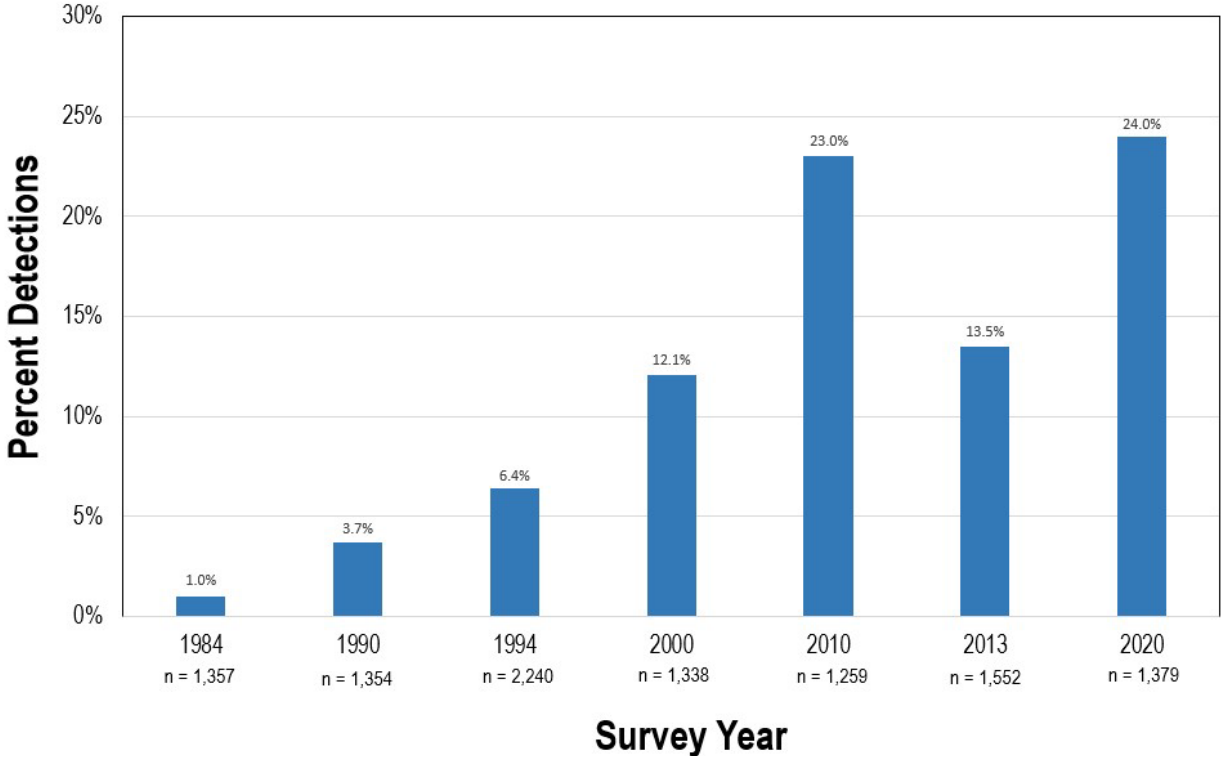


**Figure LBVI1.2.** Percent of San Luis Rey River surveyed grid cells with least Bell's vireo detections over time. The number of grid cells sampled (n) varied by year. The baseline survey year was 1984 and 2020 is the current comparison year. Over time the trend in detections has increased.

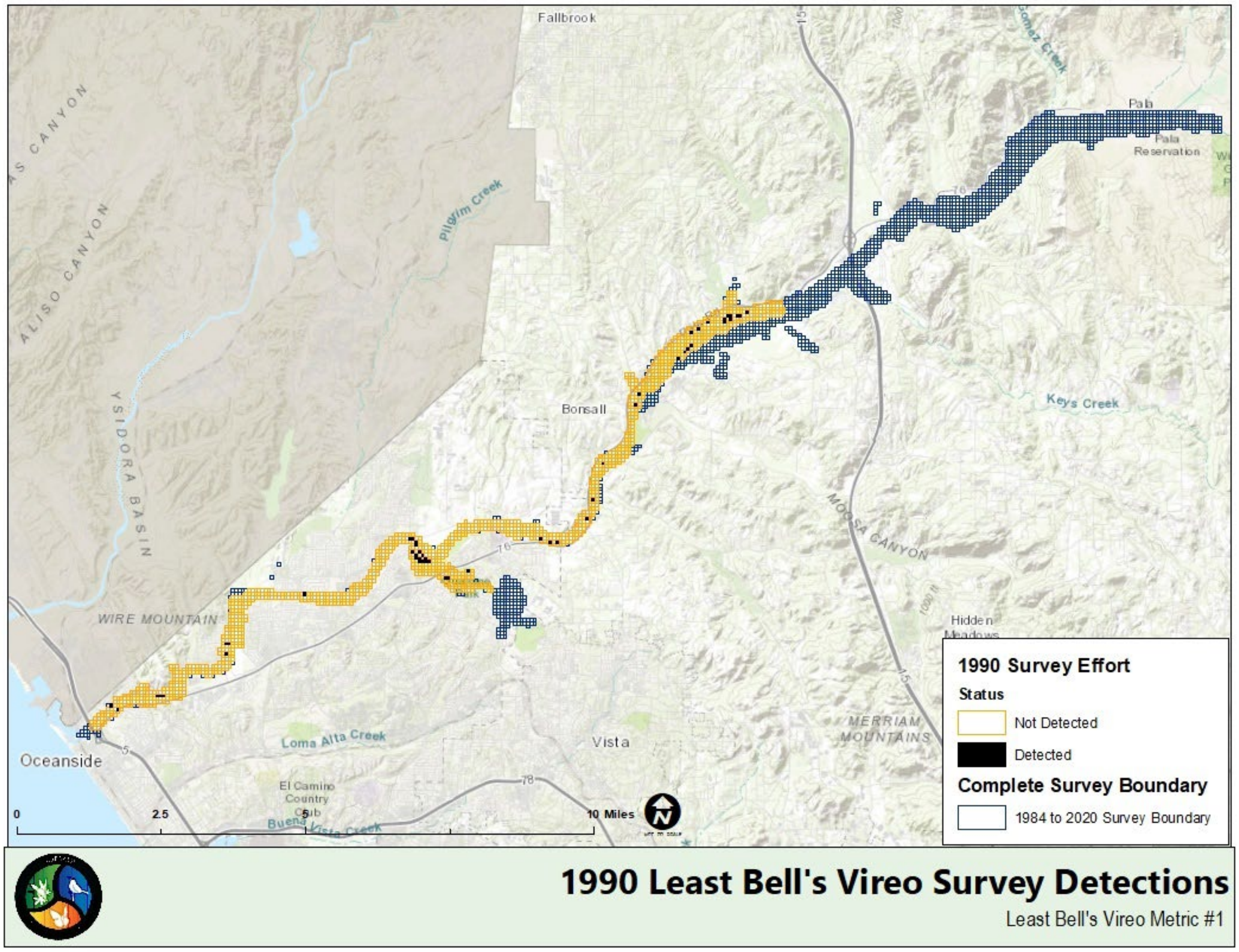


**Figure LBVI1.3.** San Luis Rey River riparian grid cells surveyed for least Bell's vireo (shown in yellow) in 1990. This map shows the complete survey boundary for the 300-ft by 300-ft grid cells (in dark blue) where least Bell's vireo populations were surveyed on the San Luis Rey River between 1984 and 2020. The grids where least Bell's vireo was detected in 1990 are shown in black.

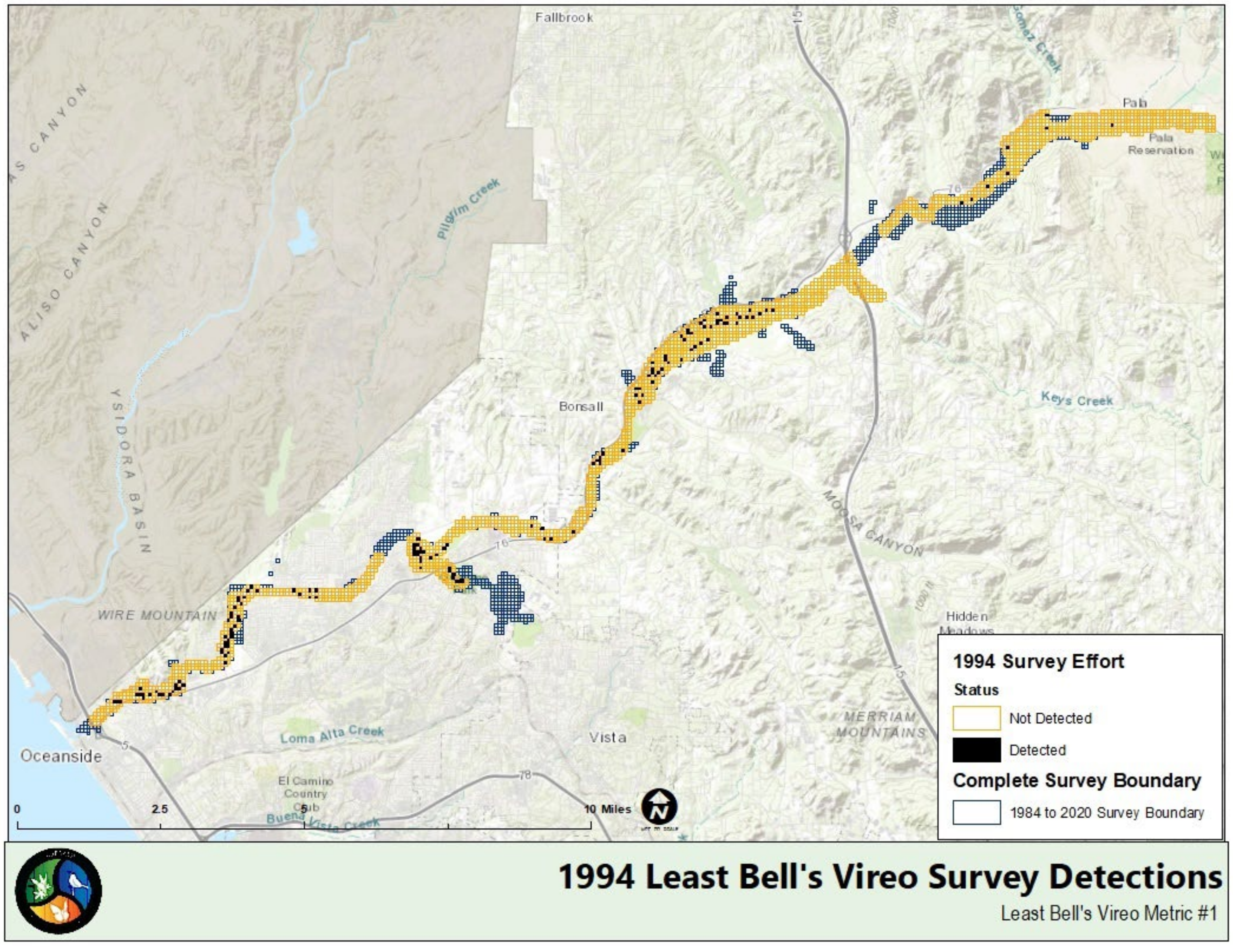


**Figure LBVI1.4.**
San Luis Rey River riparian grid cells surveyed for least Bell's vireo (shown in yellow) in 1994. This map shows the complete survey boundary for the 300-ft by 300-ft grid cells (in dark blue) where least Bell's vireo populations were surveyed on the San Luis Rey River between 1984 and 2020. The grids where least Bell's vireo was detected in 1994 are shown in black.

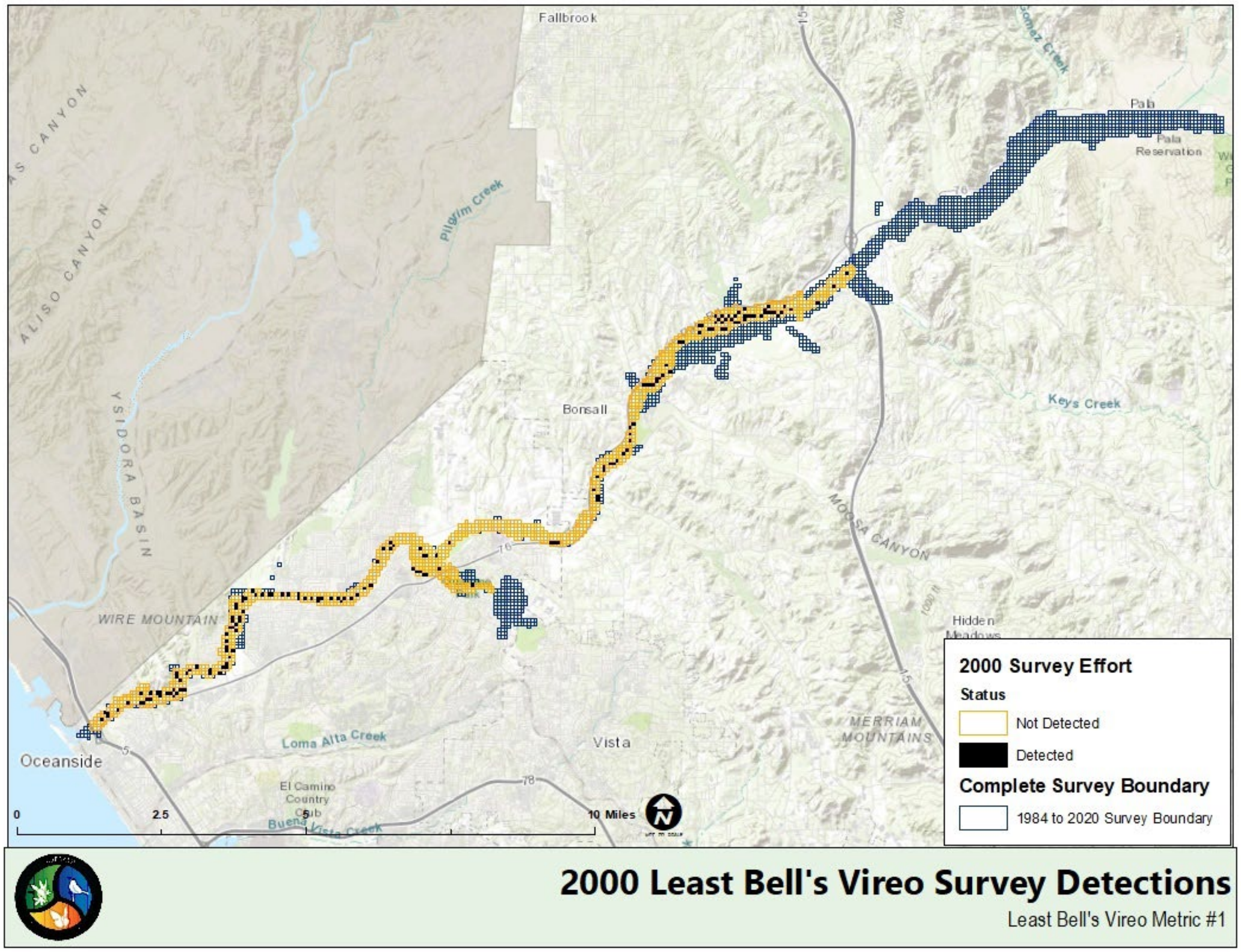


**Figure LBVI1.5.** San Luis Rey River riparian grid cells surveyed for least Bell's vireo (shown in yellow) in 2000. This map shows the complete survey boundary for the 300-ft by 300-ft grid cells (in dark blue) where least Bell's vireo populations were surveyed on the San Luis Rey River between 1984 and 2020. The grids where least Bell's vireo was detected in 2000 are shown in black.

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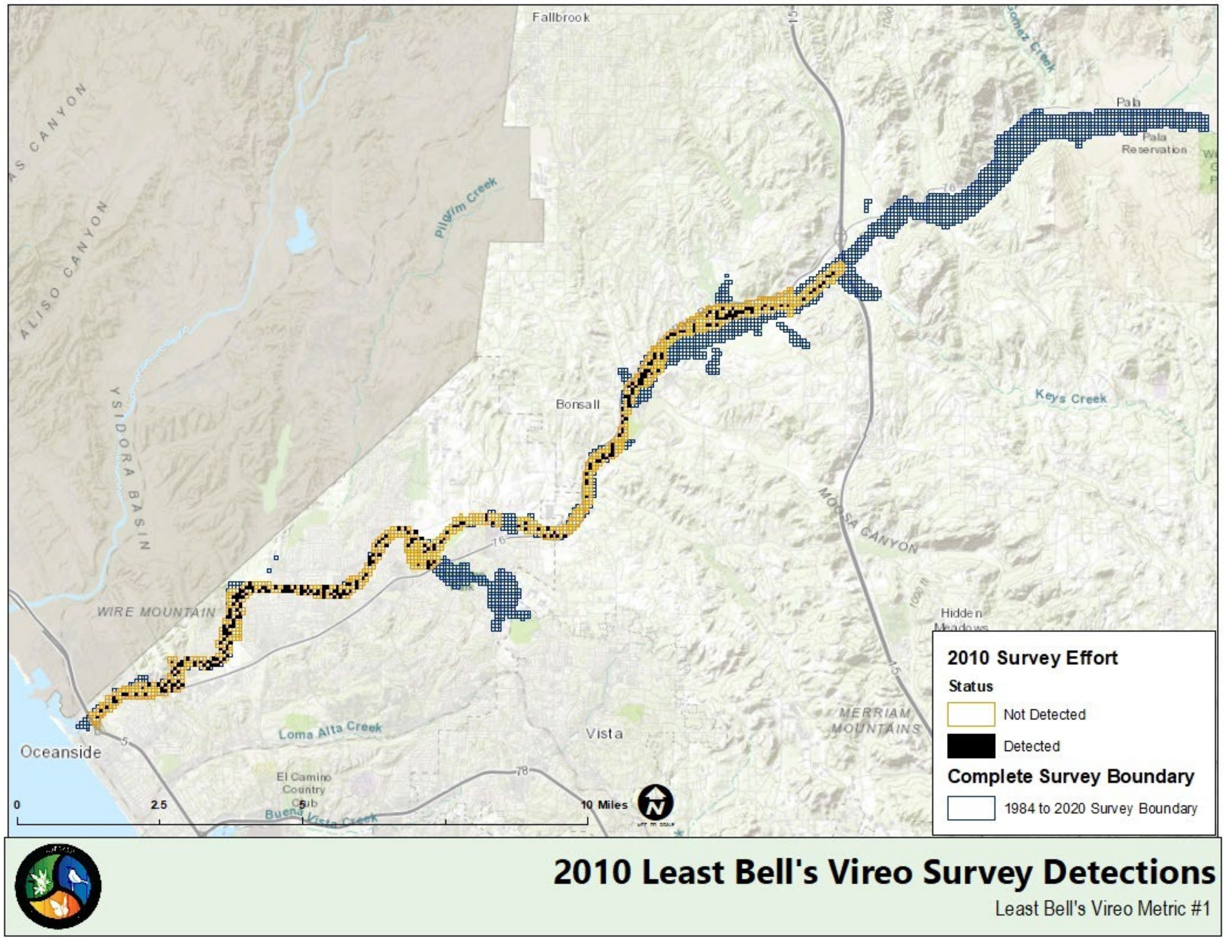


**Figure LBVI1.6.** San Luis Rey River riparian grid cells surveyed for least Bell's vireo (shown in yellow) in 2010. This map shows the complete survey boundary for the 300-ft by 300-ft grid cells (in dark blue) where least Bell's vireo populations were surveyed on the San Luis Rey River between 1984 and 2020. The grids where least Bell's vireo was detected in 2010 are shown in black.

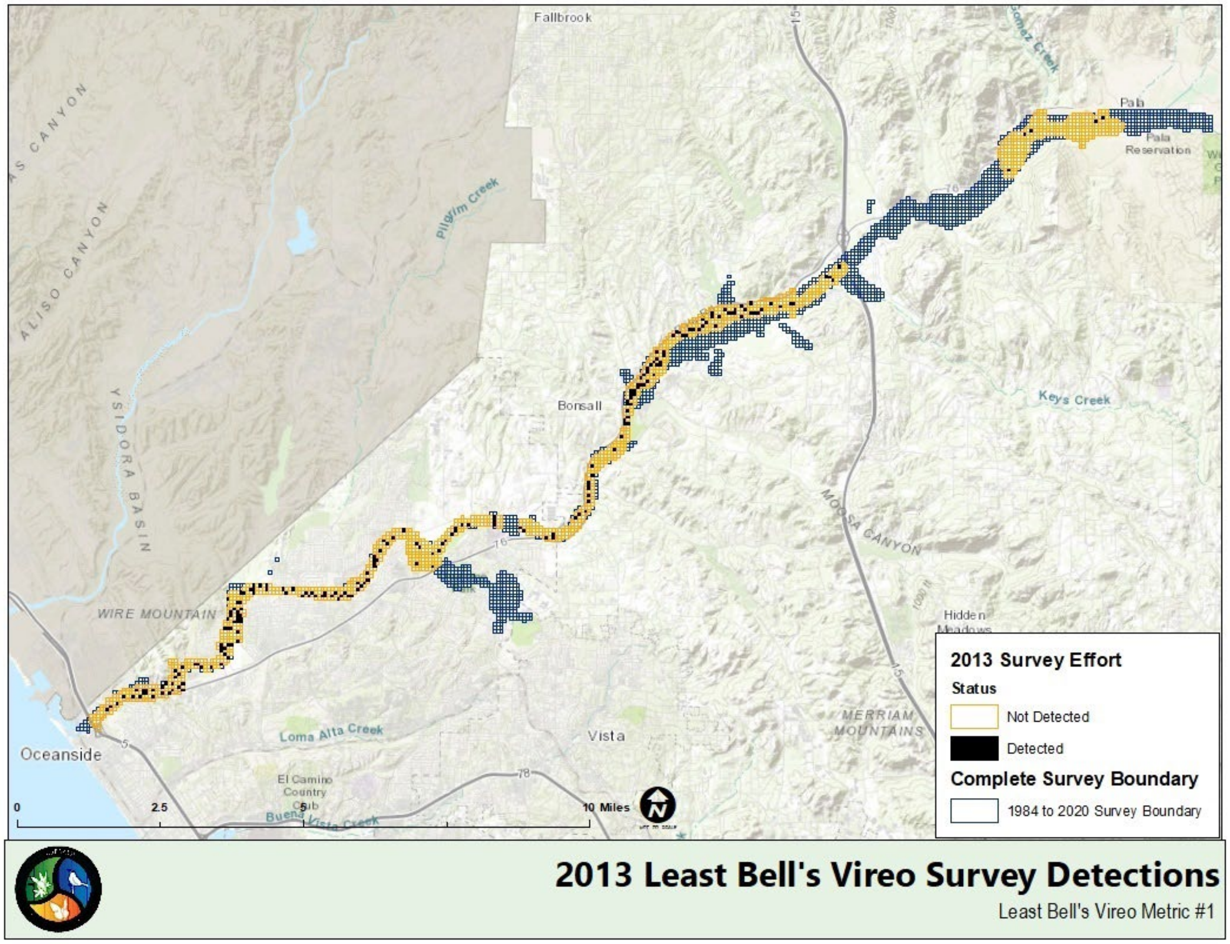


**Figure LBVI1.7.**

San Luis Rey River riparian grid cells surveyed for least Bell's vireo (shown in yellow) in 2013. This map shows the complete survey boundary for the 300-ft by 300-ft grid cells (in dark blue) where least Bell's vireo populations were surveyed on the San Luis Rey River between 1984 and 2020. The grids where least Bell's vireo was detected in 2013 are shown in black.

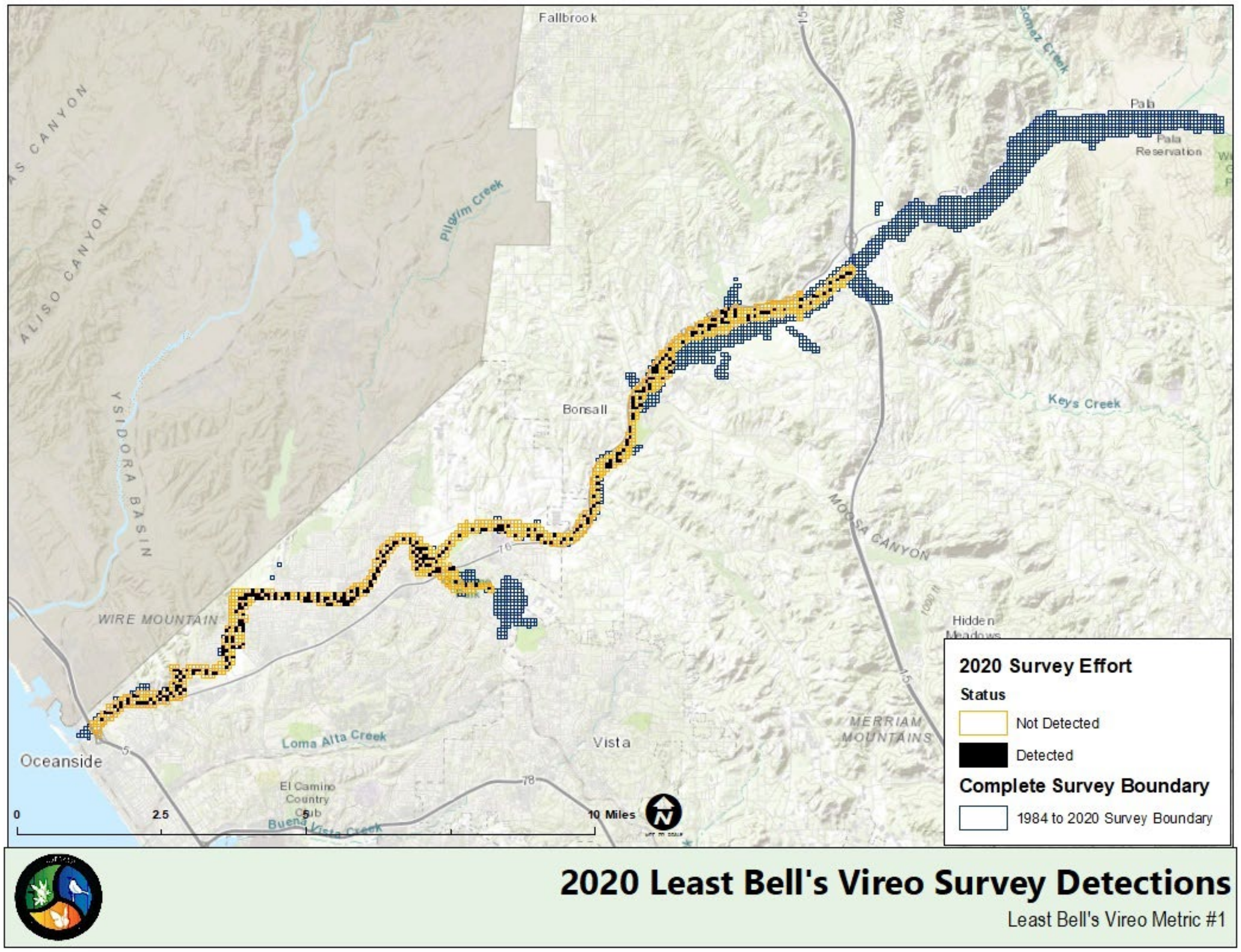


**Figure LBVI1.8.** San Luis Rey River riparian grid cells surveyed for least Bell's vireo (shown in yellow) in 2020. This map shows the complete survey boundary for the 300-ft by 300-ft grid cells (in dark blue) where least Bell's vireo populations were surveyed on the San Luis Rey River between 1984 and 2020. The grids where least Bell's vireo was detected in 2020 are shown in black.

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# Hydrology - Ecosystem Processes and Landscape-Scale Threats Indicator


### Why Is This Indicator Included?

Natural stream hydrology in the San Diego region was historically driven by both runoff and groundwater inputs. Many streams had wide, dynamic channels with sand or gravel substrates, and most were ephemeral (Taniguchi and Biggs 2015). Dams, water diversions, and increased impervious surfaces associated with urbanization have altered stream morphology and threaten watershed functions in semiarid southern California (Hawley and others 2012; Booth and Fischenich 2015).

Altered hydrology includes impacts to the natural streamflow such as dams, diversions, and increased runoff from development. These impacts can reduce the amount of available water in upper portions of the watersheds and increase the amount of available water lower in the watersheds. This can dry perennial streams or make permanent deep pools and ephemeral washes, both of which can change the species composition of the stream system (White and Greer 2006; Miller and others 2012)

Other factors impacting stream hydrological and sedimentation regimes include wildfire increasing channel sedimentation (Moody and Martin 2009) and the invasion of nonnative plant species, such as Arrundo/giant reed, reducing available surface water (Jain and others 2015) while increasing flooding during periods of heavy rainfall (Spencer and others 2013). Beavers can increase stream temperatures, impair water quality, facilitate invasive species, and alter sediment distribution (Weber and others 2017).

These impacts reduce the amount of surface water in the upper watersheds and increase channelization and runoff in lower watersheds (Booth and Fishcenich 2015; Taniguchi and Biggs

2015). Upper and middle watersheds may be left too dry to support native species such as the southwestern pond turtle or arroyo toad (Cooper and others 2013). Lower watersheds may have both increased and aseasonal flows, as well as longer hydroperiods (Cooper and others 2013; Brown and others 2020). Increased runoff and aseasonal flow associated with urbanization may also help maintain riparian habitat (White and Greer 2006) that supports some rare or threatened riparian bird species, such as least Bell's vireo (Lee and Rotenberry 2015). However, incised channels and urban runoff can increase permanent water, which can harbor and facilitate the spread of invasive species which were not adapted to ephemeral streams (for example, crayfish and bullfrogs) (White and Greer 2006; Wohlgemuth and Hubbert 2008; Moody and Martin 2009). All these issues combined can degrade habitat for many native aquatic species (Brown and others 2020).

## Stressors

- **Fire:** Watershed level wildfires can produce heavy sediment loads and reduce surface water availability (Moody and Martin 2009; Wohlgemuth and Hubbert 2008).
- **Climate Vulnerability:** Prolonged drought has direct impacts on the groundwater level and available surface water for native riparian plant and animal species (Lund and others 2018).
- **Urbanization:** Increased development (including impervious surfaces) can increase runoff, channel depth, and hydroperiod (Hawley and others 2012, Brown and others 2020).

## Desired Condition

MSP Roadmap Goal (SDMMP and TNC 2017):

*Reduce the impact of urban runoff and aseasonal flow on the highest priority MSP species and maintain riparian habitat so that species can persist over the long term (>100 years) in areas upstream and downstream of urban land uses. Reduce the impact of invasive nonnative species through restoration of natural streamflow.*

## Current Condition Status

The current overall condition status of the Hydrology Indicator is Concern based on consideration of the four metric condition values, with a slightly higher weighting for Metrics 2 and 3 (table HYD0.1). Dams and water diversions are causing hydrologic impairment (Metric 1), and across the landscape there is low to moderate native species richness, and IAS are of considerable concern (Metric 4). The percentage of watershed burned in the last 20 years is high (Metric 2), and impervious surfaces associated with development are increasing runoff (Metric 3). Additional metrics may be added as more information becomes available.

**Table HYD0.1:** Current overall condition status for the Hydrology Indicator and period of baseline to current year comparison for metric conditions, trends, and confidence levels.

| Indicator/metric (baseline – current year) | Condition | Trend | Confidence |
|---|---|---|---|
| Hydrology overall condition status | Concern | Unknown | Moderate |
| Metric 1: hydrologic impairment (2015-2020) | Caution | Unknown | High |
| Metric 2: watershed percent area burned (1980-2020) | Concern | Declining | High |
| Metric 3: impervious surfaces (2015-2020) | Concern | Unknown | Moderate |
| Metric 4: native versus invasive aquatic species index (2000-2020) | Concern | Unknown | Moderate |

## Metric 1: Hydrologic Impairment

**Overview:** This metric is the sum of impacts and impairments within a HUC12 watershed. It evaluates the naturalness of water occurrence, movement, and transport in the preserve. Hydrologic impairment is a combined scoring of several factors that remove or block the downstream flow of water along natural creeks and streams (fig. HYD1.1; USGS 2013). Impairments include dams, reservoirs, diversions (for example, flumes to municipal/residential supply lines), and groundwater wells (Hawley and others 2012; Booth and Fishcenich 2015). This metric is measured across HUC12 watersheds which capture the smallest sub-watersheds within the tributary systems (USGS 2013). The HUC12 watershed is a meaningful unit as it is at a scale that can be managed such that, for example, an invasive species may be removed or water inputs or outputs may be controlled (Mangiante 2018).

Hydrologic impairment reflects the naturalness of each HUC12 watershed, adding the values of impacts from three GIS spatial layers by giving categorical scores to dams, ground water wells, and artificial channels and diversions (USGS 2013; Taniguchi and Biggs 2015). The dam impact score is based on the number of dams in a HUC12 watershed. Each dam within a HUC12 watershed receives 0.5 points up to a maximum of 5.0 points for 10 or more dams. The HUC12 watershed with the largest number of dams in San Diego County has five dams for a score of 2.5. Groundwater wells are given categorical scores from low density (1-34 wells are given 1 point) to high density (>505 wells are given 5 points). The artificial channels and diversions index is a categorical score based on the ratio of length of artificial channel or diversion in kilometers to total area for the HUC12 in square kilometers. The index is scored from low relative density (between 0.01 and 0.15 is scored 1 point) to high relative density (>1.9 is scored 5 points). An overall hydrologic impairment score of 0 indicates there are no impacts at the HUC12 watershed level, and a high score of 15 indicates highest levels of hydrologic impacts over the entirety of the HUC12 watershed. Scores can be improved (lowered) through mitigation or removal of impacts, including the removal of flow barriers and wells on Conserved Lands (for example, riparian restoration at Rancho Jamul ER and land acquisition at Hollenbeck Canyon Wildlife Area). The scores for dams and diversions, groundwater wells, and artificial channels are each summed up within a HUC12 watershed. These sums are averaged across 102 HUC12 watersheds within the MSPA to produce an overall score. These are the watersheds for which there are GIS data available to calculate this metric.

**Metric Evaluation Period:** 2015 to 2020 (Baseline 2015-2020; Current: 2015-2020)

**Baseline:** The hydrologic impairment baseline score of 2.9 for 2015 to 2020 is calculated from the current number of dams, diversions, and groundwater wells per HUC12 watershed averaged across the regional preserve system (fig. HYD1.2).

**2027 Progress Towards Desired Condition:** Maintain average hydrologic impairment score of no more than 3 across the HUC12 watersheds in the preserve area (associated with 2022-2026 MSP objectives).

### Condition Thresholds:

- **Good:** Average HUC12 hydrologic impairment score <2.0.
- **Caution:** Average HUC12 hydrologic impairment score from 2.0 to 5.
- **Concern:** Average HUC12 hydrologic impairment score from 5.1 to 8.
- **Significant Concern:** Average HUC12 hydrologic impairment score >8.

### Current Condition: Caution

The current condition is the same as the baseline (2015-2020) with an average hydrologic impairment score of 2.9 across the HUC12 watershed units (fig. HYD1.2).

### Trend: Unknown

The current condition is the same as the baseline which was created with most current GIS layer and gives a single snapshot for the time period (2015-2020). This metric will be monitored and reassessed as new spatial data becomes available.

### Confidence: High

Confidence is High as the data are calculated from the most currently available GIS which are of high quality and resolution.

**Figure HYD1.1.** Example of a water diversion on the Sweetwater River (photo by C. Brown, USGS). Water diversions can impact downstream water availability and alter the stream morphology by retaining sediments.

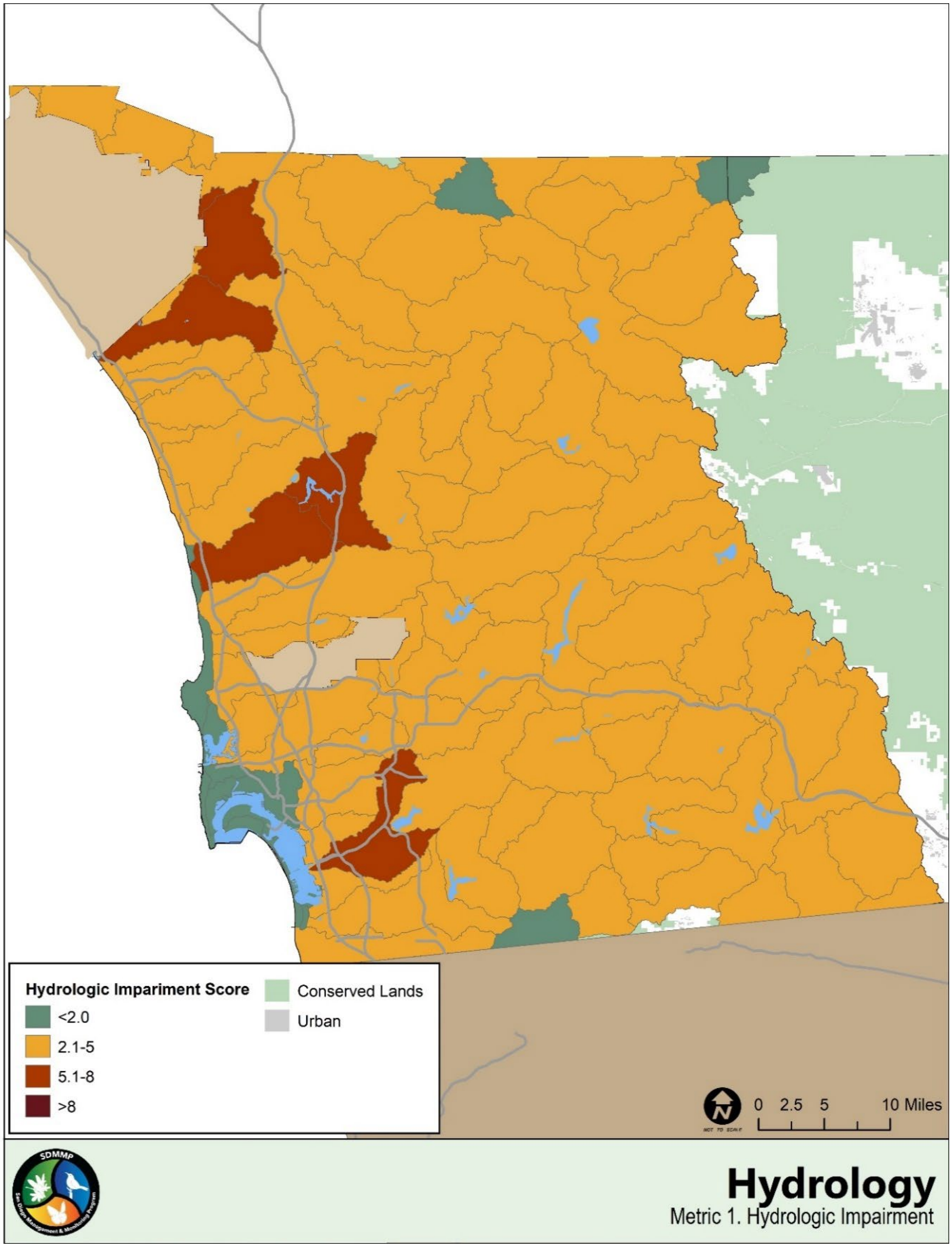


**Figure HYD1.2.** Hydrologic impairment by HUC12 watershed for the period 2015 to 2020. Watersheds are scored from 0 to 15 based on the number of dams, density of artificial channels, and number of groundwater wells. The overall hydrologic impairment score is 2.9 (Caution; represented by orange polygons) with 6 HUC12 watersheds in the Concern category (rust).

## Metric 2: Watershed Percent Area Burned

**Overview:** The watershed percent area burned is the cumulative amount of undeveloped HUC12 watershed burned over a 20-year period. Watershed-level fires affect sedimentation inputs and distribution in the natural stream system, altering the geomorphology of the stream (Moody and Martin 2009). Changes in stream structure can affect species composition (Wohlgemuth and Hubbert 2008; Brown and others 2020). Seventy-one HUC12 watersheds were scored based on the percentage of undeveloped area burned over time. Scores could exceed 100 percent if the watershed burned more than once. A watershed that burned completely once during the 20-year period would have a score of 100 percent. If the entire watershed burned twice, the score would be 200 percent. Scores currently range from 0 to 140 percent.

This watershed percent area burned metric is calculated by averaging the scores across the HUC12s in the study area. The individual HUC12s are scored by summing the area burned by each fire within a HUC12 during a 20-year period and dividing the result by the open space area within the HUC12.

Condition thresholds are based on estimates for mean fire return intervals from before Euro-American settlement, which range between 55 years for chaparral and 76 years for CSS (Van de Water and Safford 2011). Using a mean fire return interval of 66 years for the predominant vegetation communities on Conserved Lands, it’s expected that approximately 30 percent of the open space would have been impacted by wildfire within any given 20-year time period under natural circumstances.

**Metric Evaluation Period:** 1980 to 2020 (Baseline: 1980-2000; Current: 2000-2019)

**Baseline:** The baseline condition of watershed percent area burned is 16.7 for 1980 to 2000 and is calculated from the California Fire Perimeters data set (CalFire 2019). During this 20-year period, the fire frequency was even lower than estimates from the pre-Euro-American settlement of 30 percent.

**2027 Progress Towards Desired Condition:** To reach the desired condition of a more natural historic fire regime of less frequent fire involves reducing ignitions and the incidence of very large fire events. The short-term goal is to avoid having HUC12s with fire condition in the Significant Concern category. This can be achieved if watersheds recover from the extremely large fires in 2003, 2005, and 2007 with no new significant fire events (associated with 2022-2026 MSP objectives).

### Condition Thresholds:

- **Good:** Average watershed percent area burned over 20 years <17 percent.
- **Caution:** Average watershed percent area burned over 20 years from 17 to 32 percent.
- **Concern:** Average watershed percent area burned over 20 years from 33 to 66 percent.
- **Significant Concern:** Average watershed percent area burned over 20 years >66 percent.

### Current Condition: Concern

The watershed percent area burned for 2000 through 2019 is 44.7 percent (fig. HYD2.2). The current condition for 2020 is calculated from the California Fire Perimeters data set (CalFire 2019).

### Trend: Declining

The current condition of this metric has increased from 16.7 to 44.7 percent, declining from Good to Concern. This indicates a Declining trend. On average, the HUC12s across the preserve currently have a cumulative fire impact 2.7 times greater than the previous 20-year period and nearly 1.4 times what could be expected to find prior to Euro-American settlement. Also, only one HUC12 had over 100 percent area burned over time during the baseline condition whereas 16 HUC12s had over 100 percent area burned over time in the current condition (indicating they have had large fires at least twice during the 20-year period).

### Confidence: High

GIS layers for fire perimeters and watershed delineations are of high quality and precision.

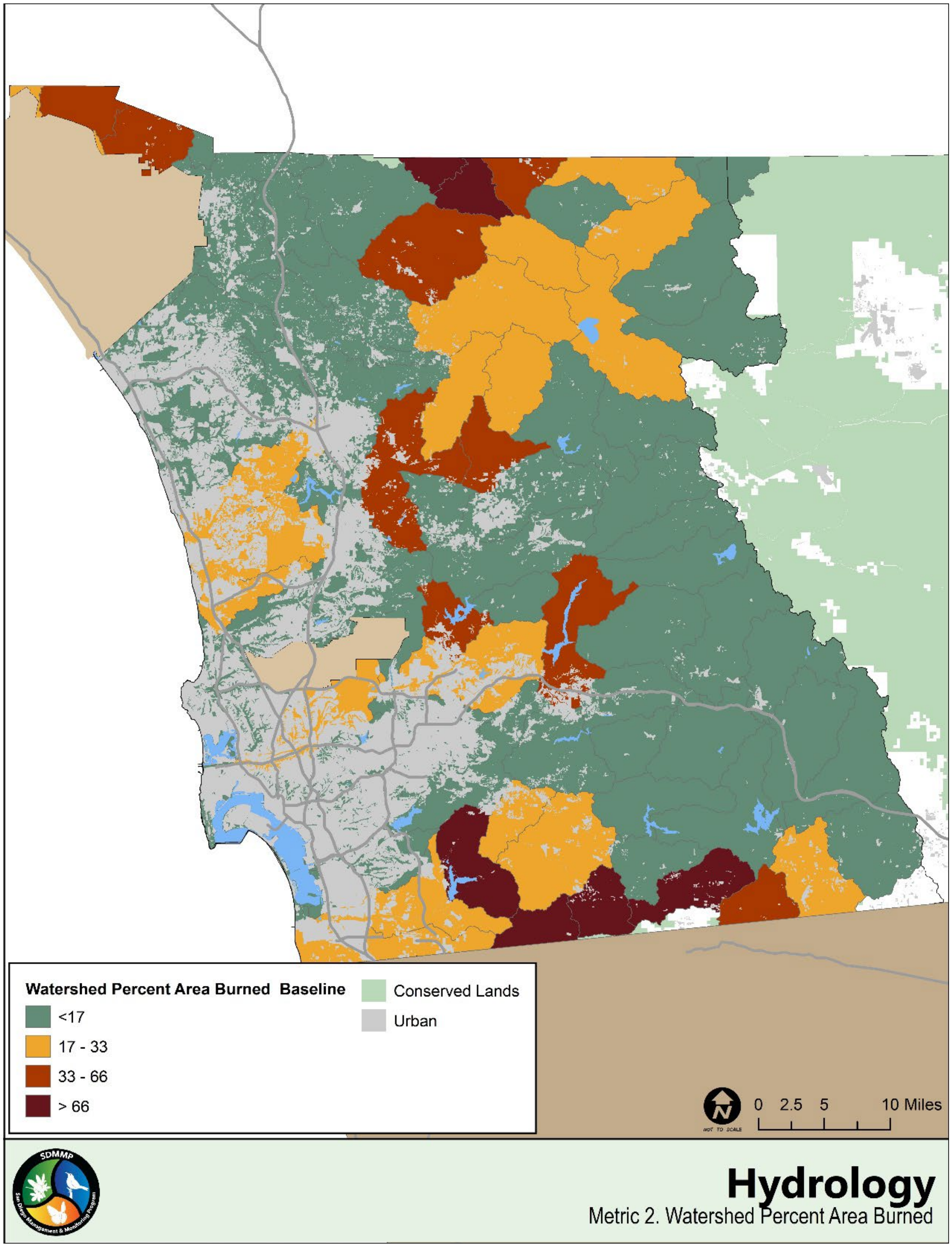


**Figure HYD2.1.** Watershed percent area burned baseline condition (1980 to 2000). Dark brown polygons represent HUC12 watersheds that are most impacted by fire and fall within the Significant Concern condition category. Rust colored HUC12 watersheds are categorized as a condition of Concern, orange as Caution, and dark green as Good.

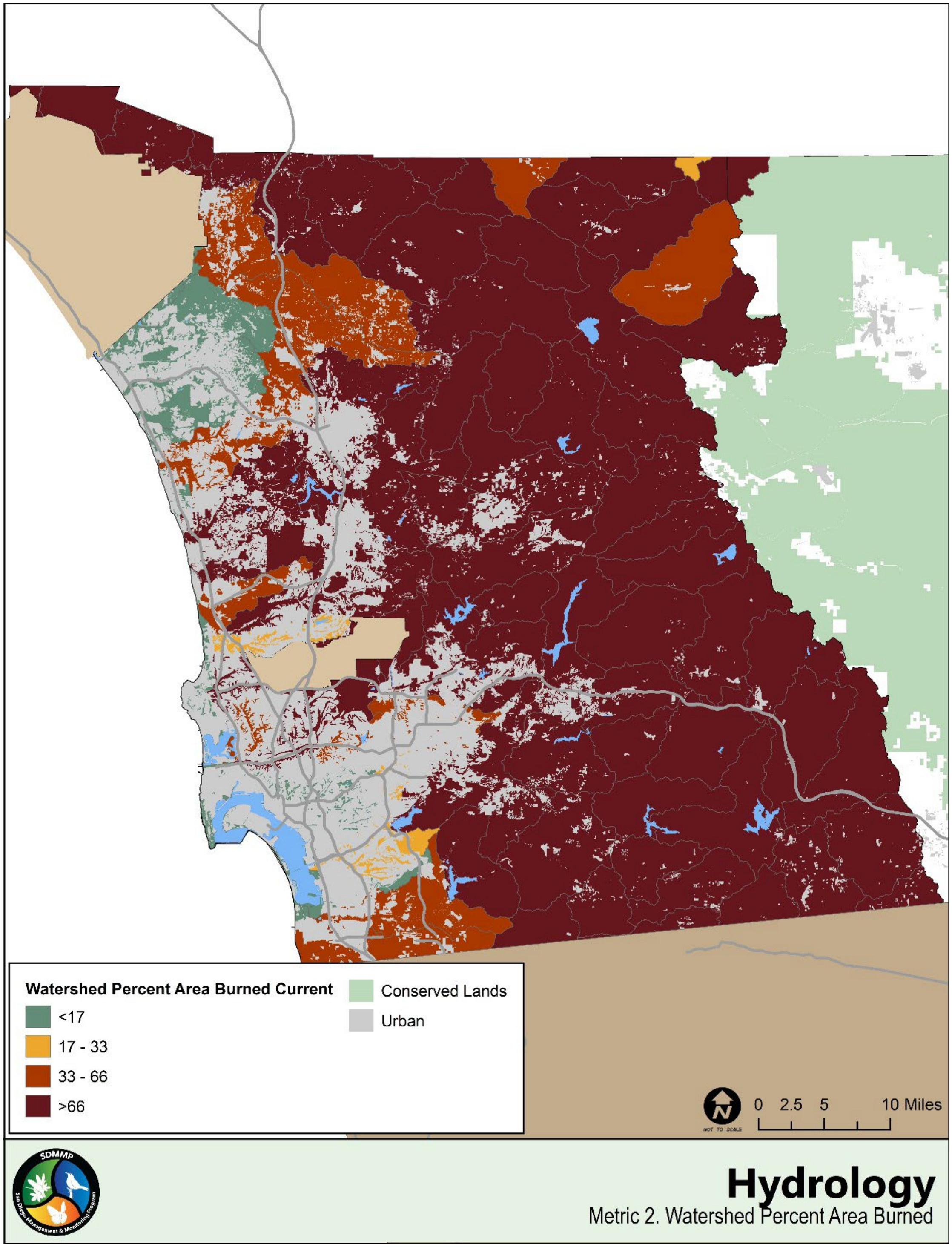


**Figure HYD2.2.** Watershed percent area burned current condition (2000 to 2020). Dark brown polygons represent HUC12 watersheds that are most impacted by fire and fall within the Significant Concern condition category. Rust colored HUC12 watersheds are categorized as a condition of Concern, orange as Caution, and dark green as Good.

## Metric 3: Impervious Surfaces

**Overview:** Impervious surfaces are hard areas often associated with urban development (for example, roads and buildings) that don't allow water to seep into the ground and where, instead, the water runs off into stream channels, storm drains, and other low-lying areas. the impervious surfaces metric is an average score of the percentage of impervious surfaces by HUC12 watershed. Impervious surfaces can alter the amount and duration of surface flow in streams and rivers. As impervious surfaces increase, the score increases. This increased urban runoff can result in more permanent water flows that change stream geomorphology with fewer flushing events to redistribute the sediments. The channels become more incised with deeper, slower moving water which facilitates expansion and persistence of IAS (White and Greer 2006; Brown and others 2020).

The impervious surfaces metric is obtained from current GIS layers for land use and watershed size. The impervious surfaces metric is calculated using the percent of each HUC12 area that is impervious (Yang and others 2003) and averaging across the HUC12s to obtain an overall score. The more desirable condition is a lower score. Studies by USGS have shown that as little as 2.5 percent impervious surfaces in a watershed can impact the downstream species composition by facilitating the persistence of IAS (Riley and other 2015). In these instances, IAS richness increases and native aquatic species richness decreases (Brown and others 2020).

**Metric Evaluation Period:** 2015-2020 (Baseline: 2015-2020; Current: 2015-2020)

**Baseline:** The impervious surfaces baseline score is 7.2 percent, calculated from 2015 to 2020 GIS impervious surface layers.

**2027 Progress Towards Desired Condition:** Maintain the baseline average and decrease the percent of impervious surfaces in ≥ 2 HUC12 watersheds through land acquisition, riparian habitat restoration, and mitigation within preserves (associated with 2022-2026 MSP objectives).

### Condition Thresholds: 2015 to 2020

- **Good:** Average impervious surfaces score is <2.5 percent impervious surfaces for the 71 HUC12s associated with Conserved Lands.
- **Caution:** Average impervious surfaces score is between 2.5 and 5.0 percent impervious surfaces for the 71 HUC12s associated with Conserved Lands.
- **Concern:** Average impervious surfaces score is between 5.1 and 7.5 percent impervious surfaces for the 71 HUC12s associated with Conserved Lands.
- **Significant Concern:** Average impervious surfaces score is >7.5 percent impervious surfaces for the 71 HUC12s associated with Conserved Lands.

### Current Condition: Concern

The current score is the same as the baseline, calculated as 7.2 percent impervious surfaces for the period 2015-2020 (fig. HYD3.2). This level of impervious surfaces is nearly three times the

2.5 percent level that has been shown to have an impact on native species (Brown and others 2020).

### Trend: Unknown

This metric uses data from 2015 to 2020 to define both the current condition and baseline. While more impervious surfaces are being created within the preserve, land acquisition with habitat restoration is also occurring to offset these changes. The trend will remain Unknown until more current and future data are collected and analyzed.

### Confidence: Moderate

The GIS layers for calculating the impervious surfaces metric are high resolution and accurate but are relatively new/recent. Continued collection and analysis of impervious surface spatial data will refine the trends analysis and increase confidence.

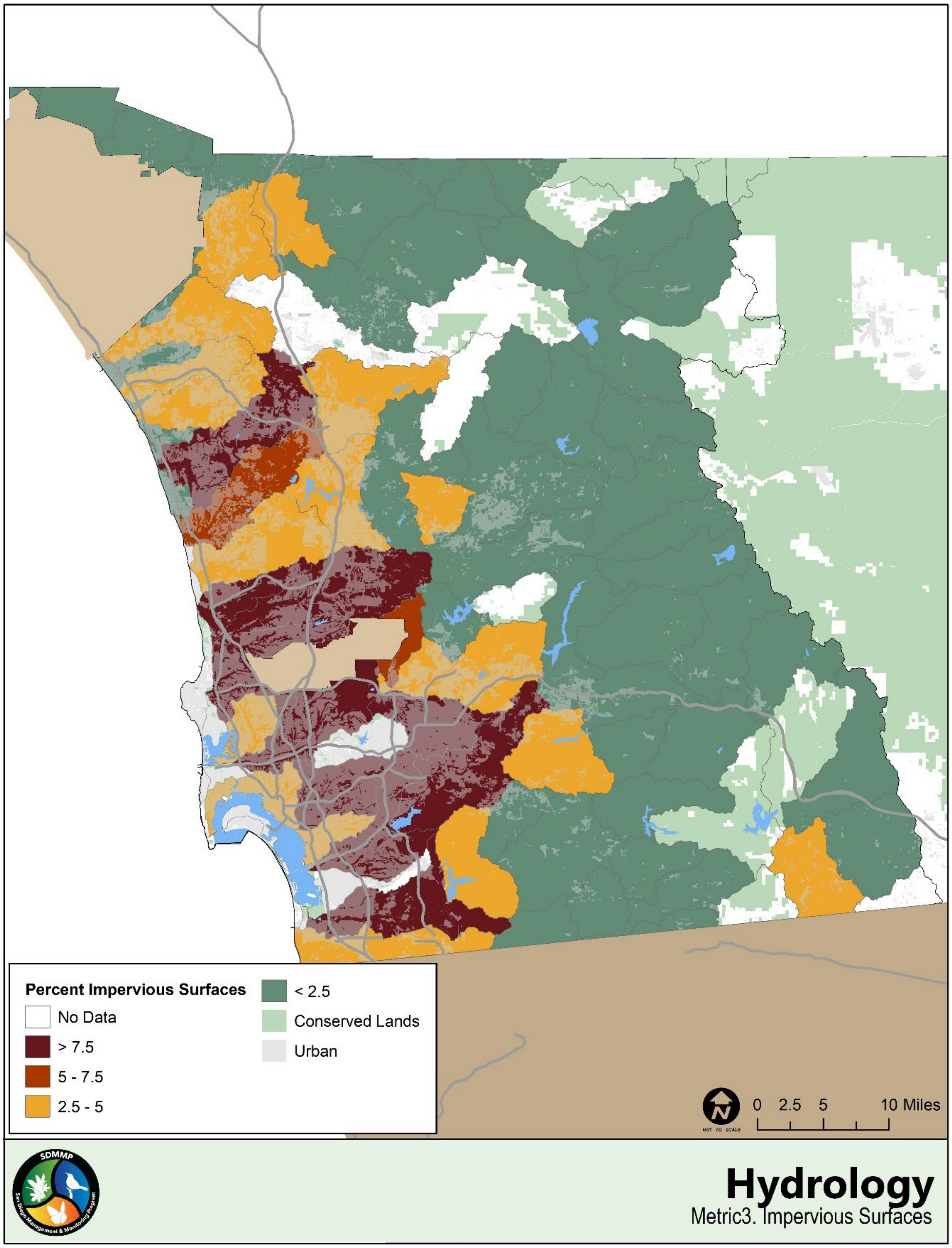


**Figure HYD3.1.** Percentage of impervious surfaces by HUC12 watershed for the period 2015 to 2020. Dark brown polygons represent HUC12 watersheds that are most impacted by impervious surfaces and fall within the Significant Concern condition category. Rust colored HUC12 watersheds are categorized as a condition of Concern, orange as Caution, and dark green as Good.

## Metric 4: Native versus Invasive Aquatic Species Index

**Overview:** Altered hydrology facilitates the expansion and persistence of nonnative IAS (White and Greer 2006; Brown and others 2020). Nonnative IAS predators (for example, largemouth bass, bullfrogs, crayfish) can impact native species abundance and even lead to local extirpation (Brown and others 2020). Other nonnative species can indirectly affect native species by affecting habitat quality (for example, zebra mussels, Asian clams, mosquitofish) (NOAA 2004). These species affect human quality of life and health, such as harboring and facilitating the spread of problem species like mosquitos though disrupting natural trophic interactions (Bucciarelli and others 2019) and have impacts to recreation and tourism in open space parks.

The Native versus Invasive Aquatic Species Index is a combined score based on the presence of native and nonnative species in a HUC12 watershed. Species included in this index rely on aquatic habitat for a portion or all of their lifecycle (for example, dragonflies, fish, stream breeding amphibians, aquatic turtles, etc.).

Initial values for the Native versus Invasive Aquatic Species Index are calculated for each HUC12 watershed based on the presence of different aquatic species. The number of native species is calculated with weighted positive values given to rare and threatened species. For example, threatened and endangered species, including the arroyo toad and southwestern pond turtle, are given a value of 10, and more common species, including Baja California treefrogs, are given a score of 1. The number of nonnative aquatic species is calculated with weighted negative scores being given to the most predatory and harmful species. For example, predatory aquatic species, including the bullfrog and crayfish, are given a score of -10, and less harmful species, including mosquitofish and Asian clams, are given a score of -1. The total score for each HUC12 watershed is calculated by adding the negative value of the nonnative invasive species score to the positive value of the native species score.

HUC12 watersheds with Native versus Invasive Aquatic Species Index scores less than -15 are heavily impacted with many nonnative species and few native species. Conversely, HUC12 watersheds with scores greater than 15 have high native diversity with at least one threatened or endangered species and few nonnative species. The overall Native versus Invasive Aquatic Species Index score the average score across the HUC12 watersheds. It can be increased through the removal of nonnative IAS or the addition of native aquatic species at the HUC12 level.

This Native versus Invasive Aquatic Species Index metric is similar to the IAS Impact Score used for the Southwestern Pond Turtle and Arroyo Toad Species Indicators but incorporates both native and invasive nonnative species. There are also some differences in the weighting of scores for individual species.

**Metric Evaluation Period:** 2000 to 2020 (Baseline: 2000-2005; Current: 2015-2020)

**Baseline:** The 2000-2005 baseline is derived from USGS, City of San Diego, County of San Diego, CDFW, and partner data on stream species collected throughout the preserve from 2000 to 2005 (Hathaway and others 2002; Madden-Smith and others 2005; Brown and others 2020).

Invasive species records are compiled to give a final average score across the 38 HUC12 watersheds with survey data from 2000 to 2005 based on number of invasive species with higher weight being given to aquatic predators. Our baseline utilizes data from Madden-Smith and others (2005) which includes survey data from 2002 to 2005 (fig. HYD4.1). We also include data from partner studies to establish a baseline for 2005 with a combined Native versus Invasive Aquatic Species Index score of -2.73.

**2027 Progress Towards Desired Condition:** Eliminate the most harmful nonnative aquatic species (bullfrogs, crayfish, bass) from Conserved Lands (associated with 2022-2026 MSP objectives).

### Condition Thresholds:

- **Good:** An average Native versus Invasive Aquatic Species Index score of >15 for the 71 HUC12s within the regional preserve system.
- **Caution:** An average Native versus Invasive Aquatic Species Index score between 0 and 15 for the 71 HUC12s within the regional preserve system.
- **Concern:** An average Native versus Invasive Aquatic Species Index index score <0 and ≥-15 for the 71 HUC12s within the regional preserve system.
- **Significant Concern:** An average Native versus Invasive Aquatic Species Index score <-15 for the 71 HUC12s within the regional preserve system.

### Current Condition: Concern

The average Native versus Invasive Aquatic Species Index score for 2015 to 2020 is -1.5 for 71 HUC12s within the MSPA. The range of individual HUC12 scores is -47 (lower San Diego River) to 43 (upper San Mateo Creek). The average score is in the Concern category (fig. HYD4.2).

### Trend: Unknown

It is difficult to determine a trend as the number of HUC12 watersheds sampled in the baseline period (2000-2005) and current period (2015-2020) differs greatly. The current data reflects a much-increased sampling effort compared with the baseline. There were 71 HUC12 watersheds to assess the current condition versus 38 HUC12 watersheds for the baseline condition. It includes more area in the north and east portions of the County; these areas generally are higher up in the watersheds and typically have fewer IAS. To directly compare and determine an overall trend will require more years of data at this larger sampling scale.

### Confidence: Moderate

The distribution of native species versus IAS has been increasingly well studied on Conserved Lands within the preserve area as new properties are conserved and surveys expand. Earlier data are more limited in scope and area making it difficult to compare across time periods. Continued survey effort will increase data quality and completeness.

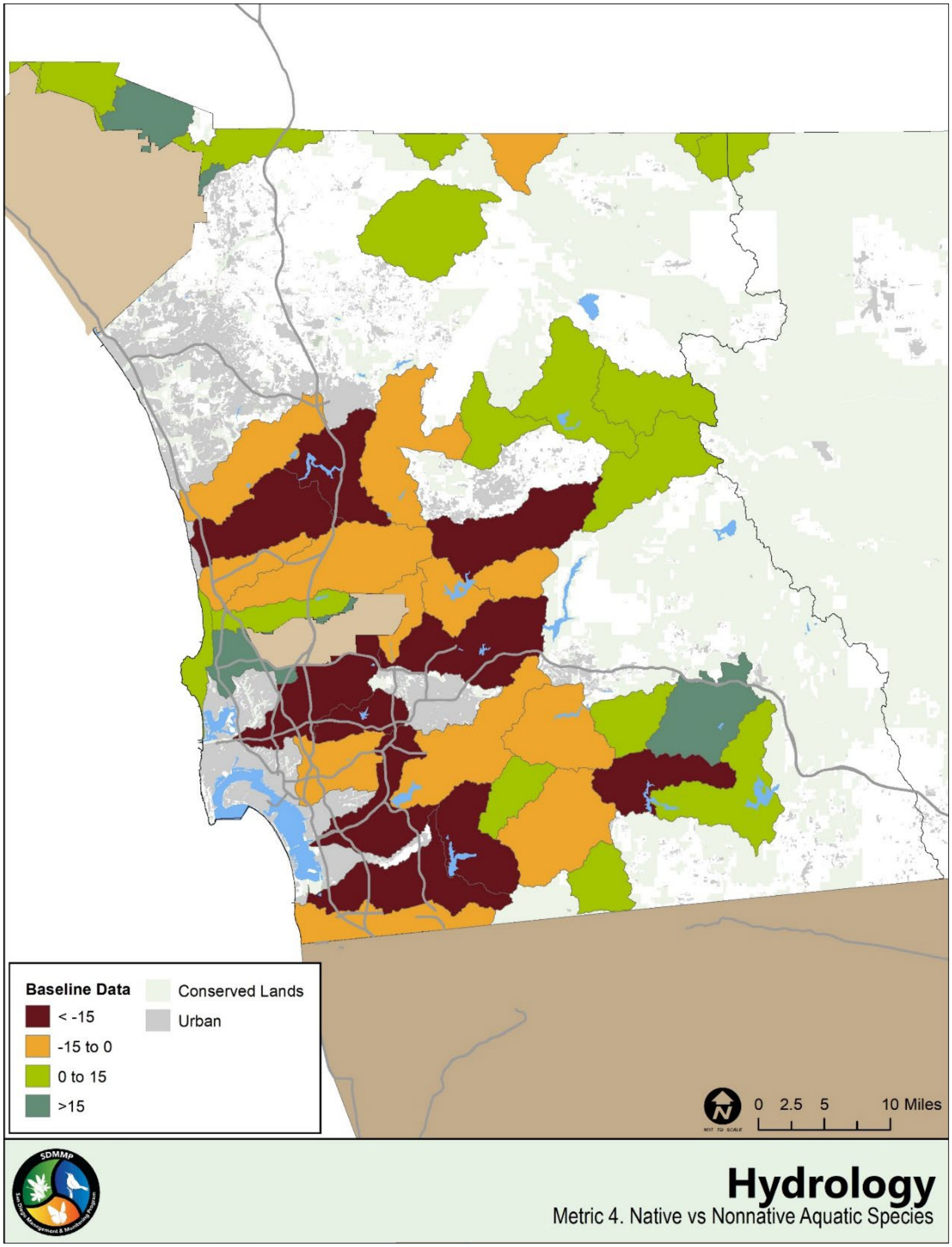


**Figure HYD4.1** Baseline (2000-2005) native versus nonnative species score by HUC12 watershed. Higher scores represent more native species and fewer invasive species. Dark brown polygons represent HUC12 watersheds that are most impacted by IAS and fall within the Significant Concern condition category. Orange colored HUC12 watersheds are categorized as a condition of Concern, light green as Caution, and dark green as Good.

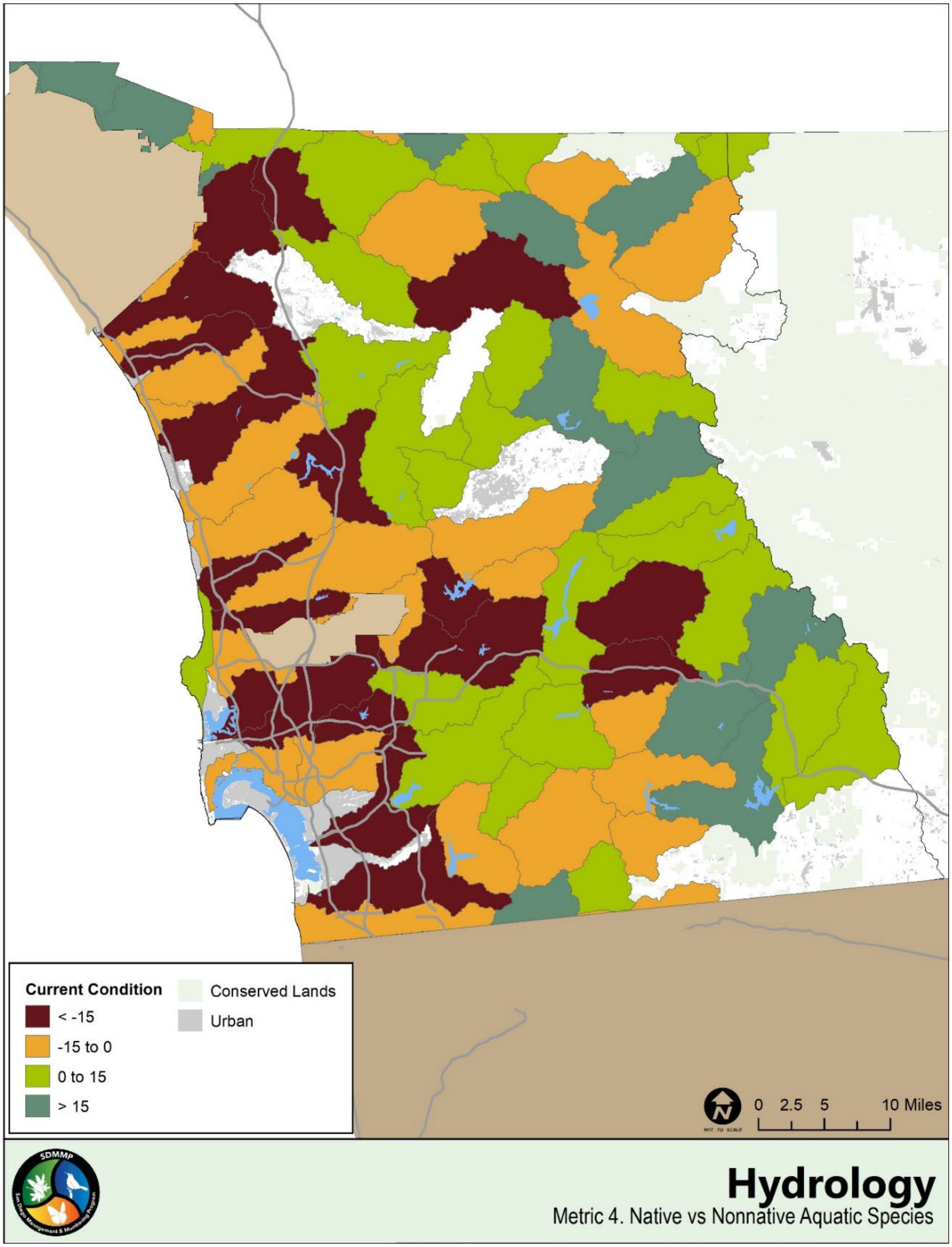


**Figure HYD4.2.** Current (2015-2020) native versus nonnative species score by HUC12 watershed. Higher scores represent more native species and fewer invasive species. Dark brown polygons represent HUC12 watersheds that are most impacted by IAS and fall within the Significant Concern condition category. Orange colored HUC12 watersheds are categorized as a condition of Concern, light green as Caution, and dark green as Good.

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## Connectivity - Ecosystem Processes and Landscape-scale Threats Indicator


### Why Is This Indicator Included?

The loss of connectivity is a major driver in the loss of biodiversity across southern California (Hilty and others 2006; Lacy 2000; Noss 1991; Barr and others 2015), including the MSPA. There are 27 species (17 plants, one amphibian, two reptiles, three birds, and four mammals) in the MSPA at risk from loss of connectivity and/or habitat fragmentation (SDMMP and TNC 2017). Connectivity is important for climate change adaptation (Jennings and Lewison 2013) and genetic diversity (Hilty and others 2006; Lacy 2000; Noss 1991; Barr and others 2015).

Connectivity is the degree to which the landscape facilitates or impedes movement of genes, individuals, propagules, or populations among resource patches (Taylor and others 1993; Hilty and others 2006). Maintaining connectivity between natural areas is essential to maintaining functional landscapes and evolutionary processes (for example, Noss 1987, 1991; Saunders and others 1991; Beier and Noss 1998). Connectivity is essential to promoting dispersal among habitat patches, maintaining gene flow, facilitating local adaptation, and promoting resilience to many threats, including fire, floods, disease, and climate change (Austin and others 2004; Anacker and others 2013).

Within the MSPA, roads and urban development have created barriers to species movement, especially for wide-ranging species that have large home ranges. Roads fragment habitat and create barriers that impede mobility and result in increased wildlife mortality (Jackson and Fahrig 2011). In addition, large wildfires in the last 20 years have resulted in loss of habitat and reduced connectivity for some species such as the coastal cactus wren (Barr and others 2015) and Hermes copper butterfly (Marschalek and others 2016). Fragmentation by anthropogenic or natural disturbances can result in genetic isolation, putting some species at risk of inbreeding and potential extirpation over the longer term (Trombulak and Frisell 2000; Van der Ree and others 2011). As habitat becomes fragmented, populations or subpopulations may become separated or even isolated in the remaining smaller habitat patches. Smaller populations are at greater risk of extirpation due to stochastic and anthropogenic events (Lacy 2000; Melbourne and Hastings 2008).

### Stressors

There are many stressors that decrease connectivity and/or compound the negative effects of loss of connectivity in the MSPA including fire, invasive plants, and human use of the preserve.

- **Fire:** Large wildfires can result in loss of habitat and reduced connectivity for some species, especially those that are sensitive to habitat fragmentation (Jennings and Lewison 2013).
- **Invasive Plants:** Invasive plants can degrade habitat and lead to fragmentation of otherwise connected habitat patches for rare species (Mullu 2016).
- **Human Use of Preserve:** Roads and urban development have created barriers to species movement, especially for wide-ranging species that need large patches of land. Roads fragment habitat and create barriers that impede mobility and result in increased wildlife mortality (Jackson and Fahrig 2011).

### Desired Condition

MSP Roadmap Goal (SDMMP and TNC 2017a):

*A connected landscape amongst core habitat areas within the MSPA and other regional conservation areas to: (1) Ensure the persistence of species across the preserve system and (2) Maintain ecosystem functions across the landscape.*

### Current Condition Status

Although large blocks of habitat have been conserved in the MSPA, the preserve system in western San Diego County is still being assembled, and gaps of unprotected habitat remain between existing Conserved Lands that, if developed, will result in the permanent fragmentation of core and linkage areas. In addition, major highways and arterial roads bisect Conserved Lands and create impediments to wildlife movement. In other areas, habitat degradation caused by nonnative, invasive plants or altered fire regimes has led to the fragmentation of otherwise connected habitat patches for rare species. On the coast, urban development and roads surround Conserved Lands, leaving narrow drainages that connect these otherwise isolated habitat patches.

Connectivity of the landscape has many facets that should be measured to understand fully the condition and trend. Currently, a large project is in progress to fully evaluate road crossings, infrastructure, and the effectiveness of linkages. These data were not available to include in this version of the report but will be included in the future. This indicator will be expanded to include several more metrics and analyses. At this point, a single metric is used as a starting point for further discussion.

The current overall condition status of the Connectivity Indicator is Significant Concern based on the percentage of linkage area conserved (table CONN0.1). Linkages considered important to maintain connectivity between core areas in the MSP have been identified by the MSP Roadmap (SDMMP and TNC 2017a). Currently, 14 percent of the identified linkage acreage has been conserved.

**Table CONN0.1:** Current overall condition status for the Connectivity Indicator and period of baseline to current year comparison for metric conditions, trends, and confidence levels.

| Indicator/metric (baseline-current year) | Condition | Trend | Confidence |
|---|---|---|---|
| Connectivity overall condition status | Significant Concern | Improving | Moderate |
| Metric 1: percent of linkage area conserved (1995-2020) | Significant Concern | Improving | Moderate |

## Metric 1: Percent of Linkage Area Conserved

**Overview:** The MSCP and MHCP first identified core and linkage areas to prioritize new conservation acquisition into large blocks of land or in the corridors between them (City of San Diego and others 1998; AMEC and others 2003). These were designed to connect large open space areas throughout each specific plan area but did not account for connections between plan areas or in areas where plans were still being developed (North County and East County). In 2017, SDMMP and The Nature Conservancy (TNC) (2017b) incorporated the original plan designs while expanding the core and linkage system to the entire MSPA and connecting MSCP and MHCP plan areas.

Some of the linkages included in the MSP Roadmap were not included in this metric because they consist of a single road crossing between cores, and it is not possible to conserve the land. These will be addressed in future editions of this report. For this metric, linkages between cores that consist of open space were considered (fig. CONN1.1).

Conservation of these areas was calculated using the 2020 Conserved Lands Database (SDMMP 2020). The percent conserved was calculated as the area of land conserved within the linkage divided by the total linkage area. Further descriptions of the linkage areas and how they were drawn is provided in the MSP Roadmap (SDMMP and TNC 2017a).

**Metric Evaluation Period: 1995-2020** (Baseline: 1995; Current: 2020)

**Baseline:** The baseline year was 1995 because it represents the baseline land conservation at the start of the plans. In 1995, 3,766 acres (7.1 percent) of the 52,863-acre linkage area was conserved.

**2027 Progress Towards Desired Condition:** There is no short-term project milestone in progress towards the desired condition, as this is dependent on each plan's requirements and timeline (associated with 2022-2026 MSP objectives).

### Condition Thresholds:

Condition thresholds are based on general targets for conservation. These may be refined further as more analysis is completed.

- **Good:** Conserved ≥75 percent of linkage area identified in the MSP Roadmap.
- **Caution:** Conserved between 50 percent and 74 percent of linkage area identified in the MSP Roadmap.
- **Concern:** Conserved between 25 percent and 49 percent of linkage area identified in the MSP Roadmap.
- **Significant Concern:** Conserved <25 percent of linkage area identified in the MSP Roadmap.

### Current Condition: Significant Concern

Across all linkages in 2020, 8,698 of 52,863 acres (16 percent) of linkage area had been conserved (fig. CONN1.1; SDMMP 2020). The current condition is Significant Concern.

### Trend (1995-2020): Improving

In 1995, only 7.1 percent of the linkage area was conserved. The linkage area conserved has increased by 130 percent (slightly more than doubled) in the last 25 years (fig. CONN1.2; SDMMP 2020). The trend is Improving.

### Confidence: Moderate

The confidence in data is Moderate as the linkage areas need to be refined based upon analyses from the ongoing linkage evaluation project.

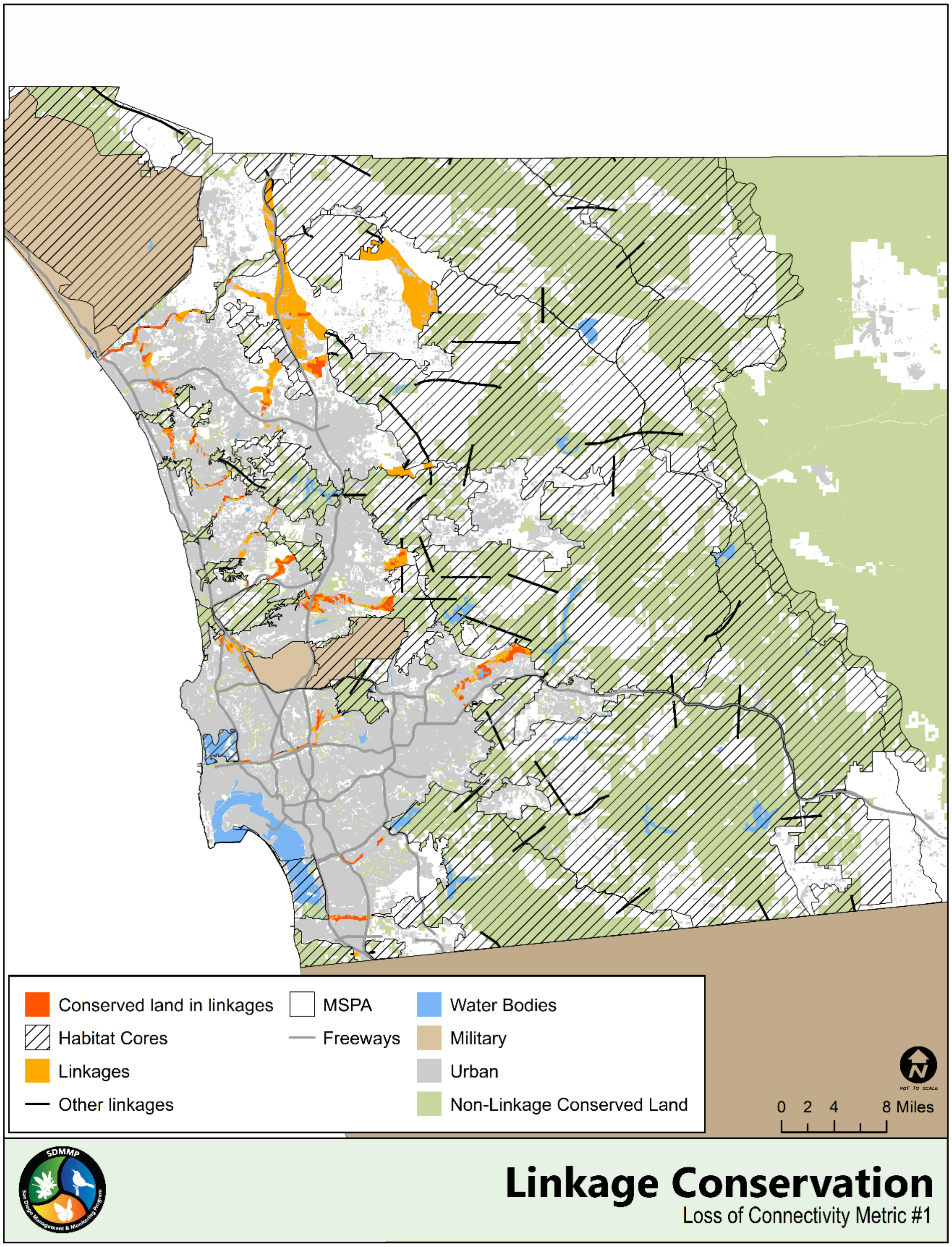


**Figure CONN1.1.** Map of conserved land within between-core linkage polygons in the MSPA. This map depicts polygon linkage areas for between-core linkages (SDMMP and TNC 2017b) with Conserved Lands within the linkage area showing in green.

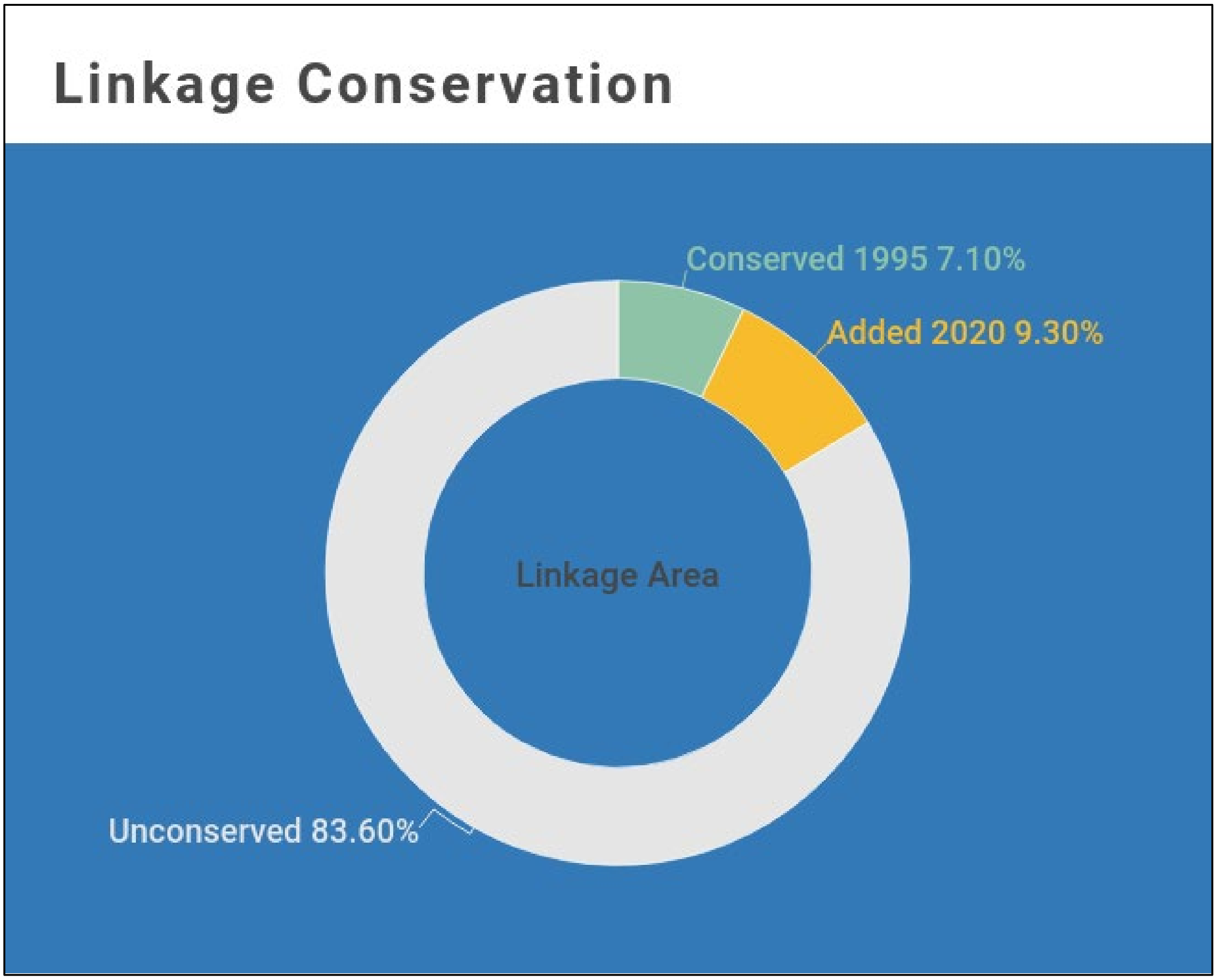


**Figure CONN1.2.** Graph of the change in Conserved Land in linkage areas from baseline (1995) to current (2020) time periods. This pie chart shows the entire acreage (52,863 acres) within the linkage areas and the percent of conserved area in 1995 (green), added between 1995 and 2020 (yellow), and unconserved in 2020 (grey).

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## Fire - Ecosystem Processes and Landscape-scale Threats Indicator


**Why Is This Indicator Included?**

Most of the species in southern California shrublands and forests are adapted to a natural fire regime; however, humans are altering the frequency of wildfires, which can have adverse effects on natural resources (Keeley 1991). Large, wind-driven fires have impacted large areas of habitat and pose a threat to the continued persistence of Covered Species. A longer fire season is predicted by the mid-21st century due to warmer, drier weather and Santa Ana wind conditions shifting into November and December (Miller and Schlegel 2006; Yue and others 2014). CSS and chaparral are the two dominant vegetation communities in the MSPA and are prone to wildfires, with plant species adapted to specific fire regimes (Barro and Conrad 1991; Keeley and others 2005).

Changes to the fire regime, such as fire frequency, can pose a threat to species persistence (Pausas and others 2004; Keeley 2005; Syphard and others 2007a; Keeley and others 2011). Anthropogenic disturbances to the natural fire regime can alter ecosystem processes and have a negative impact on even fire-adapted plant and animal species and natural communities. Southern California shrublands are susceptible to type conversion of shrublands to nonnative, invasive annual grassland through repeated fire (Minnich and Dezzani 1998; Keeley 2002; Keeley and Brennan 2012; Pausas and Keeley 2014a). Conversion of shrublands to nonnative grasslands has a positive feedback of increasing fire frequency due to the fine fuels that ignite easily and readily carry fire. Fire facilitates the rapid spread and widespread establishment of nonnative, invasive plants (Keeley and Brennan 2012).

An altered fire regime can be detrimental to endemic and other native species through habitat destruction, limitations to food availability, altered community structure, and direct mortality. Results of post-fire monitoring show that wildfires have a negative impact on small animals such as salamanders, small snakes, coastal cactus wrens, and coastal California gnatcatchers. For example, significant portions of Hermes copper butterfly habitat burned in 2003 and 2007, causing the loss of 13 populations and further restriction of the species range (Marschalek and Klein 2010).

Southern California's Mediterranean climate is characterized by a cool, wet growing season followed by a long, hot summer and fall with little rainfall. The region's climate, shrublands, and extensive Wildland-Urban Interface (WUI) make it one of the most fire hazardous areas within North America (Keeley 2002). There are two primary categories of wildfires in southern California: (1) fires occurring in the summer months under hot, dry conditions and associated with weak onshore winds and (2) fires that typically occur in the fall months and are driven by strong offshore Santa Ana winds (Jin and others 2014).

The current wildfire regime in southern California consists of many small fires with less frequent, but large, stand-replacing crown fires, usually associated with strong Santa Ana winds (Barro and Conrad 1991; Keeley and Fotheringham 2001; Peterson and others 2011). During the 20th century, fire return intervals averaged around 30–40 years, with high site variability (Keeley and Fotheringham 2001).

Fire is a natural part of shrubland and forest ecosystems in the Mediterranean climate region of southern California. In general, many plant species have evolved adaptations to fire that allow them to recover in place through soil seed banks and vegetative resprouting (Barro and Conrad 1991; Keeley and others 2005). In contrast, animal species may be more vulnerable to fire intensity and size, and if they do not survive within a fire perimeter, will need to recolonize from surrounding unburned areas (Van Mantgem and others 2015).

### Stressors

- **Climate Vulnerability:** Global climate change is predicted to increase the number and extent of fires in California. Modeling indicates that global climate change has the potential to double the area burned in southwestern California by 2046–2065 under a scenario of moderate growth in greenhouse gases (Yue and others 2014). A longer fire season is also predicted by the mid-21st century due to warmer, drier weather and Santa Ana wind conditions shifting into November and December (Miller and Schlegel 2006; Yue and others 2014). Large, intense fires have the potential to increase under global warming and a changing hydrological cycle (Bowman and others 2011).
- **Invasive Plants:** Southern California shrublands are susceptible to type conversion to nonnative, invasive annual grassland through repeated fire (Minnich and Dezzani 1998; Keeley 2002; Keeley and Brennan 2012; Pausas and Keeley 2014). Conversion of shrublands to nonnative grasslands has a positive feedback, increasing fire frequency because of fine fuels that ignite easily and readily carry fire.
- **Human Use of Preserve:** Anthropogenic factors associated with an altered fire regime include development in fire-prone areas creating extensive WUI (Syphard and others 2007a; Syphard and others 2007b; Moritz and others 2014); an increase in human-caused fire ignitions (Syphard and Keeley 2015); introduction of invasive, nonnative plants that alter flammability (Pausas and Keeley 2014); and a build-up of fuels in some areas due to fire suppression over past decades (Minnich 2001).

### Desired Condition

MSP Roadmap Goal (SDMMP and TNC 2017):

*To maintain the long-term ecological integrity and viability of ecosystems, MSP species, and vegetation communities on Conserved Lands by managing the current human altered fire regime to promote a more natural fire regime with lower fire frequency and reduced impacts (direct and indirect) to natural resources.*

### Current Condition Status

Establishing a baseline for fire frequency is not straightforward. Humans have been influencing the natural fire regime for thousands of years. Fire perimeter records have only been kept since 1878 and are not reflective of pre-European fire conditions. Pre-European values are also not likely to be useful or realistic targets. Ideally, a goal for fire frequency would be based on how much fire the landscape can tolerate before there is degradation or permanent change. Analysis of these values is in progress and will be available in future reports. Thresholds and baseline values may change as new information becomes available. This report utilized the long-term fire record and the available data to choose targets and thresholds for the metrics.

The historical fire record was graphed using overlapping 30-year intervals (fig. FIRE1.1). Starting in 1909 until the period ending in 1999, there was an average of 331,569 acres burned in a 30-year period (not restricted to Conserved Lands) with a standard deviation of 47,000 acres. The two most-recent 30-year periods (1979-2009 and 1989-2019) had a significant increase in the total acreage burned to average of 887,583 acres, well outside of two standard deviations from the mean for historical data. Because vegetation mapping data are available in 1995 and that year falls within the range of fires in the period of record, the time period 1969-1999 was chosen as baseline for all three Fire Indictor metrics and other vegetation-specific fire metrics (Chaparral Metric 3 and CSS Metric 3). The current status uses the most recent data available (1989-2019). Metric values were restricted to the regional preserve system.

From 1989 to 2019 (current period), 476,273 acres of Conserved Lands burned at least once. This is 36 percent of total Conserved Lands. In 2019, 9 percent of Conserved Lands burned two or more times since 1989, compared to 1989 when only 2 percent of Conserved Lands burned two or more times. Two percent of Conserved Lands have burned three or more times in last 30 years, above the baseline from recorded fire history.

The current overall condition status of the Fire Indicator is Significant Concern based on consideration of the three metric condition values (table FIRE0.1). All three metrics fell into the Significant Concern category because there has been a significant increase in the area of land burned (Metric 1) and the frequency of burns (Metrics 2 and 3). All metrics are moving away from the desired condition and baseline values and therefore were given a trend of Declining. The confidence for all metrics is High because they use high-quality, established data sets. Additional metrics will be added as more information becomes available.

**Table FIRE0.1:** Current overall condition status for the Fire Indicator and period of baseline to current year comparison for metric conditions, trends, and confidence levels.

| Indicator/metric (baseline – current year) | Condition | Trend | Confidence |
|---|---|---|---|
| Fire overall condition status | Significant Concern | Declining | High |
| Metric 1: percent of Conserved Lands burned at least once (1969-2019) | Significant Concern | Declining | High |
| Metric 2: percent of Conserved Lands burned two or more times (1969-2019) | Significant Concern | Declining | High |
| Metric 3: percent of Conserved Lands burned three or more times (1959-2019) | Significant Concern | Declining | High |

## Metric 1: Percent of Conserved Lands Burned At Least Once

**Overview:** This metric measures the percentage of conserved lands burned at least once in the last 30 years. These lands may need additional management or monitoring to ensure that conditions recover to their natural state and changes are not permanent.

**Metric Evaluation Period:** 1969-2019 (Baseline: 1969-1999; Current: 1989-2019)

**Baseline:** Baseline values for goals and condition thresholds were taken from the percent of Conserved Land burned in the 30-year period from 1969-1999. An explanation for the reasoning behind this baseline is included above. The acreage burned in the chosen baseline period (1969-1999) falls within one standard deviation of the average (fig. FIRE1.1) and is below the maximum value for the historical record (maximum is 381,731 acres burned between 1939 and 1969). Because a vegetation map was created in 1995, 1969-1999 is a good baseline to represent the known historical fire history in San Diego County and has reliable associated vegetation map and Conserved Lands data.

In the two most recent 30-year periods (1979-2009 and 1989-2019), the average area burned has increased by over 556,000 acres to 887,583 acres. The recent increase in area burned is due, in large part, to the 2003 and 2007 fire seasons, which both had extraordinarily large areas burned during Santa Ana wind events. However, the area burned in the last 10 years has increased even more compared to the historical average, even in the absence of extreme fire events.

**2027 Progress Towards Desired Condition:** There is no short-term project milestone in progress towards the desired condition, as this is dependent on each plan's requirements and timeline.

### Condition Thresholds:

Condition thresholds were based on baseline values of the percent of Conserved Lands burned from 1969-1999. A Good condition would meet baseline values. Threshold values will be further refined, if necessary, as more analysis becomes available.

- **Good:** ≤13 percent of Conserved Lands burned at least once in the last 30 years.

- **Caution:** >13 percent and ≤20 percent of Conserved Lands burned at least once in the last 30 years.
- **Concern:** >20 percent and ≤30 percent of Conserved Lands burned at least once in the last 30 years.
- **Significant Concern:** >30 percent of Conserved Lands burned at least once in the last 30 years.

### Current Condition: Significant Concern

In the current period (1989-2019), 476,273 acres of Conserved Lands burned at least once. This is 36 percent of the total Conserved Lands (fig. FIRE1.2; CalFire 2019; SDMMP 2020).

### Trend (1969-2019): Declining

In the baseline period (1969-1999), 159,908 acres burned, which was 13 percent of the Conserved Lands. The number of acres burned increased by 475 percent over the time period used to evaluate the current condition (1989-2019), which represents a Declining trend (moving away from the desired condition) from the baseline period (fig. FIRE1.3; CalFire 2019; SDMMP 2020).

### Confidence: High

Metric uses well-established data sources.

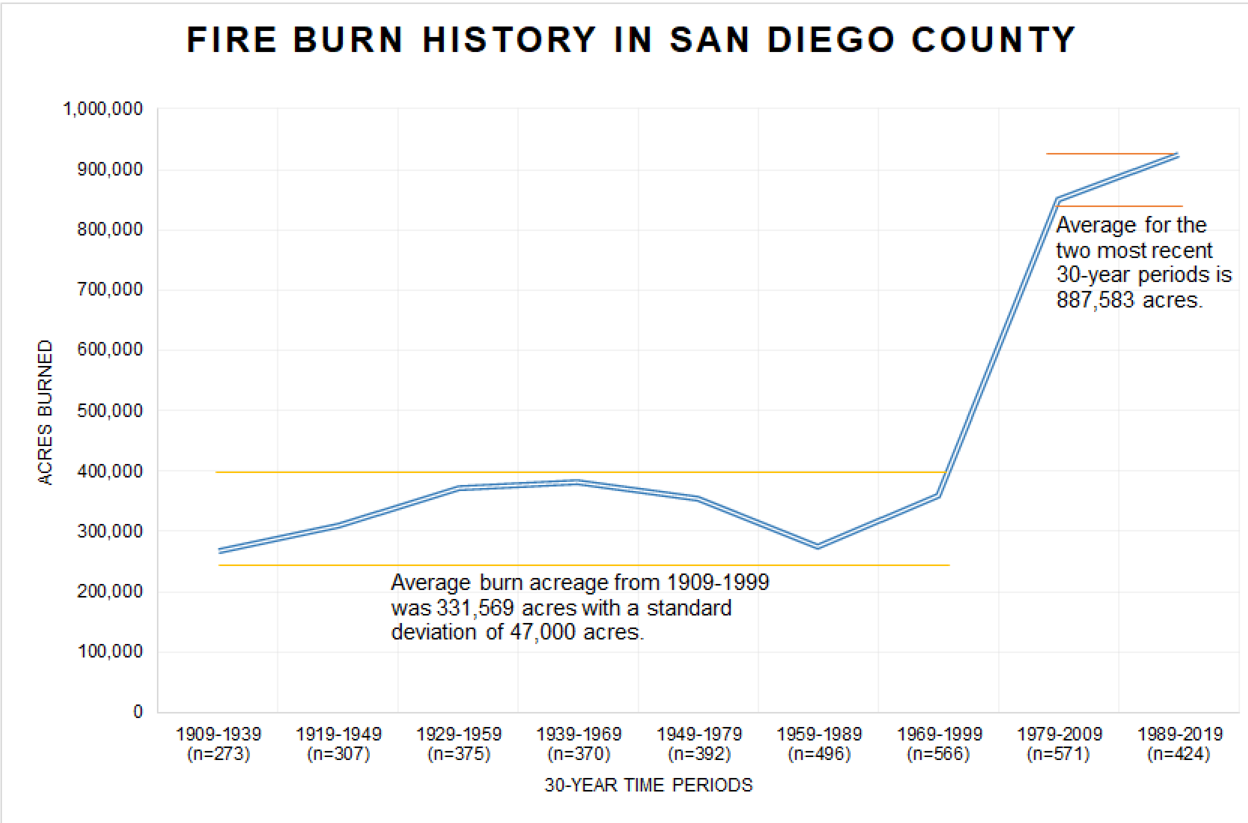


**Figure FIRE1.1.** Acres burned >1 time in 30-year periods for recorded fire history from 1909-2019. CalFire fire perimeters were used to calculate total acres burned in San Diego County for overlapping 30-year periods starting in 1909. A large increase in area burned occurred in 1979-2009 and 1989-2019, largely due to 2003 and 2007 fire seasons.

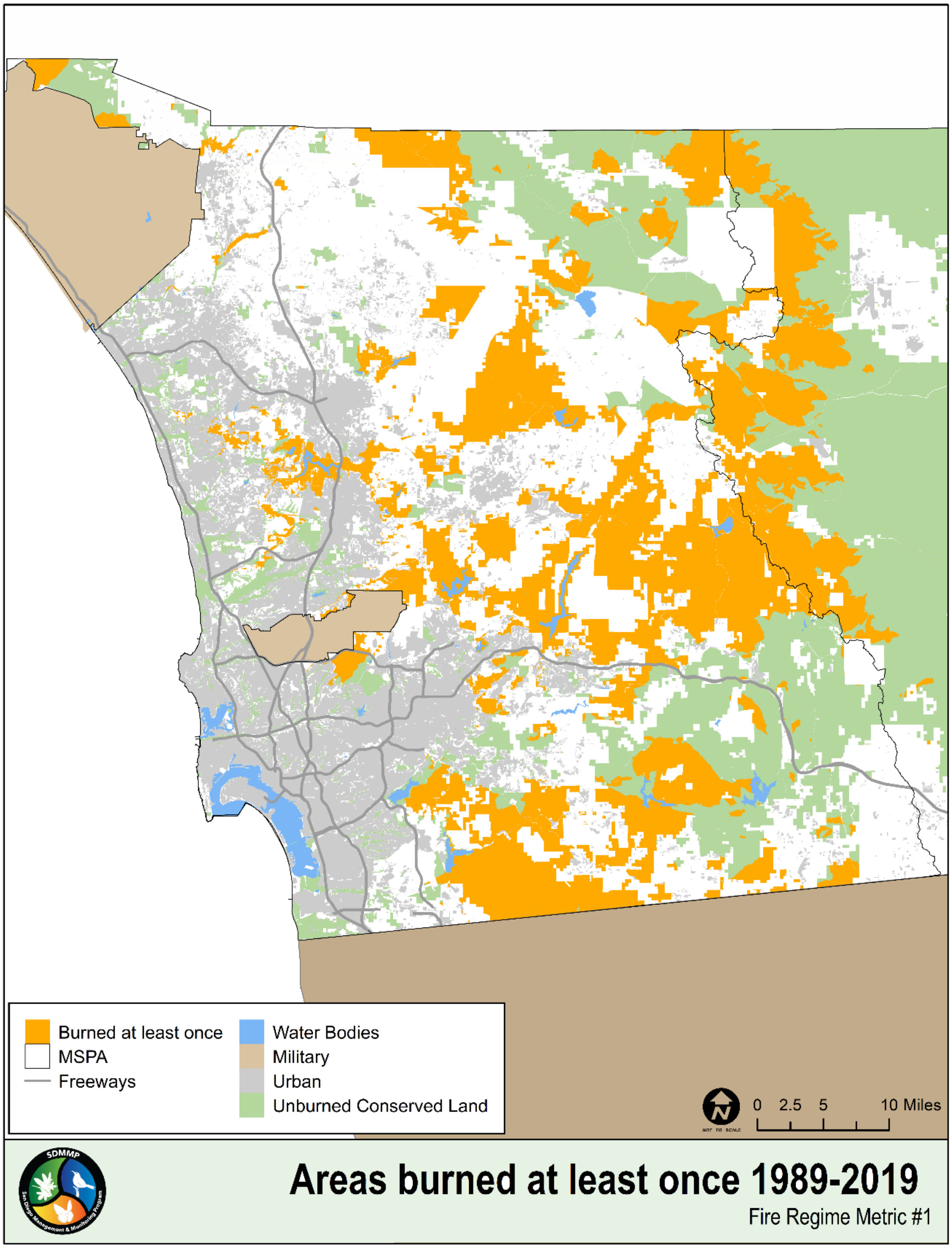


**Figure FIRE1.2** Map of areas burned at least once in the last 30 years (1989-2019)

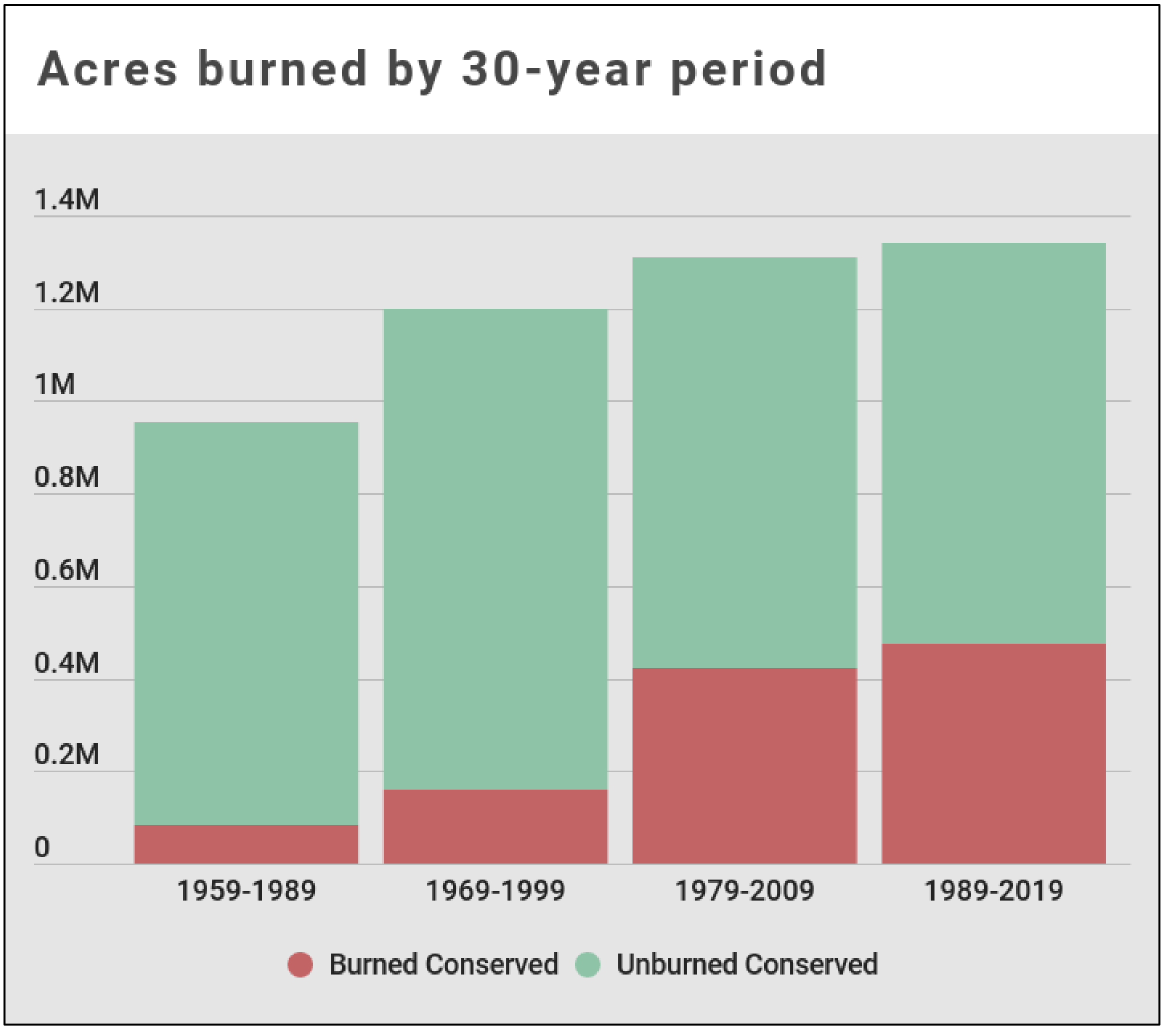


**Figure FIRE1.3:** Graph of the total number of acres burned for conserved and unconserved lands for 30-year time periods from 1959 to 2019.

## Metric 2: Percent of Conserved Lands burned two or more times

**Overview:** Frequent repeated burns can lead to type conversion as shrubs do not have sufficient time to recover while grasses invade the bare ground exposed by fire (Minnich and Dezzani 1998; Keeley 2002; Keeley and Brennan 2012; Pausas and Keeley 2014). Areas that have burned multiple times in the last 30 years may be more susceptible to these changes and are considered in early succession. Different vegetation communities have evolved with different fire regimes, and some may be more resilient to shorter fire return intervals. Individual metrics for chaparral and CSS are calculated in the vegetation community sections to account for these differences (see Chaparral Metric 3 and CSS Metric 3).

**Metric Evaluation Period:** 1969-2019 (Baseline: 1969-1999; Current: 1989-2019)

**Baseline:** From 1909 to 1989, the amount of land burned two or more times in a 30-year period ranged from 57,000 acres to 92,000 acres (fig. FIRE2.1). The number of acres burned two or more times began to rise in the 30-year period from 1969 to 1999 with an additional large increase starting in 1979. In the baseline period (1969-1999), 4.5 percent of Conserved Lands burned ≥2 times.

**2027 Progress Towards Desired Condition:** There is no short-term project milestone in progress towards the desired condition, as this is dependent on each plan's requirements and timeline.

### Condition Thresholds:

Thresholds were determined by baseline values. From 1969-1999, 4.5 percent (54,889 acres) of Conserved Lands burned two or more times. A Good condition would meet the baseline period of 1969-1999.

- **Good:** ≤4.5 percent of Conserved Lands burned ≥2 times in the last 30 years.
- **Caution:** >4.5 percent and ≤5.5 percent of Conserved Lands ≥2 times in the last 30 years.
- **Concern:** >5.5 percent and <7.5 percent of Conserved Lands burned ≥2 times in the last 30 years.
- **Significant Concern:** ≥7.5 percent of Conserved Lands burned ≥2 times in the last 30 years.

### Current Condition: Significant Concern

In the current period, 119,068 acres (9 percent) of Conserved Lands had burned ≥2 times in the last 30 years (fig. FIRE2.2; CalFire 2019; SDMMP 2020). The two most recent 30-year periods (1979-2009 and 1989-2019) had an average of over 210,000 acres burned two or more times.

### Trend (1969-2019): Declining

In the baseline period (1969-1999), 54,889 acres (4.5 percent) of conserved land burned two or more times. Compared to the baseline period, in the current period (1989-2019) there was an 866 percent increase in acres of Conserved Land burned two or more times, which represents a Declining trend (moving away from the desired conditions) from the baseline period (fig. FIRE2.3; CalFire 2019; SDMMP 2020).

### Confidence: High

Data include CalFire Fire Perimeters and the Conserved Lands Database.

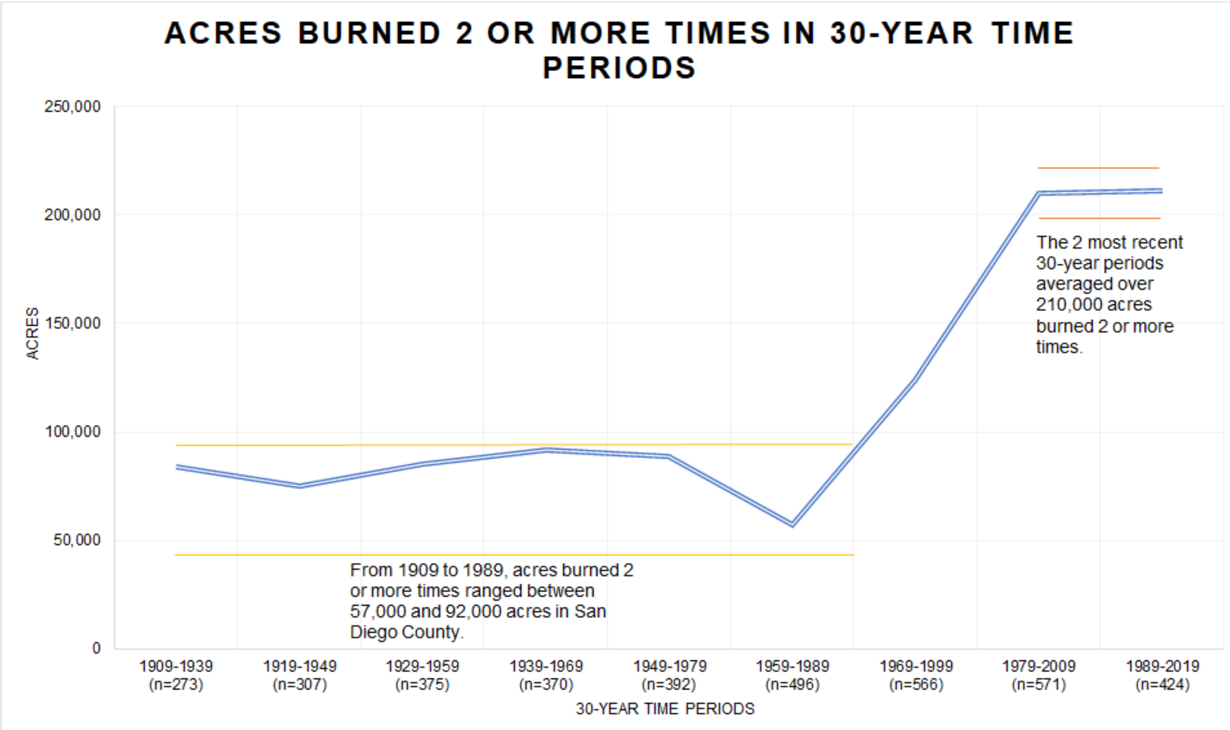


**Figure FIRE2.1:** Fire history of acres burned in San Diego County two or more times in overlapping 30-year periods from 1909 to 2019.

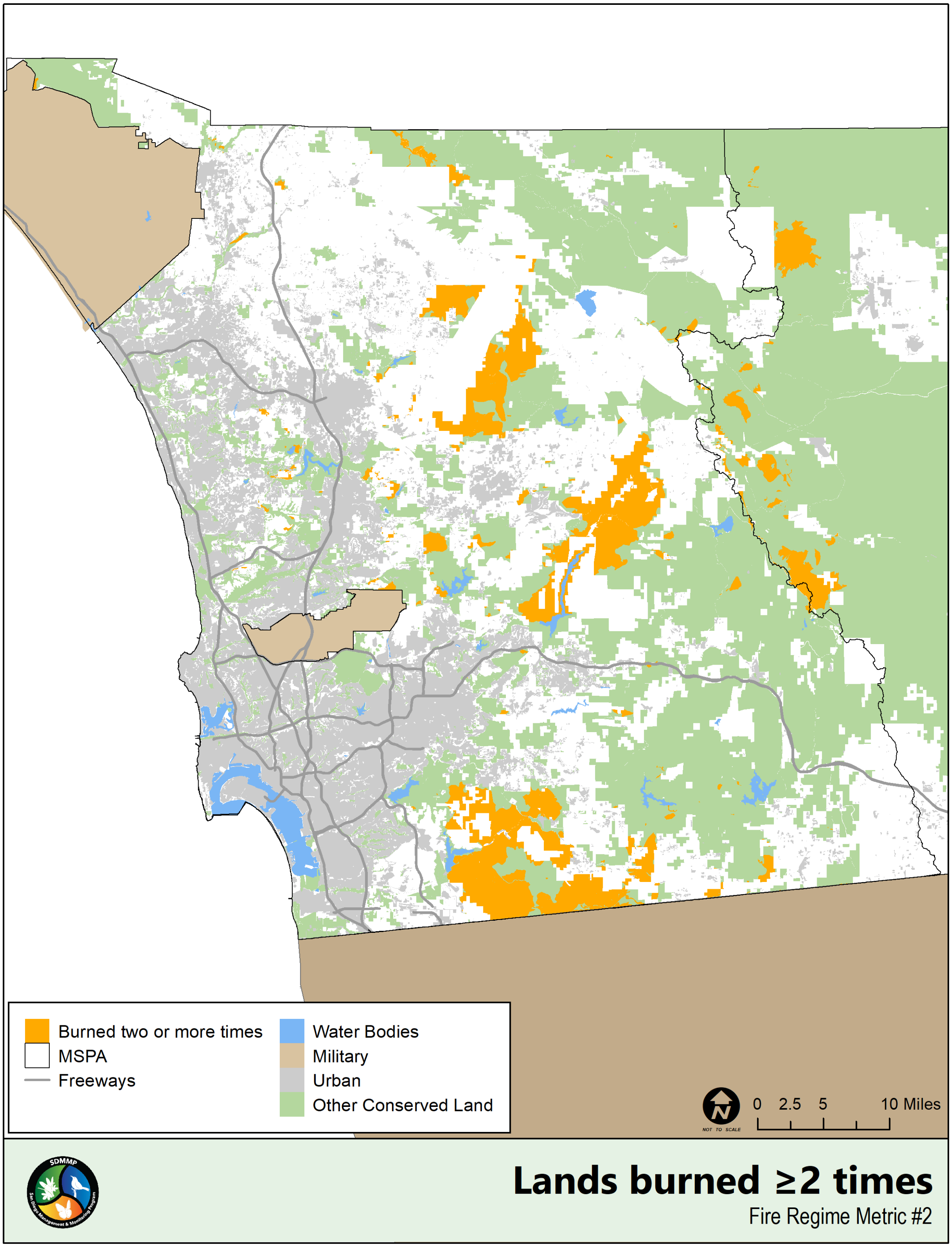


**Figure FIRE2.2:** Conserved Lands that have burned two or more times in the last 30 years.

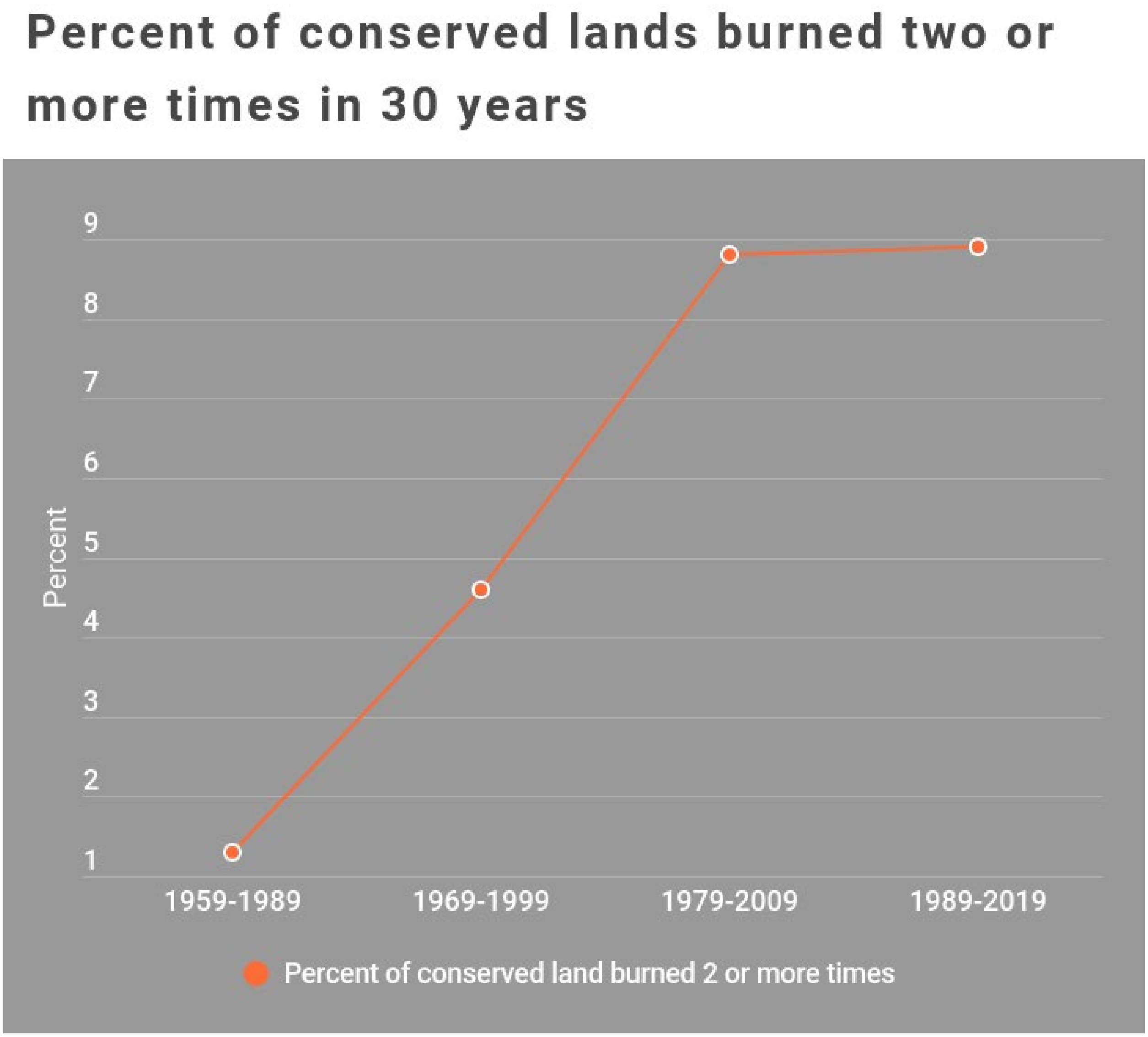


**Figure FIRE2.3:** Acres of Conserved Lands burned in overlapping 30-year periods from 1959-2019.

## Metric 3: Percent of Conserved Lands Burned Three or More Times

**Overview:** Natural lands that have a high frequency of fire are at a high risk of type conversion. Lands burned three or more times in the last 30 years are of particular concern. While a relatively small area of Conserved Lands has been affected by this many fires, the increase in repeated burns indicates a significant change in the fire landscape and threats to Conserved Lands.

**Metric Evaluation Period: 1959-2019** (Baseline: 1959-1989; Current: 1989-2019)

**Baseline:** Between 1959-1989, 1,017 acres burned three or more times while from 1969-1999, 17,562 acres burned three or more times. A baseline period of 1959-1989 is used for this metric.

From 1959 to 1989, about 0.1 percent of Conserved Lands burned three or more times, only 13 acres burned four times, and no land burned more than four times.

**2027 Progress Towards Desired Condition:** There is no short-term project milestone in progress towards the desired condition, as this is dependent on each plan's requirements and timeline.

### Condition Thresholds:

Condition thresholds were chosen based on the baseline period of 1959-1989. A Good condition would meet baseline conditions. Thresholds will be refined as more information becomes available.

- **Good:** ≤0.1 percent of Conserved Lands burned three or more times in the last 30 years.
- **Caution:** >0.1 percent and <0.5 percent of Conserved Lands burned three or more times in the last 30 years.
- **Concern:** >0.5 percent and ≤1 percent of Conserved Lands burned three or more times in the last 30 years.
- **Significant Concern:** >1 percent of Conserved Lands burned three or more times in the last 30 years.

### Current Condition: Significant Concern

In the current period (1989-2019), 1.6 percent of Conserved Lands had burned three or more times in the last 30 years, with over 3,000 acres burned four times, and over 300 acres burned five or six times (fig. FIRE3.1; CalFire 2019; SDMMP 2020).

### Trend (1959-2019): Declining

In the baseline period (1959-1989), 0.1 percent of Conserved Lands burned three or more times. Compared to the baseline period, in the current period (1989-2019), there had been a 1500 percent increase in acres of Conserved Lands burned three or more times (fig. FIRE3.2; CalFire 2019; SDMMP 2020). The trend is Declining (moving away from the desired condition) from the baseline period.

### Confidence: High

Data includes CalFire Fire Perimeters and the Conserved Lands Database.

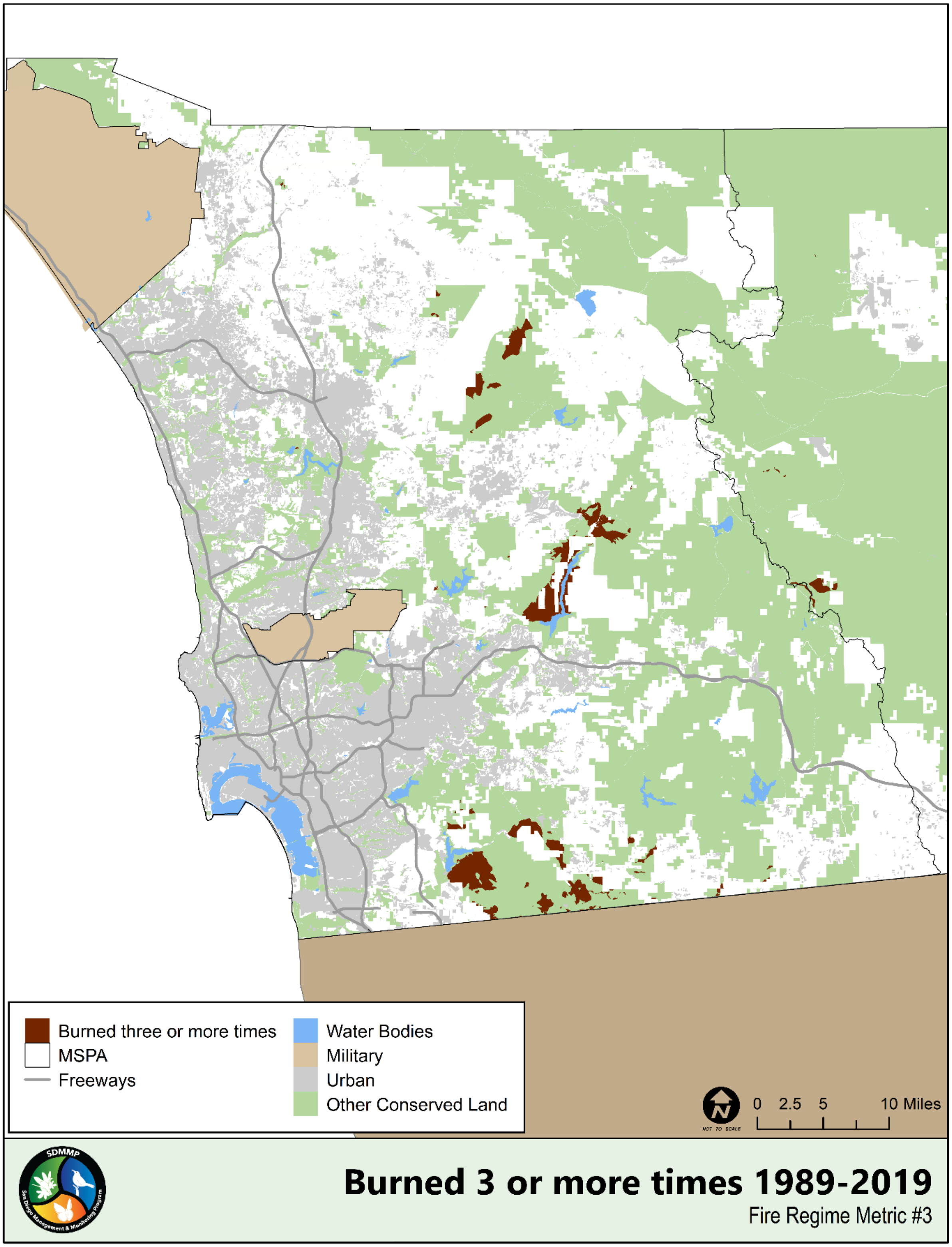


**Figure FIRE3.1:** Map of Conserved Lands in San Diego County that burned three or more times in the last 30 years (1989-2019).

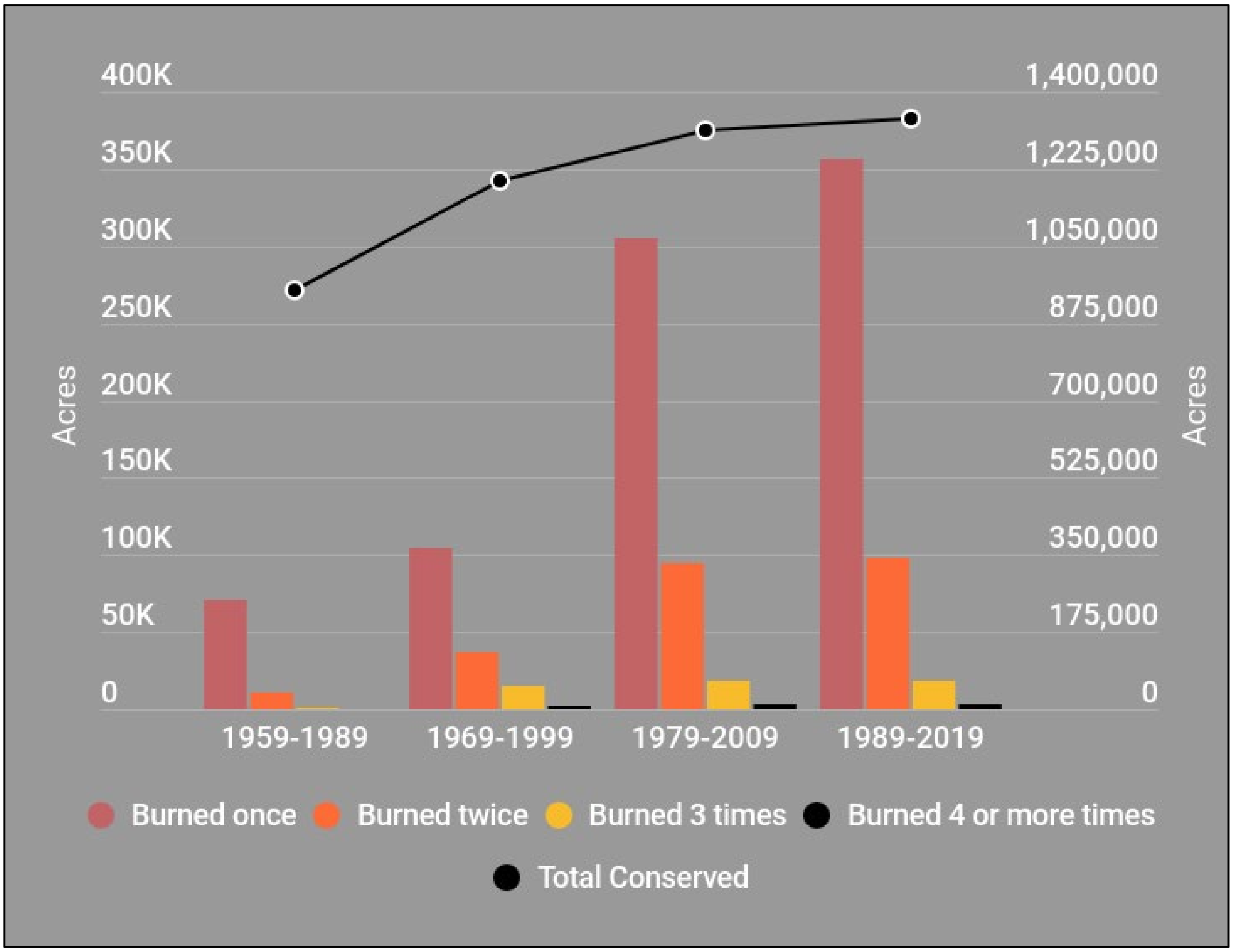


**Figure FIRE3.2** Acres burned one, two, three, and four or more times in overlapping 30-year periods from 1959 to 2019.

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## Invasive Nonnative Plants - Ecosystem and Landscape-scale Threats Indicator


### Why Is This Indicator Included?

Invasive, nonnative plants are plants from other areas that have invaded and naturalized or have the potential to naturalize and negatively impact the native community. Invasive, nonnative plants impact local rare, threatened, and endangered plant and animal species in San Diego County, as well as the habitat and vegetation communities upon which many species rely (SDMMP and TNC 2017). Invasive, nonnative plants can affect native habitats through direct competition for resources, such as sunlight, moisture, nutrients, and space. They can decrease species diversity, degrade water quality, increase soil erosion, and more (D'Antonio and Meyerson 2002; Pejchar and Mooney 2009; Vila and others 2011; Vitousek and others 1997).

Additionally, invasive, nonnative plants also contribute to vegetation type conversion. With short fire-return intervals, invasive herbaceous species may be favored and convert woody shrub vegetation to grassland (Syphard and others 2019). In large areas where introduced annual grasses and forbs dominate, they can convert vegetation types, such as CSS and native grassland, to nonnative grassland. Of the 111 MSP species for in San Diego County, 63 are threatened by nonnative, invasive plants, including 42 rare plant species that have specific invasive plant management and monitoring objectives (SDMMP and TNC 2017). Invasive, nonnative plants not only threaten local plants and animals but are a threat to humans through their contribution to fire ignition and spread.

*"Invasive plants often increase the frequency of fires by providing more continuous fuels that are easier to ignite. After fires, these weedy invaders typically reestablish more rapidly than native plants, suppressing the recovery of the natives and allowing the weeds to expand their range"* (Bell and others 2009).

The dense growth of nonnative, invasive plants, like Arundo/giant reed, increases the amount of biomass available as fuel for fires. Nonnative, annual grasses increase fire spread by providing continuous fuel for the fire. Unlike native grasses, these grasses complete their lifecycle before summer, leaving large amounts of dried material that can fuel fires throughout the summer and fall fire season (Bell and others 2009).

The biological monitoring plan for the MSCP defines invasive, nonnative species as aggressive or noxious weed species that are growing or spreading rapidly, outcompeting native species, and are difficult to control (Ogden Environmental and Energy Services Co. 1997).

Over time, introduced annual grasses and forbs have become well established in the landscape, often intermixed with native perennial grasses and forbs. With increased globalization, exotic plants continue to be accidentally or intentionally introduced into native environments (SDMMP and TNC 2017).

Invasive, nonnative plants can negatively impact soils, hydrological regimes, and native species, as well as increase erosion and fire spread. Invasive, nonnative species respond to ecosystem modifications at a landscape level. These modifications include removal of native species for development, changes in impervious surfaces and hydrological systems, nitrogen deposition, global climate change, and other disturbances that land managers cannot control (CBI and others 2012). As an alien species with different growth patterns and without many natural consumers, it is often easy for nonnative, invasive plants to outcompete native vegetation (SDMMP and TNC 2017).

### Stressors

- **Human Use of Preserve:** Human uses contribute to the spread of invasive plants on preserves. Visiting humans can bring in invasive seeds on their shoes, car tires, bike tires, and more.
- **Hydrology:** Invasive, nonnative plants contribute to and benefit from altered hydrology. Invasive, nonnative plants like Arundo/giant reed and tamarisk can alter "geomorphology, groundwater availability, soil chemistry, fire frequency, plant community composition, and native wildlife diversity" (Lovich 2000).
- **Fire:** Invasive, nonnative plants contribute to and benefit from an altered fire regime. Invasive, nonnative plants often increase the frequency of fires by providing more "flashy" and continuous fuels that are easier to ignite. After a disturbance like fire, the nonnative, invasive plants often reestablish more rapidly than native plants. The biomass and litter that nonnative, invasive plants leave behind, for example, from pampas grass (*Cortaderia* spp.), tamarisk, and Arundo/giant reed, increase the fuel supply and fire potential (Bell and others 2009).

## Desired Condition

MSP Roadmap Goal (SDMMP and TNC 2017):

*Reduce the cover/acreage of nonnative, invasive plants and eradicate species, when possible. This will be achieved by: (1) Protecting Conserved Lands from new or expanding nonnative, invasive plant species, (2) Detecting new nonnative, invasive species and new invasions early on and controlling them before the plants have a chance to establish, and (3) Addressing nonnative, invasive species using the response appropriate for the level of invasiveness (level 1 through 5) as defined in the "Management Priorities for Invasive Non-native Plants: A Strategy for Regional Implementation, San Diego County" (Invasive Plant Strategic Plan (IPSP); CBI and others 2012).*

## Current Condition Status

Through accidental or intentional introductions, the number of invasive, nonnative species in San Diego has increased over the years, each with its own risk to native species. In 2012, CBI, Cal-IPC, and Dendra, Inc. created the IPSP. This was the result of a multi-step process in which they identified 253 invasive, nonnative plant species in western San Diego and then narrowed the list down to 29 species to be considered for near-term management and monitoring as part of the IPSP. In the plan, nonnative, invasive plants were assessed and ranked by their prevalence and harmfulness (CBI and others 2012).

Since 2015, using information from the IPSP, the *TransNet* Environmental Mitigation Program (EMP)-funded Regional Invasive Plant Management Early Detection Rapid Response Program (Regional EDRR Program) has surveyed, treated, and monitored 25 invasive, nonnative plant species on Conserved Lands in San Diego County. Work for the Regional EDRR Program is supported by SANDAG (through funding to San Diego County Agriculture, Weights, and Measures) to treat high priority invasive, nonnative plant occurrences throughout San Diego County. Prior to 2015, invasive, nonnative plants were primarily treated by the preserve or land managers. The first year of the Regional EDRR Program, 10 invasive, nonnative plant species were managed. This management included surveying, monitoring, or treatment (manual or herbicide). Six years later, there are now 21 species targeted by the program. In 2021, 18 of those species are currently receiving some form of treatment for control (Dendra, Inc. 2014, 2015a-d, 2016a-d, 2017a-c, 2018a-d, 2019a-d, 2020a-d).

In addition to the EDRR program, 44 *TransNet* EMP Land Management Grants (LMG) have targeted 89 different plant species since 2006. Figure INVPL0.1 shows the number of grants targeting the top 18 invasive, nonnative plant species treated by LMGs.

In San Diego, the invasive, nonnative plant threat can be grouped into two categories: ubiquitous species that have, in some cases, become naturalized (for example, *Brachypodium distachyon,* purple false brome) and novel species that have the potential to be eradicated. The 29 invasive, nonnative plant species evaluated in the IPSP were placed into five management levels based on: species distribution and abundance in western San Diego County; geographic scale of coordinated implementation (region, watershed, management unit, reserve, or site); management feasibility (costs, impacts, and likelihood of success); and current management status for the species.

Regional surveillance is recommended for Level 1 species not currently present in the County. Eradication with a regionally coordinated control program is recommended for Level 2 species with a limited distribution and a few individuals or populations. Containment by management unit or watershed through coordinated eradication programs is recommended for Level 3 species due to their variable distribution. Directed management and control within the preserve or sub-management unit is recommended for Level 4 species due to their wide and abundant distribution. Directed suppression, typically to allow recovery of a disturbed site, is recommended for Level 5 species due to their wide and abundant distribution.

The current overall condition status for the Invasive Nonnative Plants Indicator in the MSPA is rated as Concern based on consideration of three metrics: number of invasive, nonnative plant species eradicated (Metric 1), number of sites eradicated (Metric 2), and number of sites treated (Metric 3). The confidence for each of the three metrics is High as there are ample data from the EDRR program; however, the overall confidence is Moderate. This is due to the lack of data on invasive removal work conducted by individual land managers outside of the EDRR program. In the future, it is anticipated that there will be additional tracking of invasive, nonnative plant removal from Conserved Lands that are not part of the Regional EDRR Program. As more information becomes available, future reports will include additional metrics evaluating the threat from invasive, nonnative plants and management prioritization based on threat risk.

**Table INVPL0.1:** Current overall condition status for the Invasive Nonnative Plants Indicator and period of baseline to current year comparison for metric conditions, trends, and confidence levels.

| Indicator/metric (baseline – current year) | Condition | Trend | Confidence |
|---|---|---|---|
| Invasive nonnative plants overall Status | Concern | Improving | Moderate |
| Metric 1: number of species eradicated (2015-2020) | Significant Concern | No Change | High |
| Metric 2: number of sites eradicated (2015-2020) | Concern | Improving | High |
| Metric 3: number of sites treated (2015-2020) | Caution | Improving | High |

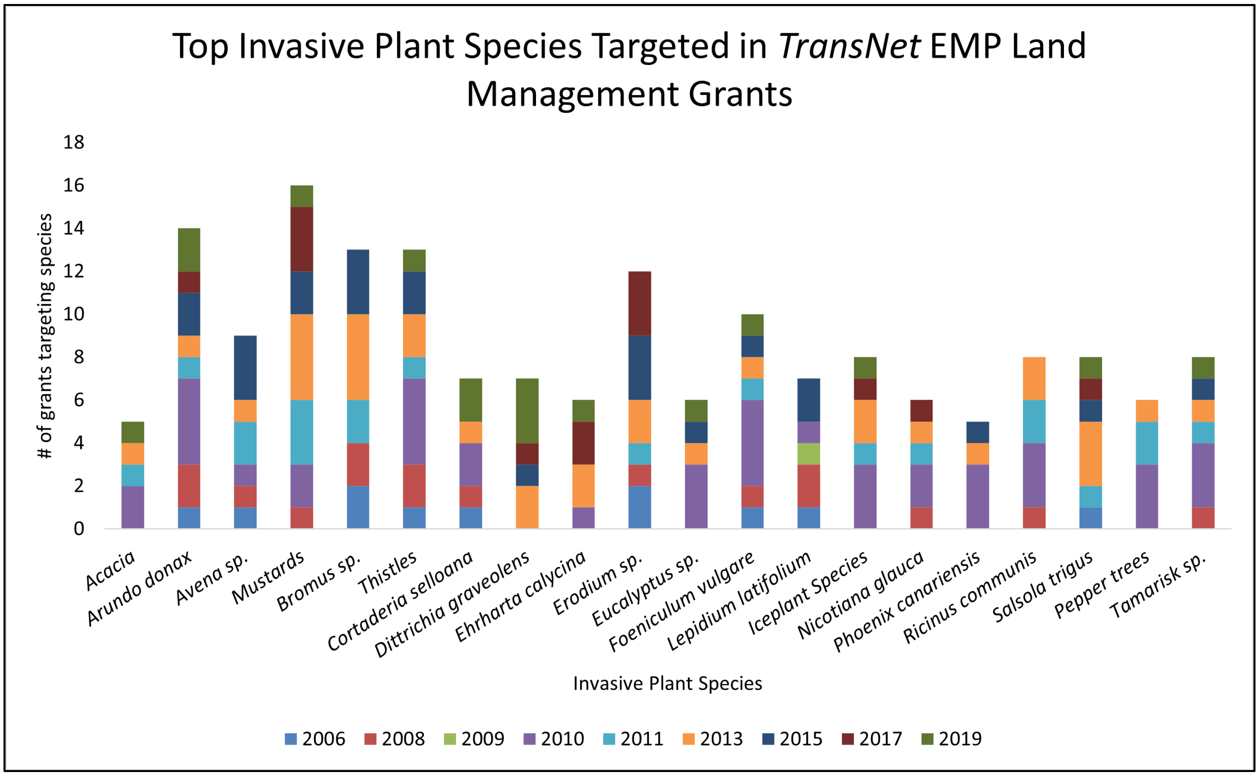


**Figure INVPL0.1.** Top Invasive, Nonnative Plant Species Targeted in *TransNet* EMP Land Management Grants.

The most frequently treated nonnative, invasive plant species using LMG funding. Some species are grouped to the genus level (for example, *Avena*, *Bromus*, *Erodium*). The graph shows the number of grants for each year that target that species.

## Metric 1: Number of Species Eradicated

**Overview:** The Regional EDRR Program targets Level 1 and 2 invasive, nonnative plant species for eradication. A five-step process is followed for species targeted by the Regional EDRR Program: 1) identify the species; 2) review the site conditions, such as soil texture, slope, standing water, irrigation, or storm drains; 3) identify and avoid any streamside management areas and surface waters to prevent drift and application of pesticides not labeled for aquatic use onto surface waters; 4) identify the most appropriate method of control based on integrated pest management methods, designed to minimize the scale and number of pesticide applications; and 5) apply the least persistent and least toxic pesticide to effectively mitigate the target pest.

Even with these efforts, eradication is a difficult task for pervasive and resilient invasive, nonnative plant species. Additionally, eradication is difficult because all populations of the plant may not be known, and some populations may exist on private property without access. While the total eradication of a species from the County is a very difficult task and a long-term effort, there are a few invasive, nonnative plant species where eradication may be possible.

Treatment and eradication goals assume ongoing funding by SANDAG, California Department of Food and Agriculture (CDFA), and others.

**Metric Evaluation Period:** 2015-2020 (Baseline: 2015; Current: 2020)

**Baseline:** Historically, one invasive, nonnative plant species, Scotch broom (*Cytisus scoparius*) has been reported as eradicated from the County (J. Geissow, pers. comm). While the Regional EDRR Program has not eradicated any species yet, the focused control effort has eradicated 12 species from 23 treatment sites in the MSPA. As those efforts continue and biosecurity efforts remain vigilant, EDRR crews will move closer toward eradicating invasive, nonnative plant species from the County. Figure INVPL1.1 shows the top 13 species receiving treatment from the Regional EDRR Program.

**2027 Progress Towards Desired Condition:** Eradicate five invasive, nonnative plant species from the western San Diego County (barbed goat grass [*Aegilops triuncialis*], leafy spurge [*Euphorbia virgata*], boneseed [*Osteospermum monilifera*], rattlebox [*Sesbania punicea*], and desert knapweed [*Volutaria tubuliflora*]) for a total of six species (with Scotch broom) eradicated. This is achievable with persistent effort, as well as treatment on non-Conserved Lands (associated with 2022-2026 MSP objectives).

### Condition Thresholds:

Condition thresholds were chosen based on the 5 years of treatment and mapping data collected by Dendra, Inc., the Regional EDRR Program lead. The feasibility of eradicating certain invasive, nonnative plant species was determined by Dendra, Inc. based on planned future efforts for the Regional EDRR Program.

- **Good:** 10 or more invasive, nonnative plant species eradicated in the MSPA.
- **Caution:** 6-9 invasive, nonnative plant species eradicated in the MSPA.
- **Concern:** 4-5 invasive, nonnative plant species eradicated in the MSPA.
- **Significant Concern:** <4 invasive, nonnative plant species eradicated in the MSPA.

### Current Condition: Significant Concern

In the current period (2020), one of 10 known EDRR invasive, nonnative plant species had been eradicated from the MSPA.

### Trend (2015-2020): No Change

Each year new invasive, nonnative plant sites are treated. Additionally, many sites require and receive follow up, repeated treatment. The Regional EDRR Program continues to work towards eradicating specific invasive, nonnative plants from specific sites, and eventually, from the MSPA. No new species have been eradicated since the historic eradication of Scotch broom.

### Confidence: High

Data for sites eradicated were sourced from Dendra, Inc. and describe the treatment and eradication conducted by Dendra, Inc. and the County Agriculture, Weights, and Measures (AWM) crews (Dendra, Inc. 2014, 2015a-d, 2016a-d, 2017a-c, 2018a-d, 2019a-d, 2020a-d).

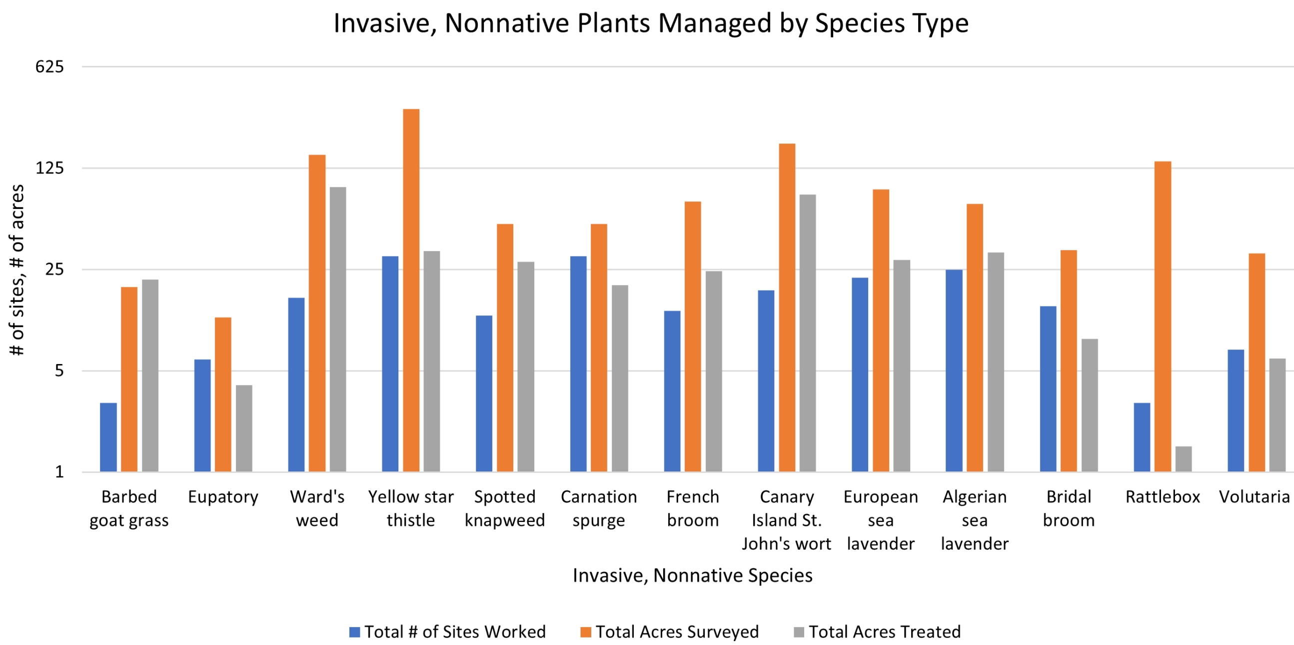


**Figure INVPL1.1.** Regional EDRR Program Invasive, Nonnative Plants Managed by Species. This graph shows the 13 invasive, nonnative plant species treated by the Regional EDRR program (beyond monitoring status). The graph shows, by species, the total number of sites worked, the total acres surveyed, and the total acres treated. Additional surveys are conducted at new reported sites or when a new species is added to the Regional EDRR Program.

## Metric 2: Number of Sites Eradicated

**Overview:** Historically, one invasive, nonnative plant species, Scotch broom, was eradicated from the County. While the Regional EDRR Program has not eradicated any species yet, the focused control efforts by Dendra, Inc. and the County AWM crews, have eradicated invasive, nonnative plant species from dozens of sites. Prior to the Regional EDRR Program, there were hundreds of sites with species that were going untreated. A five-step process is followed for invasive, nonnative plant species targeted by the Regional EDRR Program (see description in Metric 1). Even with these efforts, eradication is a difficult task for pervasive and resilient species. Additionally, eradication is difficult as all of the locations of an invasive, nonnative plant may not be known, and some locations may exist on private property without access. While total eradication of a species from the County is a very difficult task and a long-term effort, notable gains can be made by eradicating a species from specific sites. EDRR treatment sites are the locations/areas where invasive plants are being treated or managed. There can be more than one plant species at a treatment site. An occurrence is a collection of plants that are more than 0.25 miles apart from the next occurrence of the species. The treatment site most likely encompasses the entire occurrence, but in some instances may not due to land owner and access issues. Eradication of a species from a treatment site can mark the progress towards the eventual goal of total species eradication. Treatment and eradication goals assume ongoing funding by the SANDAG, CDFA, and others.

**Metric Evaluation Period**: 2015-2020 (Baseline: 2015; Current: 2020)

**Baseline:** At the start of the EDRR in 2015, zero of the treatment sites had species eradicated from them. In the 6 years since the Regional EDRR Program began, invasive plants from 23 sites have been eradicated. Fig. INVPL2.1 shows the location and status of EDRR sites in the MSPA.

**2027 Progress Towards Desired Condition:** To move towards the eradication of an invasive, nonnative plant species, the program should eradicate species at 25 percent of all sites (35 of 139) and have 75 percent of all targeted sites under treatment (associated with 2022-2026 MSP objectives).

### Condition Thresholds:

Condition thresholds were based on 5 years of treatment and mapping data collected by the Regional EDRR Program and input from Dendra, Inc. Based on past, current, and the future efforts planned for the Regional EDRR program, and the feasibility of eradicating additional sites in mind, thresholds were developed.

- **Good:** Invasive, nonnative plant species eradicated at ≥50 percent of treated sites.
- **Caution:** Invasive, nonnative plant species eradicated at 25-49 percent of treated sites.
- **Concern:** Invasive, nonnative plant species eradicated at 15-24 percent of treated sites.
- **Significant Concern:** Invasive, nonnative plant species eradicated at <15 percent of treated sites.

### Current Condition: Concern

In the current period (2020), the invasive, nonnative plant species targeted by the Regional EDRR Program have been eradicated at 23 of 139 (17 percent) treated sites.

### Trend (2015-2020): Improving

The Regional EDRR Program Coordinator and invasive, nonnative plant species removal crews continue to work to eradicate specific invasive plants from specific sites. Twenty-three eradicated sites in 5 years is an improving trend.

### Confidence: High

Data for invasive, nonnative plant species sites eradicated were sourced from Dendra Inc. and describe the treatment and eradication that has been completed (Dendra, Inc. 2014, 2015a-d, 2016a-d, 2017a-c, 2018a-d, 2019a-d, 2020a-d).

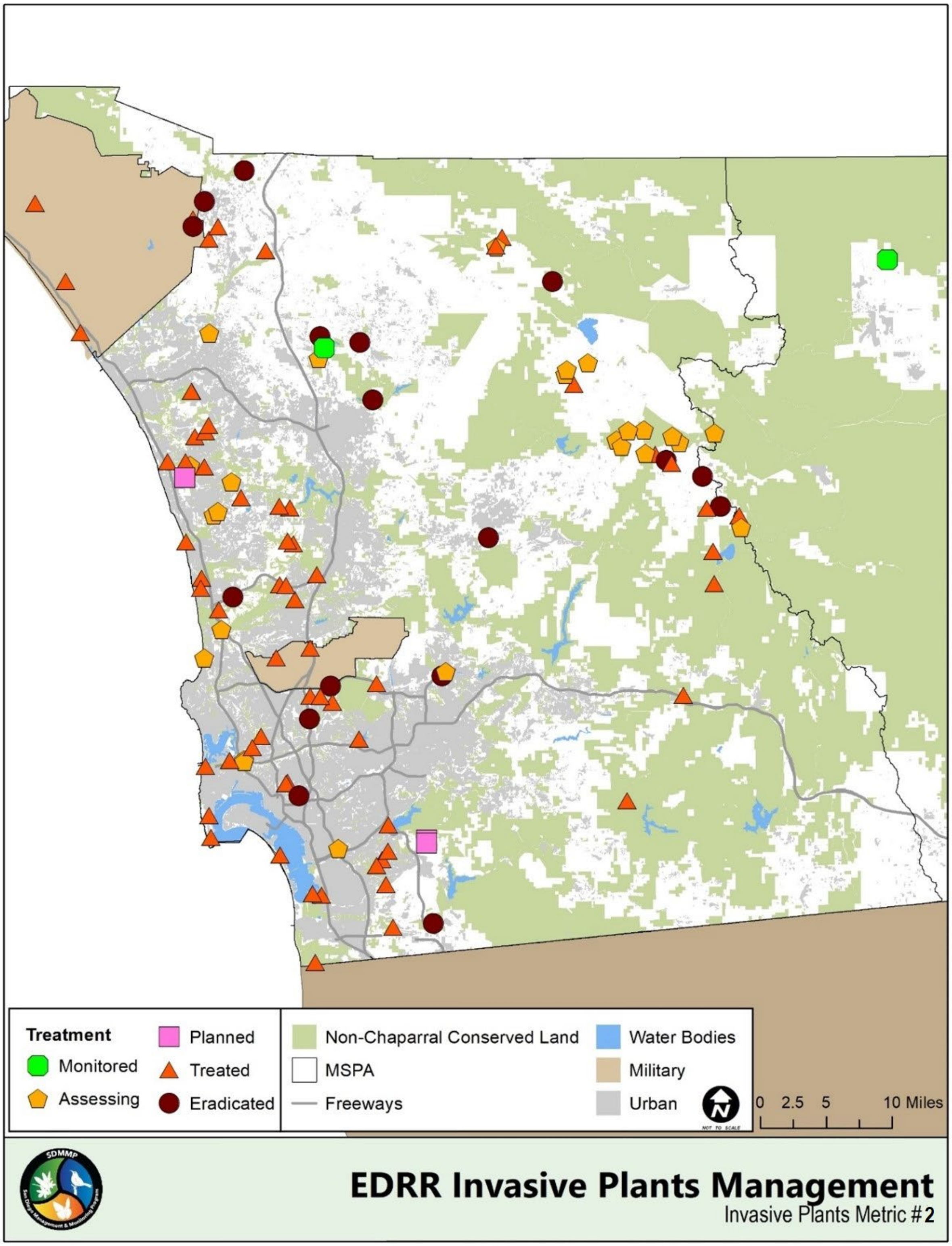


**Figure INVPL2.1.** Regional EDRR Program sites in the MSPA.

This figure shows sites in San Diego where Regional EDRR Program invasive, nonnative plant species are monitored, assessed, planned, treated, or eradicated.

## Metric 3: Number of Sites Treated

**Overview:** Even with targeted treatment efforts, eradication is a difficult task for pervasive and resilient invasive, nonnative plant species. While total eradication of a species from the County is a very difficult task and a long-term effort, notable gains can be made by eradicating a species from specific sites, marking progress towards the eventual goal of total species eradication.

The best time to control an invasive, nonnative plant species, in terms of cost and effectiveness, is when the species has just been introduced into a system. Rejmanek and Pitcairn (2002), of the University of California Davis, analyzed weed eradication efforts by the CDFA over a 30-year period. They showed that weed eradication success decreased exponentially and the effort (time, money, etc.) increased exponentially as the size of the weed infestation increased. Level 1, 2, and 3 species are much more manageable than Level 4 and 5 species. Sites are monitored to determine treatment needs. Treating species early on, when there may be just a few plants or populations, is the best option. The EDRR team targets Level 1, 2, or 3 plants to prevent invasive plant infestations from growing and pushing the species to a Level 4 or 5 species. Level 1 species only require surveillance (minimum annually) and are added to a watch list. Level 2 species have a very limited distribution within the region. The goal is to treat and eradicate them. After eradication, they are added to the Level 1 watch list. Level 3 species have a greater distribution in the region and are treated for containment at the management unit or watershed level. Much of the management need at this level is for re-treatment following initial treatments.

Twenty-one species are targeted by the Regional EDRR Program, and 18 of those species are currently (2020) receiving some form of monitoring or treatment for control (Dendra, Inc. 2014, 2015a-d, 2016a-d, 2017a-c, 2018a-d, 2019a-d, 2020a-d). Fig. INVPL3.1 shows the number of species and acres treated, as well as the number of sites worked on each year from 2015-2020. Each year, the program treats invasive, nonnative plants on dozens of acres of Conserved Lands.

Treatment and eradication goals assume ongoing funding by SANDAG, CDFA, and others.

**Metric Evaluation Period:** 2015-2020 (Baseline: 2015; Current: 2020)

**Baseline:** In 2015, the Regional EDRR Program treated or surveyed invasive, nonnative plant species at 42 of the 116 invasive, nonnative plant species sites.

**2027 Progress Towards Desired Condition:** To move towards the eradication of an invasive, nonnative plant species, the program should have 100 sites monitored and/or under treatment (associated with 2022-2026 MSP objectives).

**Condition Thresholds:**

Condition thresholds are based on 5 years of treatment and mapping data collected by the Regional EDRR Program and input from Dendra, Inc. Thresholds were developed using data from the current sites receiving treatment or being monitored and considering the sites that will receive monitoring or treatment in the future, considering the current rate of treatment.

- **Good:** ≥100 (86 percent) of 116 invasive, nonnative plant species sites in the Regional EDRR Program are monitored and/or under treatment.
- **Caution:** 85 (73 percent) to 99 (85 percent) of the 116 invasive, nonnative plant species sites are under treatment.
- **Concern:** 70 (60 percent) to 84 (72 percent) of the 116 invasive, nonnative plant species sites are under treatment.
- **Significant Concern:** <70 (<60 percent) of the 116 invasive, nonnative plant species sites are under treatment.

#### Current Condition: Caution

In the current period (2020), 89 (77 percent) of the 116 of the known Regional EDRR Program invasive, nonnative plant sites are currently under monitoring and/or treatment.

#### Trend (2015-2020): Improving

Each year new invasive, nonnative plant sites are monitored and treated. Additionally, many sites require and receive follow up, repeated treatment. The Regional EDRR Program continues to work to eradicate specific invasive, nonnative plants from specific sites. The EDRR Program increased treatment and survey efforts from 42 sites in 2015 to 89 sites in 2020.

#### Confidence: High

Data for invasive, nonnative plant sites eradicated were sourced from Dendra, Inc. and describe the treatment and eradication actions completed (Dendra, Inc. 2014, 2015a-d, 2016a-d, 2017a-c, 2018a-d, 2019a-d, 2020a-d).

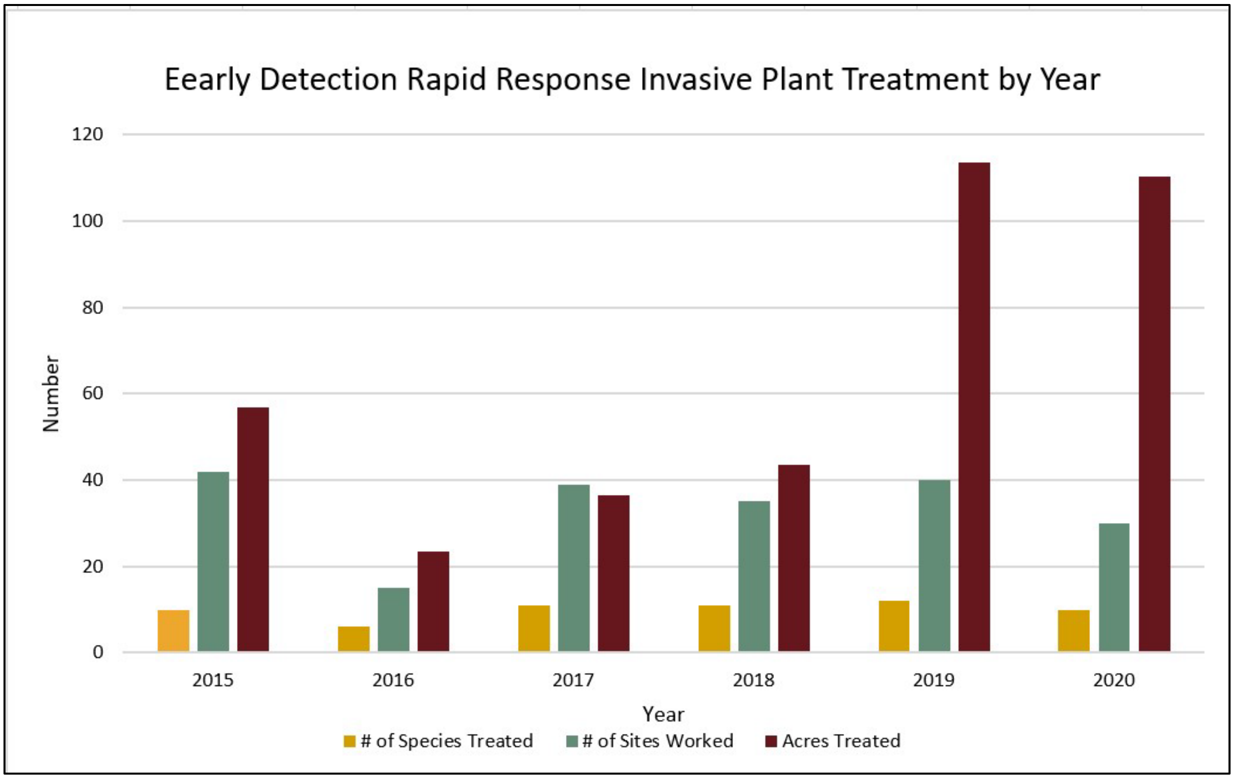


**Figure INVPL3.1.** Early Detection Rapid Response Invasive, Nonnative Plant Treatment by Year. This figure shows the number of invasive, nonnative plant species treated, number of sites worked, and number of acres treated by year for 2015-2020 as part of the Regional EDRR Program.

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