Final

TRIENNIAL MONITORING SUMMARY REPORT

Carlsbad Habitat Management Plan (HMP)
Through 2020

Prepared for
City of Carlsbad

March 2021

ESA

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Prepared by
Alanna Sullivan
Environmental Science Associates

550 West C Street
Suite 750
San Diego, CA 92101
619.719.4200
esassoc.com

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TRIENNIAL MONITORING SUMMARY REPORT

Carlsbad Habitat Management Plan (HMP)

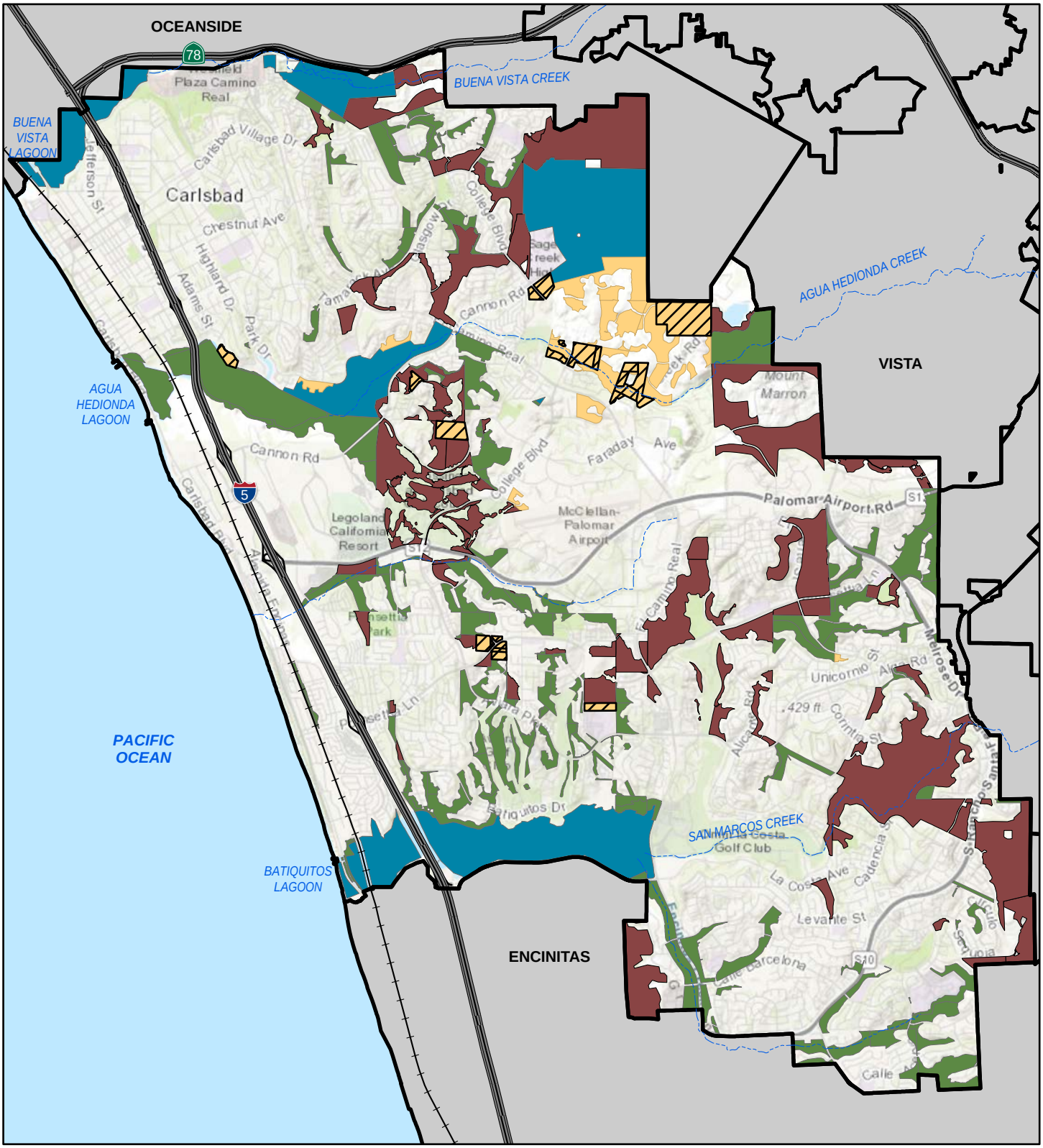
1. Introduction

This report summarizes the results of biological monitoring conducted within the Carlsbad Habitat Management Plan (HMP) preserve system since adoption of the HMP in November of 2004. This monitoring summary is provided every three years, pursuant to the HMP and Open Space Management Plan (TAIC 2004). Monitoring is conducted by the on-site preserve manager of each preserve. The monitoring results are submitted through site-specific annual reports and geographic information system (GIS) data to the HMP Preserve Steward. The HMP Preserve Steward summarizes the data every three years into a triennial monitoring summary report for the City of Carlsbad (city).

The preserve system is made up of several categories of HMP preserves (**Figure 1**):

1. Established private and city-owned preserves – established after approval of the HMP. These preserves are funded through endowments or other permanent funding sources for active management.
2. California Department of Fish and Wildlife (CDFW) ecological reserves – owned and managed by CDFW.
3. Pre-existing preserves – established prior to HMP approval. These preserves are generally owned by private homeowner associations (HOAs). Management on these lands is minimal, consisting mostly of access control and trash collection.
4. Future preserves. Future preserves include Standards Areas and Proposed Hardline Areas, which are undeveloped areas within the HMP boundary. When these areas are developed, HMP standards must be followed, including the permanent conservation of a portion of the property and funding for long-term management.

For the most part, monitoring data is collected on established private and city-owned preserves and CDFW ecological reserves. **Figure 2** shows the land owner and preserve manager for individual preserves. Results of monitoring for vegetation communities and species are summarized in Sections 2 and 3.



City of Carlsbad
Categories of HMP Preserves

Figure 1

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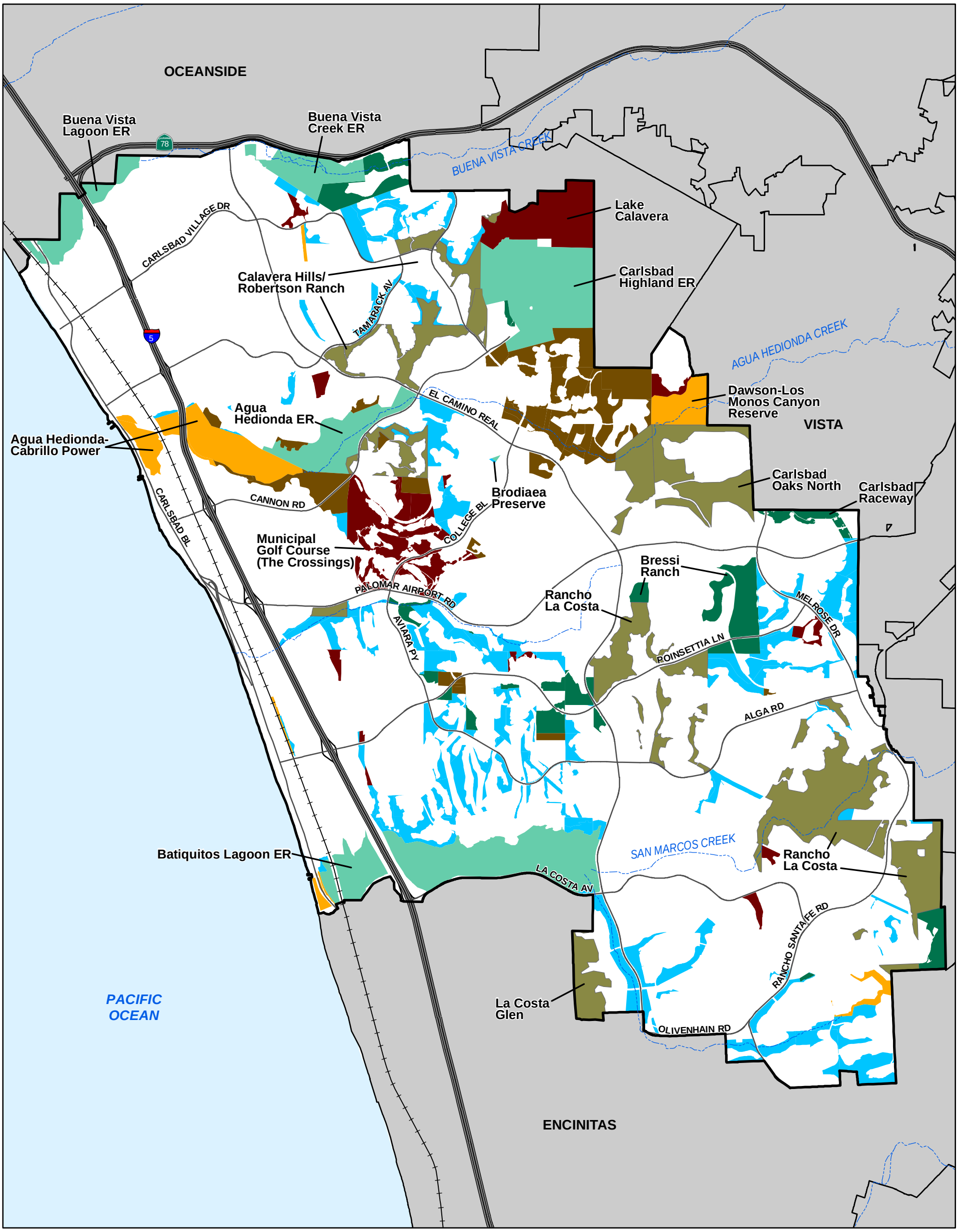

City of Carlsbad

- City Preserves*
  - Aura Circle
  - Aviara Park
  - Batiquitos Drive
  - Carlsbad Village Dr
  - Carrillo Ranch
  - Crossings Golf Course
  - Faraday
  - La Costa Canyon Park
  - La Costa/Romeria
  - Lagoon Lane
  - Lake Calavera
  - Los Monos
  - Macario Canyon
  - Poinsettia Park
  - Veteran's Park

Other Public/Semi-Public

- Other Public/Semi-Public
  - Cabrillo Power
  - Dawson-Los Monos Canyon Reserve
  - North County Transit District
  - Other Public Agencies
  - San Diego Gas & Electric
  - San Dieguito Union School District
  - State of California

Wildlife Agencies

- California Department of Fish and Wildlife
  - Agua Hedionda ER
  - Batiquitos Lagoon ER
  - Brodiaea Preserve
  - Buena Vista Creek ER
  - Buena Vista Lagoon ER
  - Carlsbad Highlands ER

Conservation Management Entity

- Center for Natural Lands Management
  - Calavera Hills II/Robertson Ranch
  - Carlsbad Oaks North
  - Encinas Creek
  - Kelly Ranch
  - La Costa Glen
  - Rancho La Costa
- Other Management Entity
  - Habitat Restoration Sciences (HRS)
  - Helix Environmental
  - San Diego Habitat Conservancy
  - San Diego Urban Corps Habitat Services

Private

- HOAs
  - Aviara HOAs
  - Calavera Hills HOAs
  - La Costa HOAs
  - Other HOAs and Private Open Space
  - Rancho Carrillo Master HOA

Future Preserves

- Future Preserves
  - Other Future Preserve
  - Pending Management
  - Undeveloped Standards Area

* Managed by Center for Natural Lands Management (CNLM)

Miles 0 1

City of Carlsbad
Current Preserve Ownership/Management

Figure 2

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2. Vegetation Communities

2.1 Influence of Weather on the Preserve System

In the past decade, drought and wildfire had a significant impact on the condition of the preserve system. Severe drought conditions were especially prominent during the 2012/2013 and 2013/2014 rainy season (generally November through April), which brought 5.2 and 4.0 inches of rain, respectively (NOAA 2020) (**Table 1**). Average annual precipitation in Carlsbad based on historical weather data from Palomar Airport is approximately 10 inches. Total precipitation in Carlsbad was below average from the 2011/2012 rainy season to the 2015/2016 rainy season; however, the 2016/2017, 2018/2019, and 2019/2020 rainy seasons were above average, with 15.4 inches, 13.39 inches, and 20.07 inches, respectively (NOAA 2020). The 2019/2020 rainy season had the highest precipitation documented across the period, with nearly 200 percent of the historic precipitation average (NOAA 2020).

The drought conditions starting from the 2011/2012 rainy season helped pave the way for the Poinsettia Fire, which burned over 300 acres in Carlsbad in May of 2014, most of which was on HMP preserve lands. On the day the fire broke out, the area was experiencing extreme Santa Ana conditions, which is a fairly rare occurrence at that time of year, bringing the humidity levels down and bringing temperatures up to 100 degrees Fahrenheit. Burned habitats are recovering, but not without added threats, such as the presence of invasive plant species. This is true particularly in the coastal sage scrub habitat, which has historically not recovered from fire as well as chaparral habitats and some of the oak woodland.

Projections of climate change in the region include warming by approximately 4 to 9° Fahrenheit, an approximately 20 percent decrease in precipitation, longer periods of drought, and rare but extreme flooding occurrences (Climate Science Alliance 2021). These extreme weather conditions, along with increased human presence, are expected to continue to put added stress onto our already vulnerable natural lands.

2.2 Vegetation Mapping

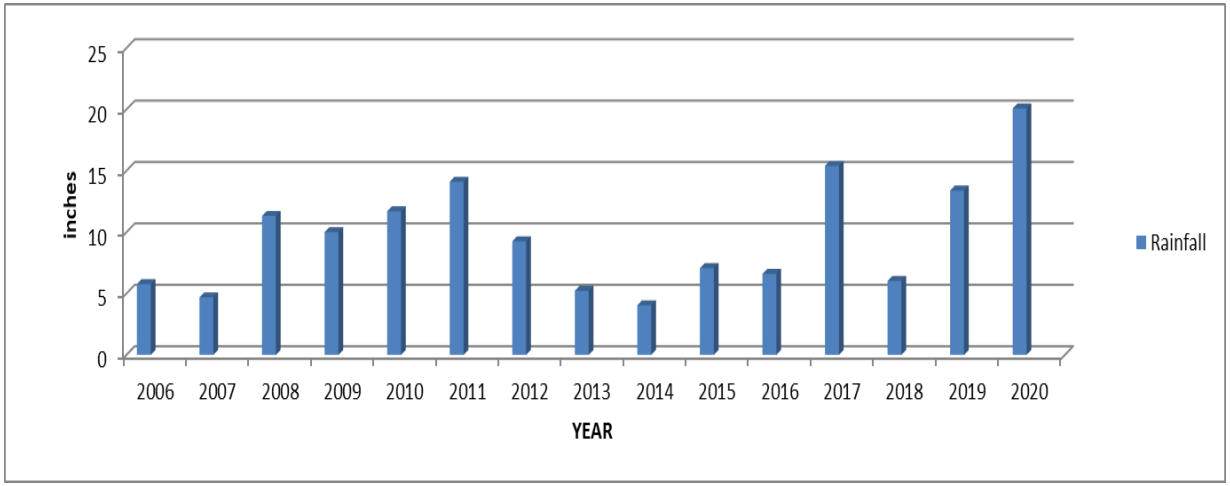
Long-term vegetation monitoring within the preserve system is accomplished through periodic mapping (required by the HMP) and focused studies. Mapping is conducted within preserves by the preserve managers every five years to document changes in vegetation community boundaries over time. Vegetation communities were originally mapped using Oberbauer-modified Holland classification system (Holland 1986, Oberbauer 2008), which is the classification system upon which the HMP habitat targets are based. However, the preserve managers now use *Vegetation Classification Manual for Western San Diego County* (SANDAG 2011), the current standard classification system for this area. This system is based on alliances and associations, which are defined by the presence and abundance of diagnostic species. This classification is much more fine-scaled, and provides more information about variation within the habitat. Site-specific vegetation mapping submitted by preserve managers is incorporated into a single citywide geospatial vegetation layer. Because the HMP requirements are tracked in the older classification system, the city's vegetation layer uses a crosswalk to the Oberbauer system for tracking purposes.

TABLE 1
PRECIPITATION IN CARLSBAD

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Recent Average
Precipitation Total (in)*	5.77	4.69	11.32	10.0	11.7	14.1	9.25	5.22	4.04	7.07	6.6	15.4	6.03	13.39	20.07	9.6

* Measurements from Palomar-McClellan Airport in Carlsbad, CA (NOAA 2020). Data taken from Nov-April. The year presented coincides with the end of the rainy season (April).

Total Annual Precipitation from 2006–2020



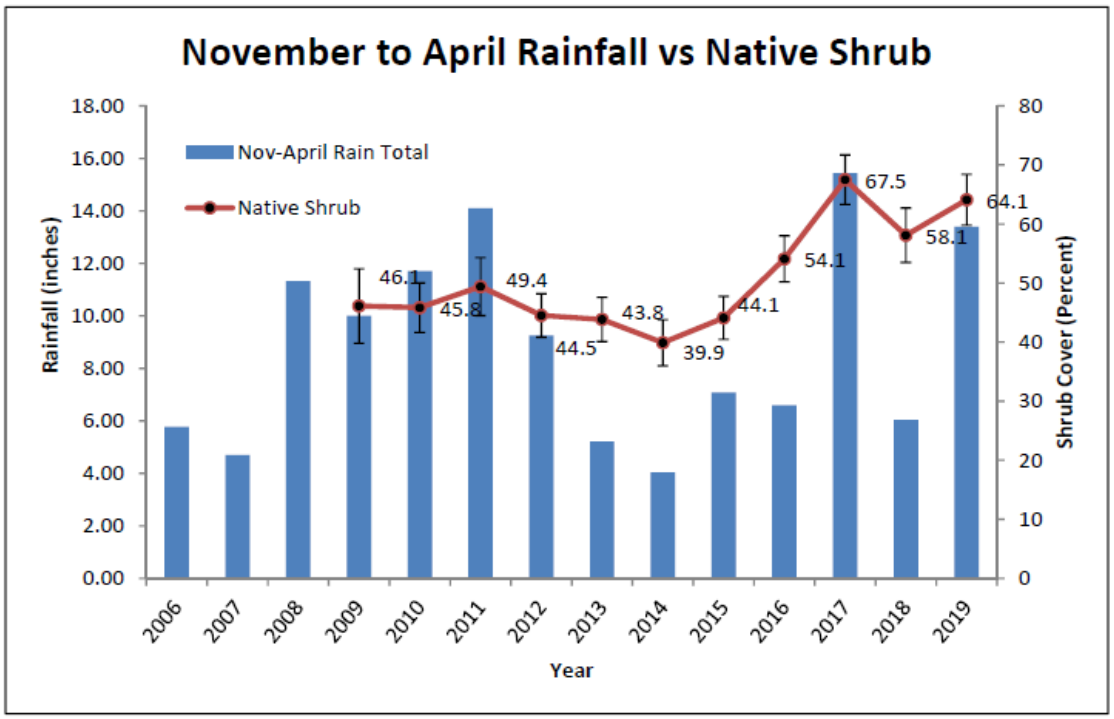
* Measurements from Palomar-McClellan Airport in Carlsbad, CA (NOAA 2020). Data taken from Nov-April. The year presented coincides with the end of the rainy season (April).

2.3 Long-Term Coastal Sage Scrub Monitoring

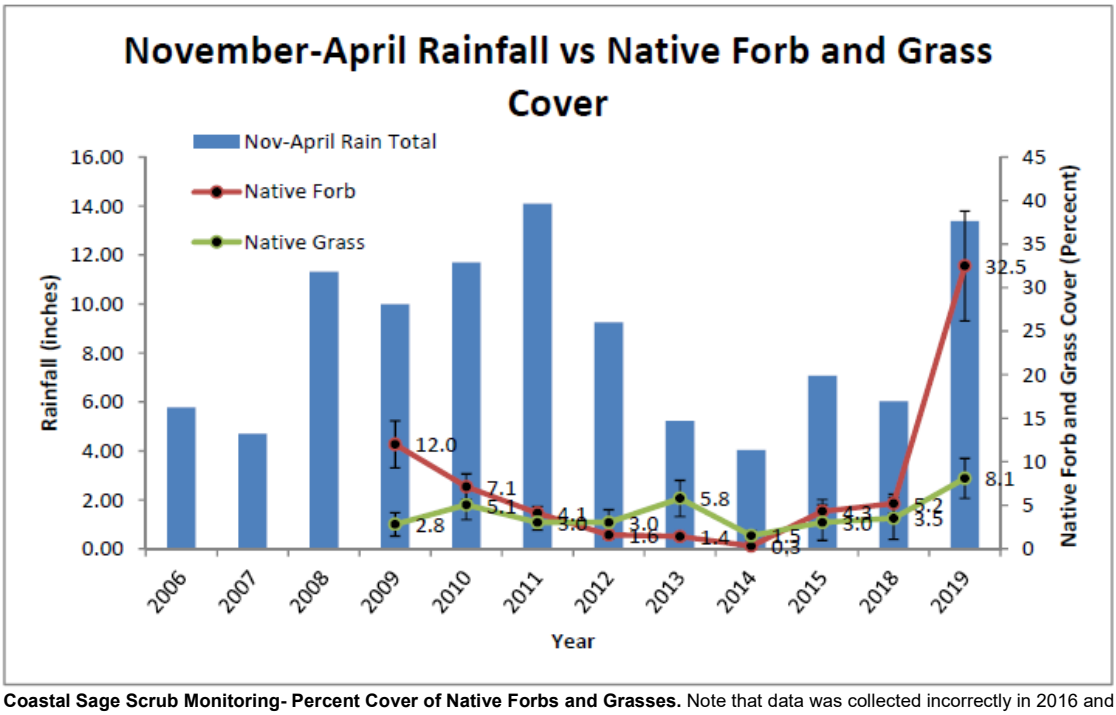
The Center for Natural Lands Management (CNLM) began a long-term monitoring program in coastal sage scrub habitat during the spring of 2009 by setting up modified Whittaker plots (see CNLM 2010 for methods and rationale). Fifty-nine plots distributed evenly across the landscape in Carlsbad have been visited every year from 2009 to 2019 on a three-year return interval. The plots are located on CNLM-managed preserves, CDFW Ecological Reserves, and the Aviara Master Association Preserve. One-third of the plots are monitored each year, and thus, each plot is visited every three years (termed rotating panel). The advantages of using a rotating panel design rather than visiting the same plots every year are that (1) it allows for sampling within a broader area, and (2) it reduces potential impacts from trampling from monitoring activities. The purpose of the study is to track and evaluate changes in the structure, composition and species richness of coastal sage scrub over time. Species richness was collected for 9 years (3 rotating panels), through 2017; it was stopped at this time as there were no meaningful trends expressed (such as loss of species). Coastal sage scrub monitoring did not occur in 2020 due to the COVID-19 stay-at-home order, but is anticipated to resume in 2021.

2.3.1 Results of Coastal Sage Scrub Monitoring

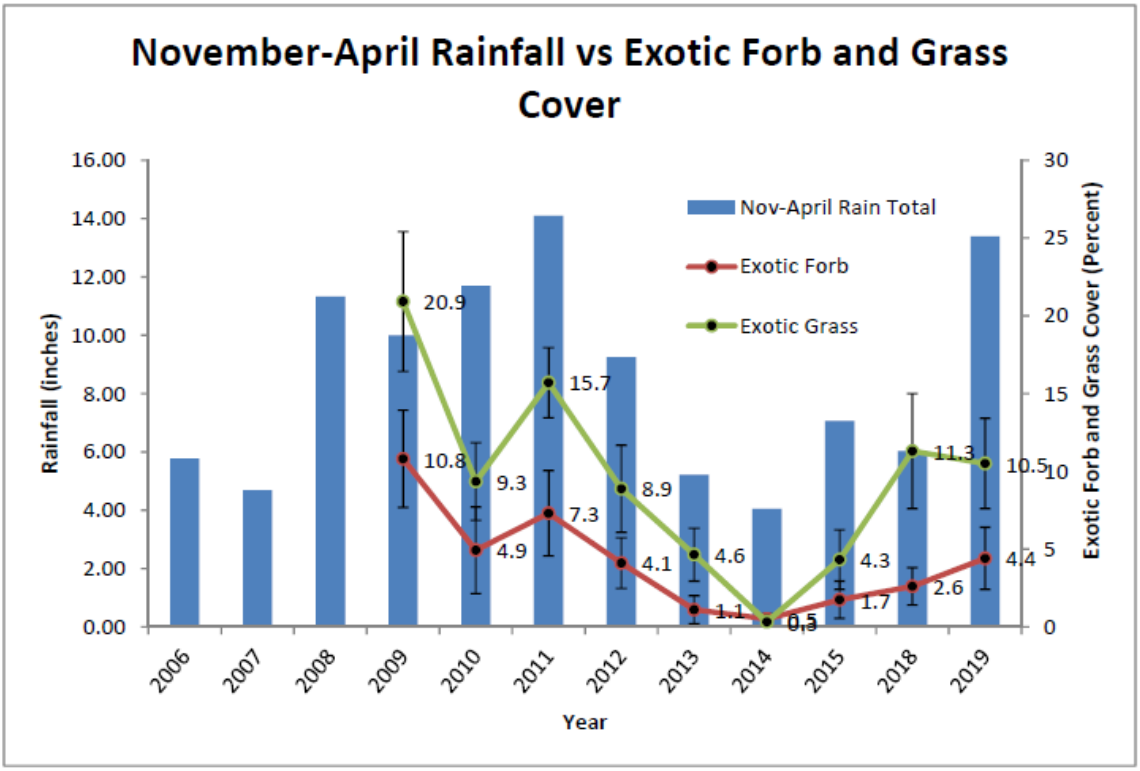
From 2009 to 2016, average percent cover of all shrubs showed a generally even trend, while 2017 showed an increase in percent cover. Shrub cover in 2019 increased from its slight dip in 2018 and was the second highest cover recorded in the 10-year trend. Average percent cover of native forbs and native grasses increased dramatically from previous drought years, potentially due to higher seed load produced in the heavy rains of 2017 and 2019. Average percent cover of both native forbs and native grass in 2019 were the highest on record for the 10-year trend. Average percent cover of non-native forbs increased slightly, while non-native grasses decreased slightly in 2019. See graphs below.



Coastal Sage Scrub Monitoring: Percent Cover of Native Shrubs. Precipitation in inches on left axis and percent cover on right axis (+/- 1 standard error).



Coastal Sage Scrub Monitoring- Percent Cover of Native Forbs and Grasses. Note that data was collected incorrectly in 2016 and 2017; therefore, those years are not included. Precipitation in inches on left axis and percent cover on right axis (+/- 1 standard error).

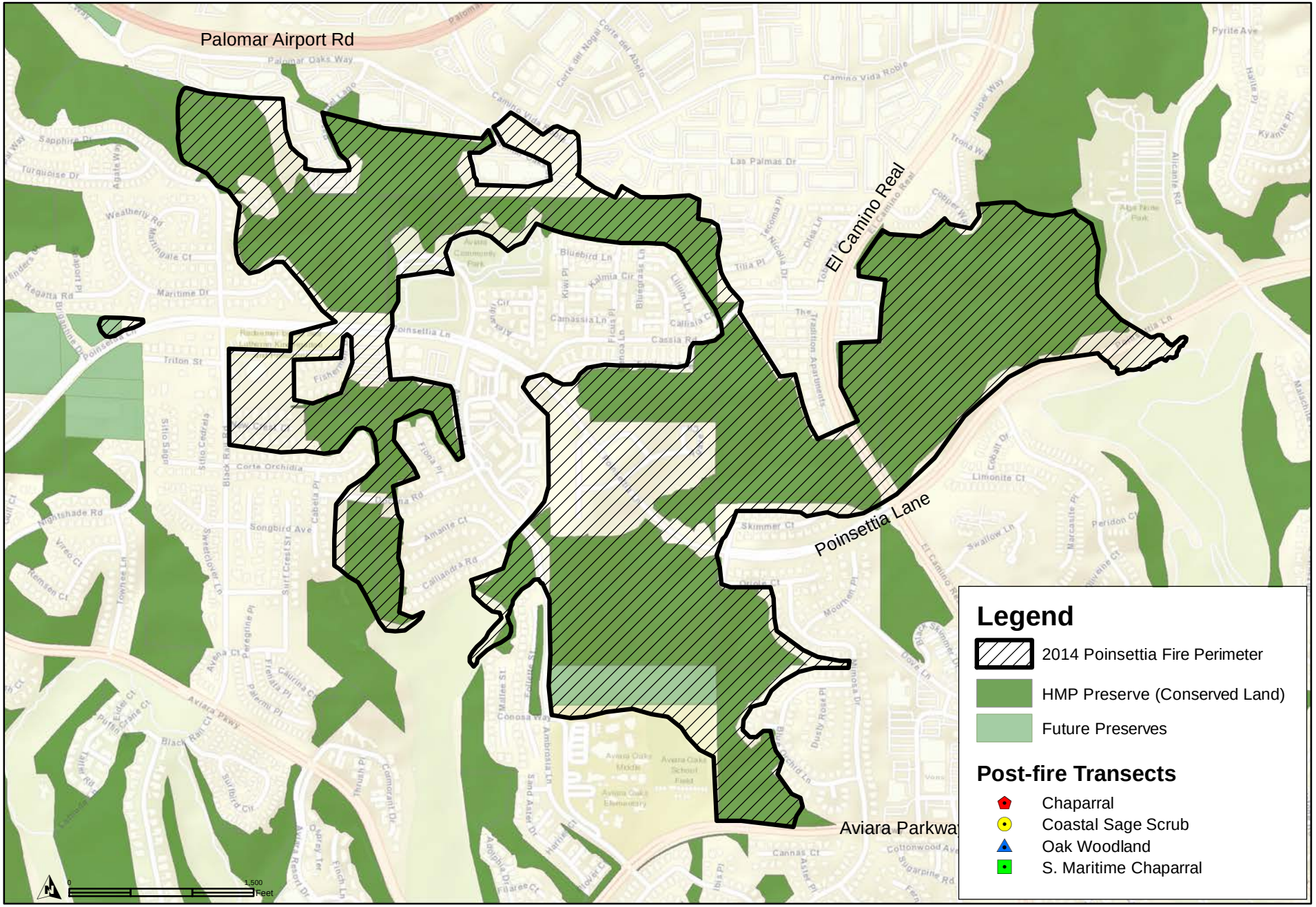


Coastal Sage Scrub Monitoring - Percent Cover of Exotic (Non-Native) Forbs and Grasses. Note that data was collected incorrectly in 2016 and 2017; therefore, those years are not included. Precipitation in inches on left axis and percent cover on right axis (+/- 1 standard error).

2.4 Post-Fire Recovery Monitoring

In May of 2014, approximately 317 acres of natural land burned in the Poinsettia Fire; of this, approximately 295 acres of habitat was within the HMP hardline. The majority of this habitat was unmanaged preserves (private HOA lands), actively managed preserves (established private and city-owned), and future preserves (Standard Areas) (**Figure 3**). The city, in coordination with the Preserve Steward and CNLM, developed and implemented the *Carlsbad HMP Post-Fire Monitoring Protocol* (Protocol, City of Carlsbad 2014). This protocol consisted of quantitative and qualitative assessments in 26 locations throughout the burn area, stratified by habitat type (southern maritime chaparral [SMC], chamise chaparral [CC], coastal sage scrub [CSS], oak woodland, and vernal pools). The monitoring was conducted annually for five years, starting in the spring of 2015 and completed in spring 2019, to evaluate the trajectory of recovery of each vegetation community, and compare it to known post-fire response expectations.

In 2019, three unburned SMC reference plots were added at La Costa Greens and City Ventures, and one unburned CSS reference plot was added at Emerald Point to provide data comparison to unburned areas. Data from the city-wide CSS monitoring program is also used in this report to provide comparison to unburned CSS in the city. Reference plots were chosen based on close proximity to the burned areas, but were just outside of the burn limits.



Poinsettia Fire Perimeter
Post-Fire Habitat Recovery Monitoring

Figure 3

City of Carlsbad

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Date: 3/3/2021

2.4.1 Results of Post-Fire Recovery Monitoring

The CC, SMC, and CSS vegetation communities are mostly recovering as expected after the Poinsettia Fire and are headed towards the desired self-sustaining trajectory. Higher than average precipitation in 2017 and 2019 was very beneficial, with most native shrub species showing good vigor, and the cover of native herbaceous species increasing and showing the expected post-fire type of species diversity.

Although non-native species were observed, the cover and density is also in-line with what is expected and tolerated, and is mostly not considered a threat that would alter the recovery and long-term species composition within each community. The relatively low cover of non-native species observed should allow for healthy vegetation communities to return overtime, given another fire is not experienced in upcoming decades.

It will take many more years for the SMC and CC communities to attain the over 90 percent cover of native shrubs that typifies these communities (including the SMC reference sites). Native shrub cover in the CSS community will likely take fewer years to recover than the chaparral communities. Native herbaceous cover in the CSS community is already robust, and will likely decrease as native shrub species become more dominant. Non-native herbaceous and grass species may be an issue in CSS, and have higher percent cover than the reference transects; however, these functional groups are expected to decrease as native shrub cover increases and out-competes these species.

Generally, the oak woodlands are on the trajectory towards recovery, with many native plant species repopulating the area. Mortality of oak trees was low on the Rancho La Costa Preserve, but much higher (35 percent) on the Manzanita Partners Preserve. The remaining oaks on the two preserves are slowly recovering. Invasive non-native species such as pampas grass (*Cortaderia selloana*) and black mustard (*Brassica nigra*) are abundant in this habitat, which may affect natural recruitment of oaks.

The presence of vernal pool indicator species on the Manzanita Preserve vernal pool site, including endangered San Diego button celery (*Eryngium aristulatum* var. *parishii*) and federally endangered San Diego fairy shrimp (*Branchinecta sandiegonensis*), indicates the habitat is on a positive trajectory toward recovery. Non-native species are abundant on site, but no more so than the pre-fire conditions.

For more details, see the final report *Poinsettia Fire Post-Fire Monitoring Results 2015*–2019, included as **Appendix E** in the Year 15 HMP Annual Report (CNLM and ESA 2020).

3. Species

This section summarizes the monitoring results for species with site-specific permit conditions (i.e., those that require individual populations to be tracked) (MHCP 2003, Vol. III). The species are grouped by general type, including upland plants, vernal pool plants and animals, lagoon/coastal birds, riparian birds, upland birds, and wildlife movement. Long-term focused species monitoring is conducted to document species persistence in the preserve system, and to inform site-specific management actions. The information summarized in this report comes from site-specific annual reports, regional species monitoring reports, and GIS data. **Table 2** below summarizes the years during which focused species surveys were conducted on each preserve. **Figures 4–9** show the known locations of these species based on data from preserve managers, California Natural Diversity Database (CNDDB), and the U.S. Fish and Wildlife Service (USFWS).

Table 2. Priority Species Surveys Conducted on Actively Managed Preserves

Land manager	CDFW	CDFW	CDFW	CNLM	CDFW	CNLM	CDFW	CNLM	SDHC	CNLM	UC	SDHC	CNLM	CNLM	CNLM	Dudek	HOA	UC	Dudek	SDHC	CNLM
Species	**Agua Hedionda Lagoon ER**	**Batiquitos Lagoon ER**	**1-Ac Brodiaea Preserve**	**BV Creek ER**	**BV Lagoon ER**	**Calavera/Rob Ranch**	**Carlsbad Highlands ER**	**Carlsbad Oaks N**	**Carlsbad Raceway**	**City Preserves**	**City Ventures**	**Emerald Pointe**	**Encinas Ck**	**Kelly Ranch**	**La Costa Glen**	**Manzanita Partners[4]**	**Morning Ridge**	**Poinsettia Place**	**Poinsettia Station**	**Quarry Creek**	**Rancho La Costa**
Upland Plant Species																					
San Diego thornmint	NP	NP	NP	NP	NP	2008-2012[2]	NP	2007-2020[2]	2017–2020[2]	NP	NP	2010, 2014-2020	NP	NP	NP	NP	NP	NP	NP	NP	2005-2020[2]
Thread-leaved brodiaea	NP	NP	2015-2020	2011-2019[2]	NP	2006-2019[2]	2008, 2015, 2016	2007-2019[2]	NP	2010-2019[2]	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	2005-2019[2]
Del Mar manzanita	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	2009, 2014, 2017, 2018, 2019	2013, 2014, 2015, 2017	2005, 2013[7]	2008	2004, 2014, 2017, 2020	NP	NP	2005, 2008, 2014-2017
Del Mar mesa sand aster	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	2014-2020	NP	NP	NP	2007, 2014-2017	1998, 2013[7]	NP	NP	NP	NP	NP
Encinitas baccharis	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	2013, 2014, 2015	NP	NP	NP	NP	NP	NP
Orcutt's hazardia	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	2004-2014, 2016, 2017-2020[2, 3, 5]	NP	NP	NP	NP	NP	NP	2004-2017-2020[2, 3]
Vernal Pool Species																					
California Orcutt grass	Vernal pools do not occur on these preserves								NP	Vernal pools do not occur on these preserves						NP	Vernal pools do not occur on these preserves		2019, 2020	Vernal pools do not occur on these preserves	
Little mousetail									NP							NP			NP		
San Diego button-celery									NP							2016-2020			2019, 2020		
Spreading navarretia									NP							NP			2019, 2020		
Riverside fairy shrimp									NP							NP			2019, 2020		
San Diego fairy shrimp									NP							2016-2017, 2019-2020			2020		
Lagoon/Coastal Species																					
Belding's savannah sparrow	1973-2015[1, 6]	1973-2015[1, 6]			1973-2015[1, 6]	Lagoon species do not occur on these preserves															
California least tern	not surveyed	2001-2016[2]			not surveyed																
Western snowy plover	2001-2017[2]	2001-2017[2]			2001-2017[2]																
Light-Ridgway's rail	2000-2020[2]	2000-2020[2]			2000-2020[2]																
Riparian Bird Species																					
Least Bell's vireo	2008	NSI	NP	2008, 2009, 2010, 2014, 2016, 2018, 2020	NSI	2008, 2009, 2013, 2014, 2017, 2018, 2019, 2020[6]	NSI	NP	NP	2009, 2010, 2011, 2014, 2016, 2019	NP	NP	2008-2020[2]	NP	NP	NP	NP	NP	NP	2016, 2019	2014, 2019, 2020
SW willow flycatcher	NSI	NSI	NP	2008, 2009, 2010, 2014	NSI	2008, 2009, 2013, 2014	NSI	NP	NP	2009, 2010, 2011, 2014, 2016, 2019	NP	NP	2008-2011[2]	NP	NP	NP	NP	NP	NP	NP	NP	NP
Upland Bird Species																					
California gnatcatcher	2008, 2010, 2013	2008, 2010, 2013	NP	2008, 2010, 2013	NSI	2007, 2010, 2013, 2015, 2016	2008, 2010, 2013, 2018, 2019	2007, 2010, 2013	2014	2011, 2013, 2018	2013, 2017, 2020	2009, 2012	2008-2020	2003-2007, 2010, 2013	2013, 2017, 2020[6]	2016	2005, 2013, 2018	2013, 2017, 2020	NP	2016	2005, 2007, 2010, 2013, 2018

NP = Not present

NSI - No survey information

[1] Every 5 years
[2] Annually
[3] Transplanted population
[4] Vernal pools burned in 2014 fire
[5] Year missed due to staff attrition
[6] 2020 missed due to Covid
[7] Every 10 years

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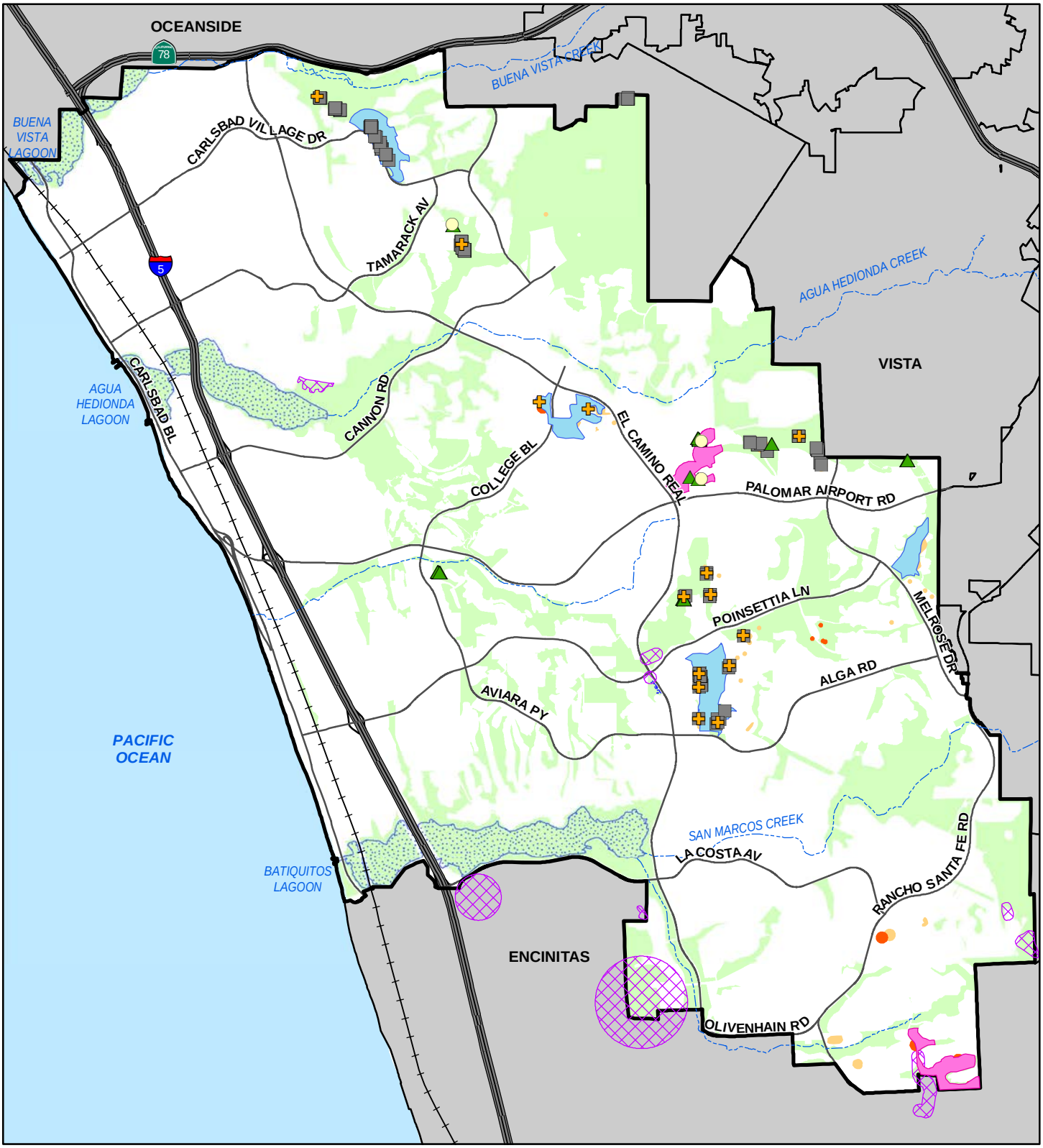

USFWS Occurrence:

- San Diego Thornmint
- Thread-leaved Brodiaea

HMP Database:

- San Diego Thornmint
- Thread-leaved Brodiaea

HMP Database:

- Del Mar Mesa Sand Aster

USFWS Critical Habitat:

- San Diego Thornmint
- Thread-leaved Brodiaea

- Existing and Proposed Hardline Preserve

CNDDB Occurence:

- Del Mar Mesa Sand Aster
- San Diego Thornmint
- Thread-leaved Brodiaea

N

0 Feet 6,400

City of Carlsbad

City of Carlsbad
Current Status of Upland Herbs

Figure 4

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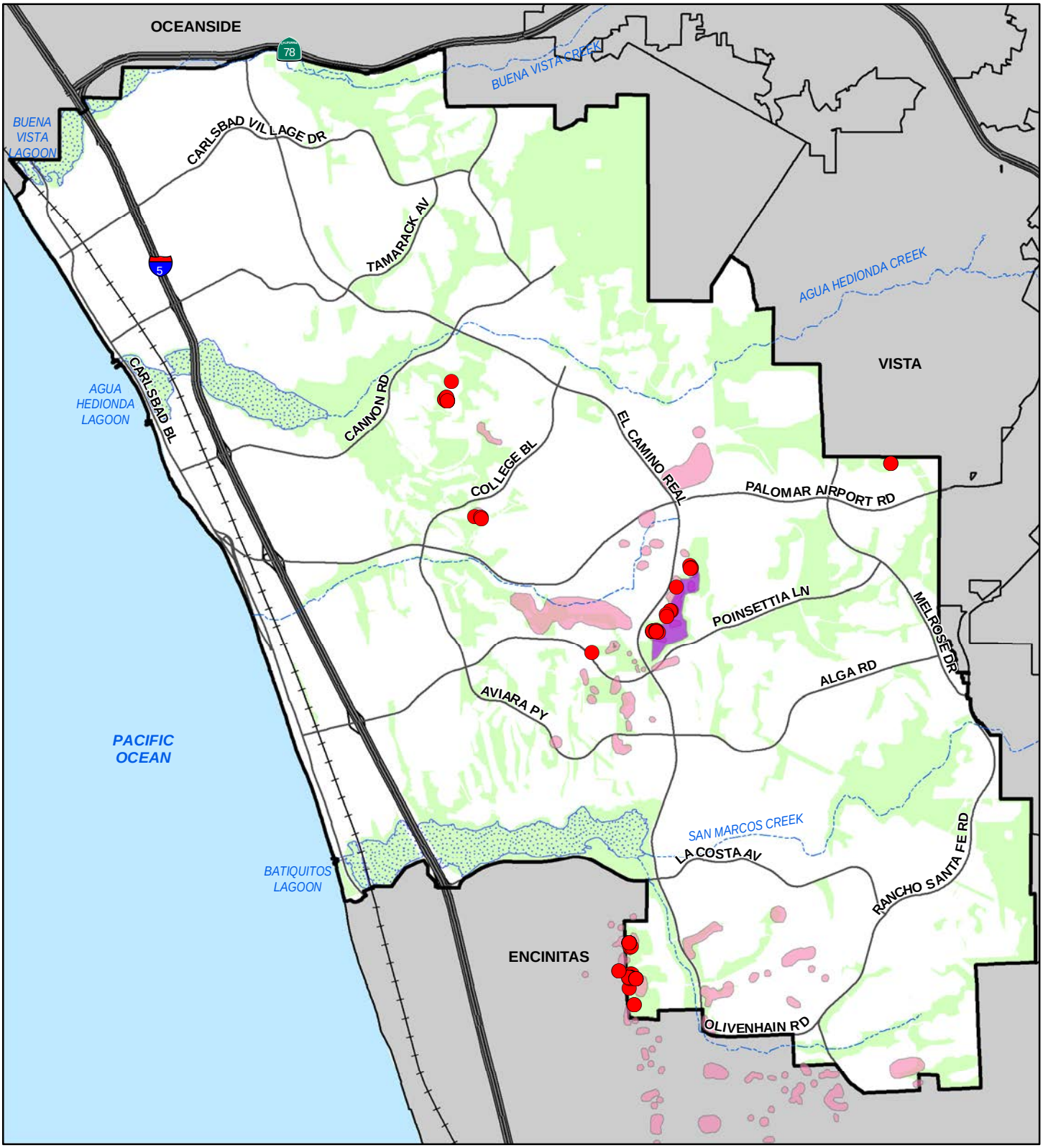

HMP Database:

- Del Mar Manzanita

HMP Database:

- Del Mar Manzanita

CNDDB Database:

- Del Mar Manzanita

- Existing and Proposed Hardline Preserve

N

0 Feet 6,400

City of Carlsbad

City of Carlsbad
Current Status of Upland Shrubs

Figure 5

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Date: 3/1/2021

HMP Database:
- Orcutt's Brodiaea

USFWS Occurrence:
- Riverside Fairy Shrimp
- San Diego Fairy Shrimp

HMP Database:
- California Orcutt's Grass
- San Diego Button-Celery
- Spreading Navarretia

CNDDB Occurrence:
- Riverside Fairy Shrimp
- San Diego Fairy Shrimp

USFWS Critical Habitat:
- San Diego Fairy Shrimp
- Spreading Navarretia

- Existing and Proposed Hardline Preserve

N

0 — 6,400 Feet

City of Carlsbad

City of Carlsbad
Current Status of Vernal Pool Species

Figure 6

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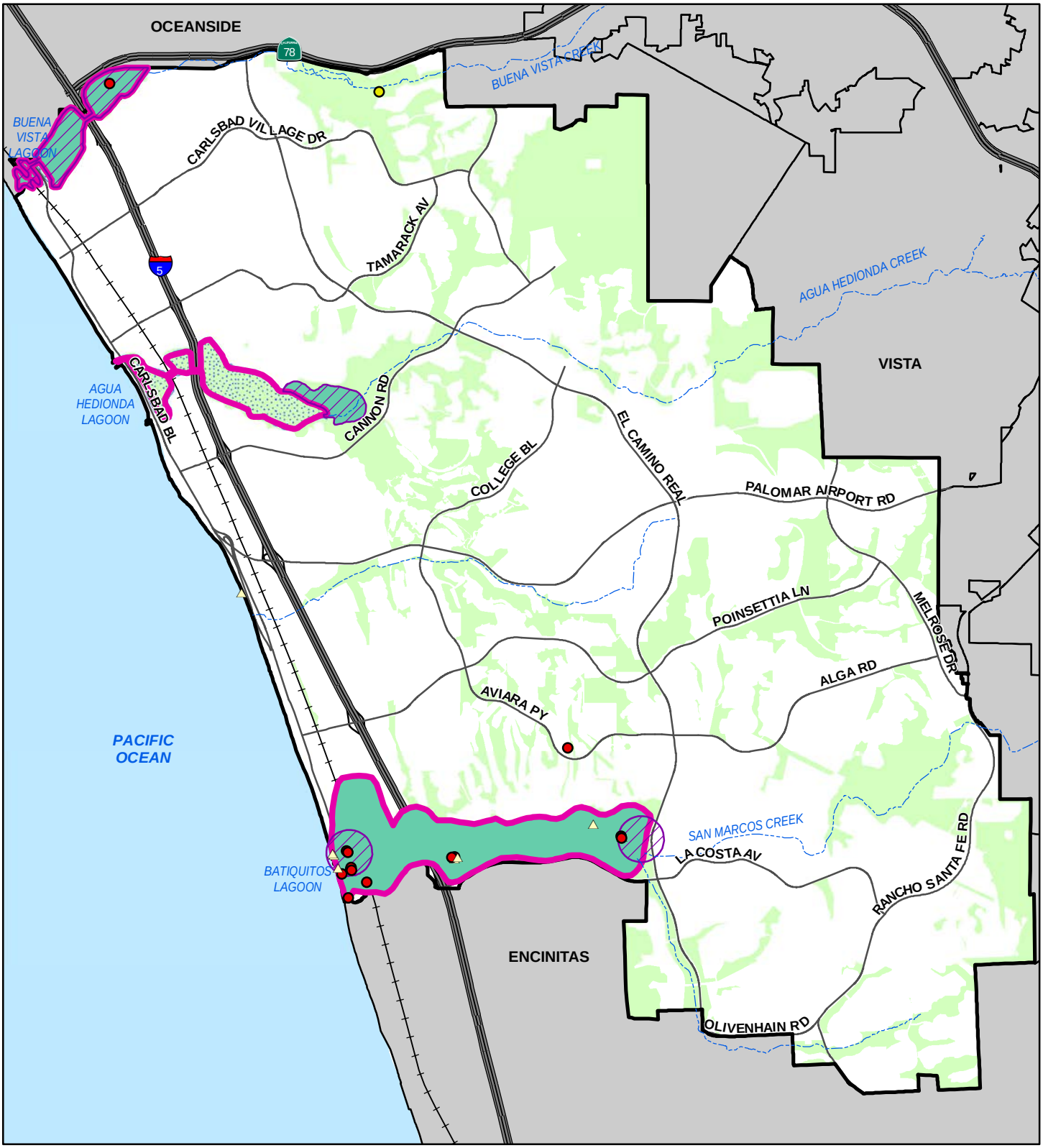

HMP Database:

- Least Tern

USFWS Occurrence:

- Least Tern
- Western Snowy Plover

CNDDB Occurrence:

- Western Snowy Plover
- Belding's Savannah Sparrow
- Least Tern

Existing and Proposed Hardline Preserve

N

0 Feet 6,400

City of Carlsbad
Current Status of Lagoon Species - Birds

Figure 7

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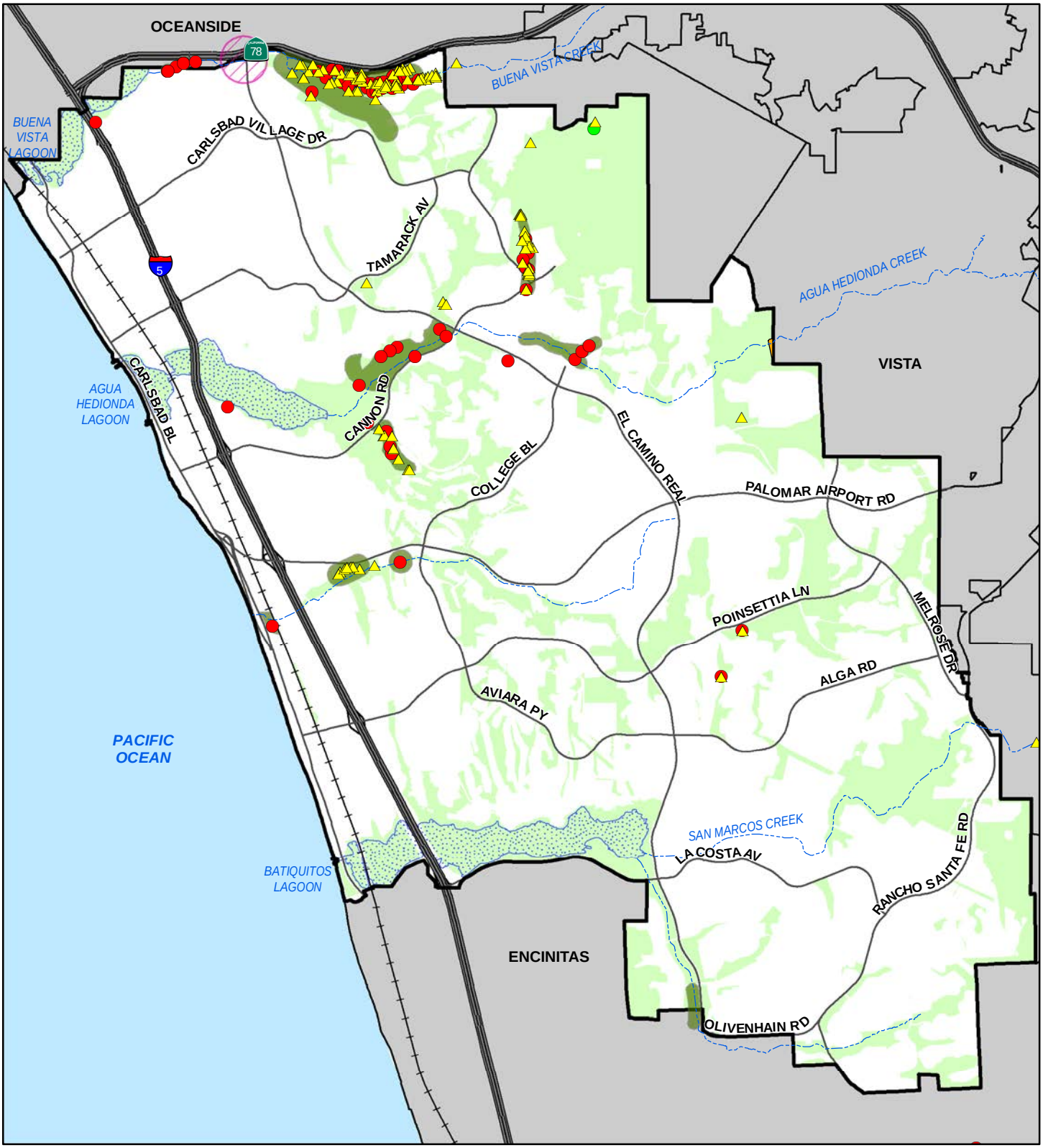

HMP Database:

- Southwestern Willow Flycatcher
- Least Bell's Vireo

USFWS Occurrence:

- Least Bell's Vireo

USFWS Critical Habitat:

- Southwestern Willow Flycatcher

CNDDB Occurrence:

- Least Bell's Vireo
- Southwestern Willow Flycatcher

- Existing and Proposed Hardline Preserve

N

0 Feet 6,400

City of Carlsbad

City of Carlsbad
Current Status of Riparian Birds

Figure 8

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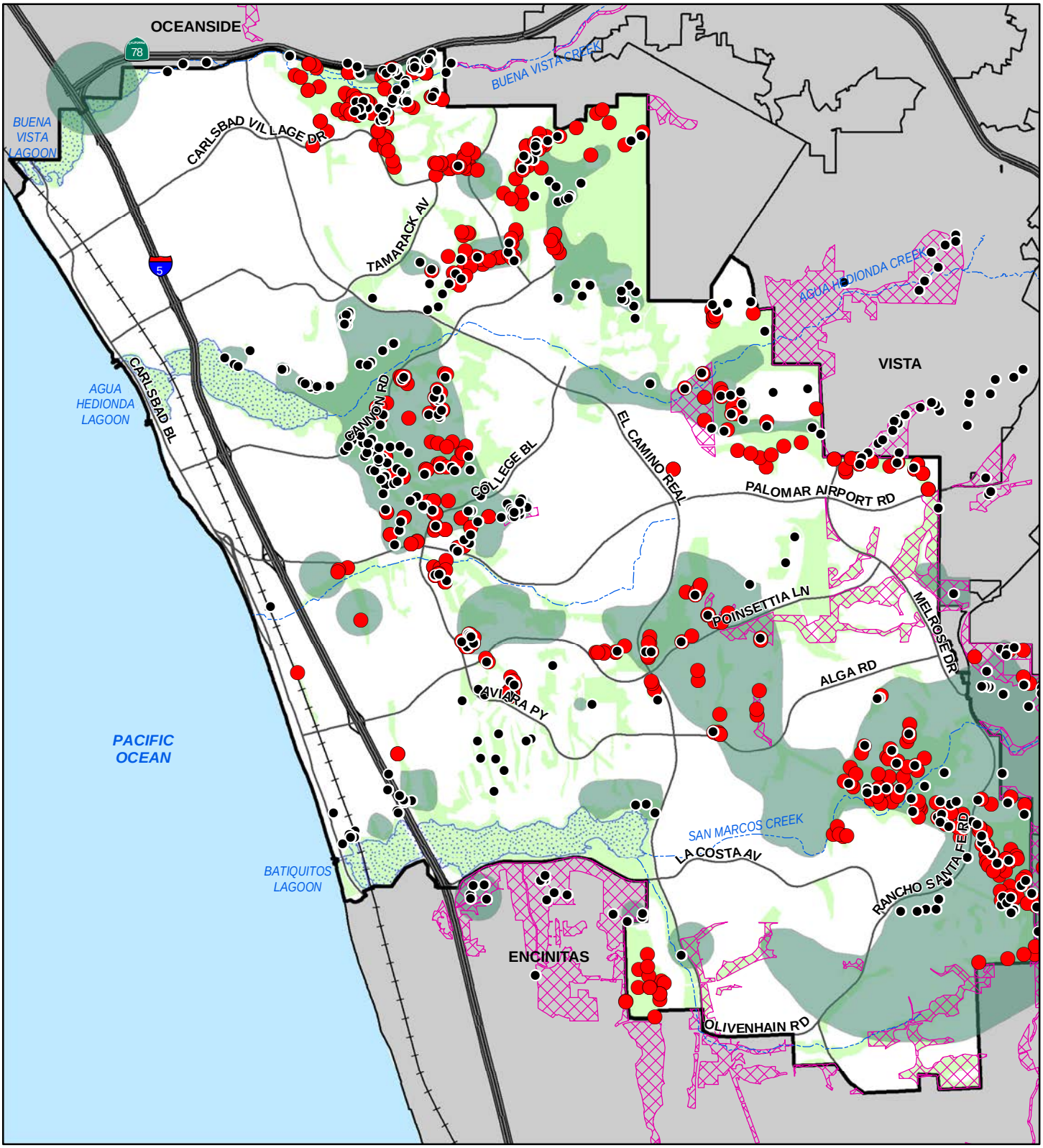

USFWS Occurrence:

- Coastal California Gnatcatcher

HMP Database:

- Coastal California Gnatcatcher

USFWS Critical Habitat:

- Coastal California Gnatcatcher

CNDDB Occurrence:

- Coastal California Gnatcatcher

- Existing and Proposed Hardline Preserve

N

0 Feet 6,400

City of Carlsbad

City of Carlsbad
Current Status of Coastal California Gnatcatcher

Figure 9

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Date: 3/1/2021

Site-specific species monitoring is designed to evaluate preserve-specific status, and does offer a look at species across the city of Carlsbad, but cannot be used to understand overall species population trends. Regional monitoring and associated research being coordinated by the San Diego Management and Monitoring Program (SDMMP) provides information about species population trends, genetic exchange, and best management practices for individual species. The SDMMP prepared a science-based regional Management and Monitoring Strategic Plan for Conserved Lands in Western San Diego County: *A Strategic Habitat Conservation Roadmap* (MSP Roadmap) (2017), which provides regional and local (population-specific) goals and objectives. This document is an adaptive management and monitoring implementation plan for priority species and habitats within Western San Diego County and is coordinated across multiple jurisdictions and key organizations and individuals in an effort to obtain a cohesive management and monitoring strategy for these species, including databases and mapping tools, species-specific monitoring protocols, and management techniques specific to local threats.

As part of the MSP Roadmap, a rare plant monitoring protocol was developed by SDMMP to identify and prioritize management objectives regarding status, threats, and management needs for 30 rare plant species (six of which occur in Carlsbad) on conserved lands in Western San Diego County. The city encourages preserve managers to participate in the regional Inspect and Manage (IMG) program for Nuttall's acmispon (*Acmispon prostratus*), Orcutt's brodiaea (*Brodiaea orcuttii*), Orcutt's hazardia (*Hazardia orcuttii*), San Diego goldenstar (*Bloomeria clevelandii*), San Diego thornmint (*Acanthomintha ilicifolia*), and thread-leaved brodiaea (*Brodiaea filifolia*). The MSP Roadmap also includes strategic plans for wildlife movement (SDMMP 2011) and invasive plants (CBI et al. 2012). The city will continue to coordinate with these regional management and monitoring efforts as feasible.

3.1 Upland Plants

3.1.1 San Diego Thornmint

Acanthomintha ilicifolia

Status: federally threatened, state endangered

MHCP Critical Locations and Major Populations

The MHCP identified critical locations and major populations in scattered locations throughout Carlsbad, mostly in private HOA preserve lands. Other populations of San Diego thornmint are located within the Carlsbad Oaks North and Rancho La Costa Preserve.

Long-Term Monitoring

Within Carlsbad, long-term monitoring for selected populations has been ongoing since 2008. Populations of San Diego thornmint at Carlsbad Oaks North, Emerald Pointe, and Rancho La Costa Preserves are regularly monitored by Preserve Managers (Figure 4). Populations monitored as part of the SDMMP rare plant monitoring program include Carlsbad Raceway, Emerald Pointe, Palomar Airport (County-owned preserve), and Rancho Carrillo (HOA-owned and managed preserve).

Status

As is typical for many annual species, San Diego thornmint counts varied tremendously at each location between 2008 and 2020 (**Table 3**). Due to the high annual variability of the populations, it is difficult to determine the overall trend of a specific population or the species as a whole. To better understand what drives dynamics of the species populations in Carlsbad, CNLM is conducting studies to evaluate the status of the plants in relation to weather, cover of native and non-native forbs and grasses, and invasive species removal. CNLM is also conducting genetic studies to understand the genetic diversity and structure of the species.

Overall, this species appears to be thriving and is well-protected on Carlsbad Oaks North, Palomar Airport (outside the HMP), and Rancho La Costa Preserves; however, populations on Carlsbad Raceway, Emerald Pointe, and Rancho Carrillo Preserves are very small and vulnerable to extirpation, which appears to have happened on the Calavera Hills/Robertson Ranch site.

TABLE 3
POPULATION OF SAN DIEGO THORNMINT ON CARLSBAD PRESERVES

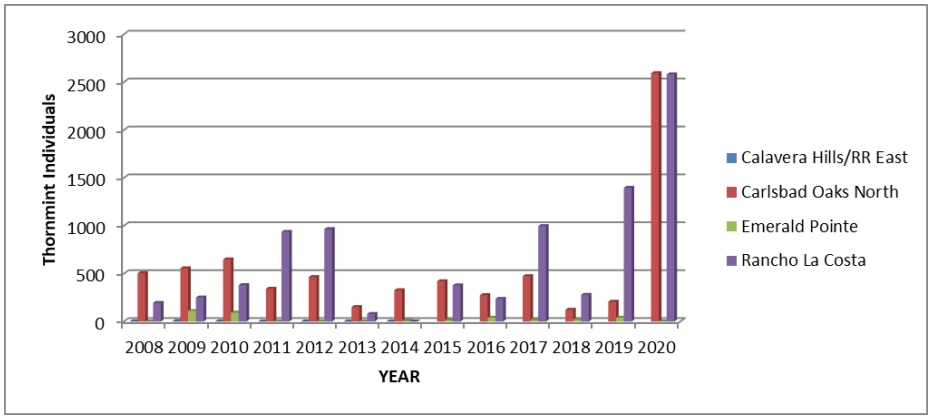
	Number of Individuals												
Preserve	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Calavera Hills/Robertson Ranch	2	4	2	0	0	NS	NS	NS	NS	NS	NS	NS	NS
Carlsbad Oaks North	505	556	648	342	464	151	327	420	276	474	123	207	2,593
Carlsbad Raceway	NS	NS	26	NS	NS	NS	NS	NS	NS	3	9	5	15
Emerald Pointe	NS	110	93	NS	NS	NS	6	14	39	17	22	40	0
Palomar Airport (outside HMP)	NS	NS	UR	NS	NS	NS	NS	NS	15,000	35,107	1,708	6,380	1,475
Rancho Carrillo	NS	NS	NS	NS	NS	NS	NS	NS	NS	23	3	5	11
Rancho La Costa (the Greens)	194	251	380	936	965	79	652	378	237	996	278	1,396	2,580

NS = not surveyed

UR = surveyed but unreported

* Measurements from Palomar-McClellan Airport in Carlsbad, CA (NOAA 2020). Data taken from Nov-April. The year presented coincides with the end of the rainy season

San Diego Thornmint Population on Carlsbad Preserves



*Calavera Hills/RR East = Calavera Hills/Robertson Ranch

**Outliers Carlsbad Raceway, Emerald Pointe, and Palomar Airport not included. Refer to Table 3.

Major Threats

The major threats to San Diego thornmint are invasive plant species, such as tocalote (*Centaurea melitensis*) and purple false brome (*Brachypodium distachyon*); human use and trampling; habitat fragmentation with loss of pollinators; climate change and prolonged drought; and small populations that are more vulnerable to environmental conditions (SDMMP 2017a). Where small numbers of the species are found, such as Carlsbad Raceway, Emerald Pointe, and Rancho Carrillo, hand watering, seed bulking and population augmentation could help ensure that the population does not become extirpated. It is critical to continue intensive invasive plant species removal efforts, as this currently appears to be the largest threat to the species' decline.

Management Actions Conducted to Protect the Species

Management and monitoring strategies for San Diego thornmint have been developed by SDMMP and CNLM based on the best available science and local knowledge of land managers. The strategies include implementing a seed banking and bulking plan, inspecting conserved occurrences on an annual basis, developing habitat suitability and climate change modeling, and additional refinement of BMPs. Management generally focuses on intensive invasive species removal around San Diego thornmint populations (including hand weeding around plants), thatch removal, and access control. The Rancho Carrillo population remains unmanaged.

In addition to general management, CNLM has commenced a San Diego thornmint out-seeding program in 2017 to enhance and buffer their existing occurrences (CNLM 2018a). CNLM attained both federal and state permits for these activities. Seed was collected from 2017 to 2020 from within Carlsbad, and was distributed to unoccupied habitat in 2019, 2020, and 2021, occurring once per out-seeding location. Results have been mixed; San Diego thornmint have flowered in several locations and increased in numbers each year, but at other locations, only a few have flowered. San Diego Habitat Conservancy has initiated seed collection for future seed bulking and expansion of the small populations on Carlsbad Raceway and Emerald Pointe and will continue weeding and hand watering as necessary to prevent extirpation.

3.1.2 Thread-Leaved Brodiaea

Brodiaea filifolia

Status: federally threatened, state endangered

MHCP Critical Locations and Major Populations

The MHCP identified critical locations/major populations in the following preserves: Calavera Hills Phase II, Carlsbad Highlands Ecological Reserve, Rancho Carrillo, Fox-Miller, Brodiaea Preserve, and Rancho La Costa. This is an endemic species to San Diego County and known from 20 occurrences on Conserved Lands (SDMMP 2017a).

Long-Term Monitoring

Index Plot Monitoring

Long-term monitoring of thread-leaved brodiaea consists of monitoring index plots at preserves managed by CNLM and CDFW. Index plots are used to sample a subset of the entire populations

to evaluate trends in vegetative individuals and flowering rates. Some occurrences have thousands of individuals, which is too difficult and exhaustive to monitor. This is a preferred method to counting just flowers, as vegetative growth occurs annually, and flowering rates vary in relation to total precipitation. Index plots were monitored annually between 2012 and 2017, then every other year thereafter when numbers indicated the population was stable enough to reduce frequency (CNLM 2019a).

Life-History Study

CNLM initiated a 5-year life-history study in the winter of 2013–2014 that was completed in 2018 on its preserves. Life-history plots tracked individual plants throughout the vegetation and flowering phases of thread-leaved brodiaea each season from year to year, with the purpose of providing information about the degree of flowering, variance of dormancy, and how these factors relate to flowering. This information was used to determine the best method for estimating counts (e.g., whether flowering counts are a suitable replacement for vegetative counts).

Pollinator Study

CNLM and other entities have observed a lack of seed pod and seed production on flowering thread-leaved brodiaea individuals. This lack of seed production may be attributed to a reported self-incompatibility issue (Niehaus 1971), but could also be due to a lack of pollinators or effective pollination services. To investigate the lack of seed pod and seed production in thread-leaved brodiaea, CNLM developed a pollinator study to assess pollinator diversity and abundance, flower visitation rates, and seed pod and seed production. The study began in 2019 within known areas of thread-leaved brodiaea occurrences on CNLM Preserves (Rancho La Costa, Buena Vista Creek, and Calavera Hills).

Status

Overall, this species is considered to be doing relatively well within Carlsbad. Vegetative counts of this species appear to be relatively stable but flowering counts vary tremendously year to year depending on timing and amount of precipitation, the season during which the surveys were conducted, and other factors that are undetermined. CNLM has determined that the plant count during the flowering season may represent 0 to 35 percent of the actual population size, since only a fraction of a population flowers at a given time. Figure 4 shows known locations of thread-leaved brodiaea in Carlsbad and USFWS critical habitat for this species. **Tables 4 and 5** show the vegetative and flowering counts.

The results of the life history study concluded that vegetative production is relatively consistent across years despite differences in annual precipitation, and dormancy associated with little precipitation was not observed; individuals with four leaves tend to flower more than individuals with fewer than four; and flowering percentage seems to be correlated with total precipitation (CNLM 2020a).

Pollinator diversity and abundance results from pan traps are included in **Table 6**, and pollinator visitation rates are included in **Table 7**. Seed production results are included in **Table 8**. Based on 2020 pollination study results, specifically the level of seed pod development and seed production, CNLM concluded that pollinators can effectively pollinate thread-leaved brodiaea

and produce seed under the right conditions; however, total seed production is low compared to other native plants within the same habitat (CNLM 2020b).

TABLE 4
SAMPLE POPULATION OF THREAD-LEAVED BRODIAEA BY VEGETATIVE COUNT ON CARLSBAD PRESERVES

Preserve	2012	2013	2014	2015	2016	2017	2018	2019	2020
Buena Vista Creek	647	817	753	979	1,047	1,338	NS	1,684	NS
Calavera/Robertson Ranch	226	628	481	505	784	773	NS	1,211	NS
Carlsbad Oaks North	102	224	189	145	217	325	NS	492	NS
Rancho La Costa	NS	3,457	2,421	4,833	2,946	3,293	NS	2,662	NS

NS = not surveyed

* Measurements from Palomar-McClellan Airport in Carlsbad, CA (NOAA 2020). Data taken from Nov-April. The year presented coincides with the April date

Sample Population of Thread-Leaved Brodiaea on Carlsbad Preserves (by Vegetative Count)

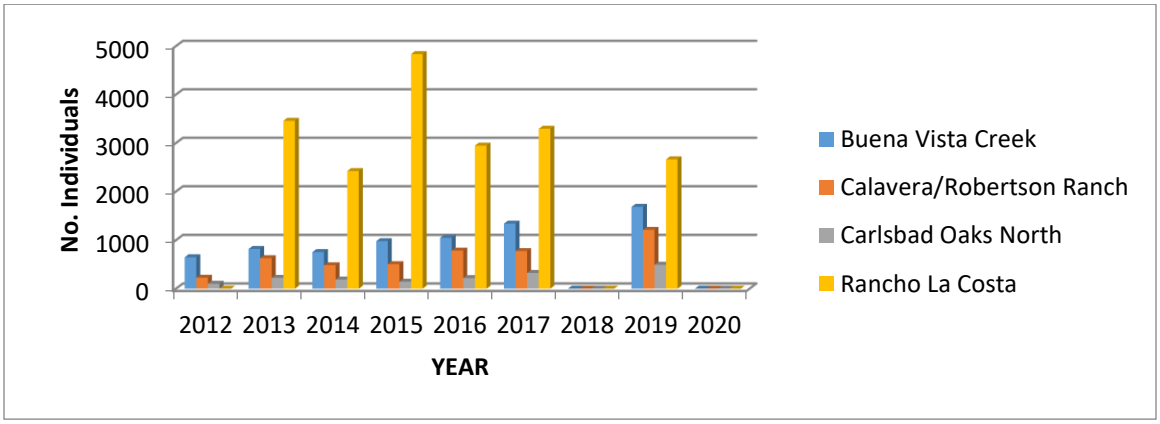


TABLE 5
SAMPLE POPULATION OF THREAD-LEAVED BRODIAEA BY FLOWERING COUNT ON CARLSBAD PRESERVES

Preserve	2012	2013	2014	2015	2016	2017	2018	2019	2020
Buena Vista Creek	0	13	2	6	25	48	NS	139	NS
Calavera/Robertson Ranch	1	3	0	22	3	26	NS	20	NS
Carlsbad Oaks North	14	1	4	30	15	67	NS	103	NS
Rancho La Costa	NS	0	0	29	90	835	NS	323	NS

NS = not surveyed

* Measurements from Palomar-McClellan Airport in Carlsbad, CA (NOAA 2020). Data taken from Nov-April. The year presented coincides with the April date

Sample Population of Thread-Leaved Brodiaea on Carlsbad Preserves (by Flowering Count)

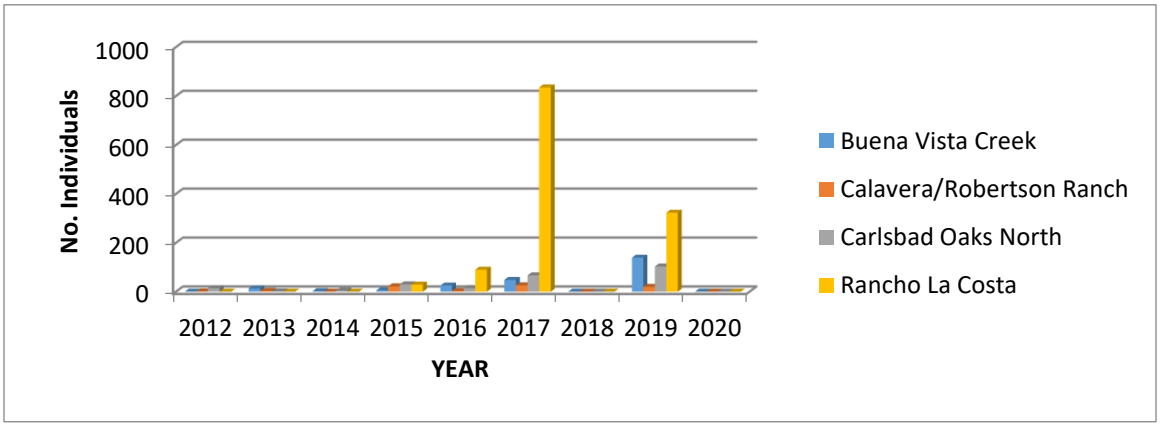


TABLE 6
POLLINATOR DIVERSITY AND ABUNDANCE ON CARLSBAD PRESERVES

	Pan Trap Diversity[1]		Pan Trap Abundance[2]		Net Capture Diversity[1]		Net Capture Abundance[2]	
Preserve	**2019**	**2020**	**2019**	**2020**	**2019**	**2020**	**2019**	**2020**
Buena Vista Creek	6	4	43	36	5	3	11	27
Calavera Hills	8	5	80	24	4	3	24	31
Rancho La Costa	5	3	44	13	4	3	12	14

NOTES:

* Diversity and abundance is based on pan trap data only

1 Diversity = number of potential pollinator species detected.

2 Abundance = number of distinct potential pollinator individuals detected.

TABLE 7
THREAD-LEAVED BRODIAEA FLOWER VISITATION RATES ON CARLSBAD PRESERVES*

Preserve	**2019**	**2020**
Buena Vista Creek	100.0	33.3
Calavera Hills	34.1	29.0
Rancho La Costa	75.0	64.3
Average	*61.4*	*37.5*

* Visitation rate: average number of minutes between pollinator visits per thread-leaved brodiaea flower.

TABLE 8
SEED PRODUCTION OF PIN-FLAGGED THREAD-LEAVED ON CARLSBAD PRESERVES

	Total Seeds		Individual Thread-Leaved Brodiaea With Seeds		# Flowers With Seeds	
Preserve	**2019[1]**	**2020[2]**	**2019[1]**	**2020[2]**	**2019[1]**	**2020[2]**
Buena Vista Creek	0	10	0	3	0	3
Calavera Hills	0	0	0	0	0	0
Rancho La Costa	6	62	2	13	2	24

NOTES:

1 In 2019, 25 thread-leaved brodiaea individuals were pin-flagged at each Preserve.

2 In 2020, 30 thread-leaved brodiaea individuals were pin-flagged at each Preserve.

Major Threats

The main threats to this species within Carlsbad are invasive non-native grass species (e.g., slender wild oat [*Avena barbata*] and purple false brome) and non-native forbs (e.g., black mustard and bristly ox-tongue [*Helminthotheca echioides*]), thatch build-up, and self-incompatibility limiting seed production (CNLM 2020a). Although it is difficult to determine the population trajectory of Carlsbad occurrences (increasing, decreasing, or stable), the populations managed by CNLM and CDFW appear to be well protected due to intensive, localized management efforts that are regularly conducted. Populations managed by other entities should, at minimum, be inspected to confirm presence and population-specific threats should be identified and addressed.

Management Actions Conducted to Protect the Species

A management and monitoring approach developed by SDMMP and CNLM includes inspecting conserved occurrences every two years beginning in 2017, implementing routine management as determined when monitoring, developing habitat suitability and climate change modeling, surveying historical occurrences to determine status, and initiating seed collection and banking. Invasive non-native species management is the primary management for this species.

3.1.4 Del Mar Mesa Sand Aster

Corethrogyne filaginifolia var. *linifolia*

Status: California Rare Plant Rank (CRPR) 1B.1

MHCP Critical Locations and Major Populations

There are no MHCP critical locations in Carlsbad. The closest MHCP major population is at the southern boundary of Carlsbad. The majority of the population within the MHCP Subregion is in the City of Encinitas but may extend into Carlsbad on private HOA lands. However, this species does occur within three Carlsbad preserves.

Long-Term Monitoring

Long-term monitoring was initiated in 2014 for the La Costa Collections population of Del Mar Mesa sand aster. The surveys consist of delineating the boundaries of sand aster patches and estimating the density of the patches using 20 stratified, random 0.25 square meter plots (J. Whalen Assoc. 2014). In 2014, the density was 0.85 per 0.25 square meter. The densities in 2015, 2016, and 2017 were 0.65, 0.8, and 0.95, respectively. A complete count from 2005 recorded 1,540 total individuals at La Costa Collections Preserve. The preserve manager estimates that numbers have increased from this count, but recent counts have not continued.

Long-term monitoring for the Manzanita Partners Preserve population was initiated in 2013. Monitoring on this preserve consists of general rare plant surveys every 10 years to confirm presence. This population was burned in the Poinsettia Fire and has not been observed within Manzanita Partners Preserve since the fire. A survey for this species will be performed in 2023 within the Manzanita Partners Preserve.

Within City Ventures Preserve, a Del Mar Mesa sand aster survey was conducted in 2018 to map the current population boundaries. The 2018 survey effort included flagging the limits of the population and initiated an annual census count, which resulted in 672 individuals. In 2019 and 2020, 662 and 828 individuals were counted within the mapped population area, respectively. Figure 4 shows the locations of Del Mar Mesa sand aster on actively managed preserves.

Status

Del Mar sand aster seems to be stable.

Major Threats

The greatest threats are unauthorized access including trails, trampling, and other edge effects, such as trash and invasive plant species.

Management Actions Conducted to Protect the Species

Populations are being managed through general habitat management (e.g., invasive plant species removal, trash removal, access control [HRS 2014; G. Cummings, personal communication, 2018]). Potentially suitable habitat for this species within the HMP preserve system, which consists of coastal bluff scrub and openings within coastal sage scrub and chaparral, is also being managed through general habitat stewardship. Del Mar Mesa sand aster was not identified by the SDMMP as a high priority for regional management and monitoring; therefore, BMPs have not been developed for this species.

3.1.3 Del Mar Manzanita

Arctostaphylos glandulosa ssp. *crassifolia*

Status: federally endangered

MHCP Critical Locations and Major Populations

The MHCP identified critical locations/major populations on preserve lands owned by the city, the County, private HOAs, and La Costa Villages.

Long-Term Monitoring

Surveys for Del Mar manzanita are conducted periodically on the following preserves: La Costa Glen, Kelly Ranch, Manzanita Partners, Morning Ridge, Poinsettia Place, and Rancho La Costa (see table below for dates) (**Figure 5**). Because the non-sensitive Eastwood manzanita (*Arctostaphylos glandulosa* ssp. *glandulosa*) also occurs on Rancho La Costa Preserve and Kelly Ranch Preserve, Del Mar manzanita has been re-mapped individuals to the subspecies level by taxonomic experts (Spiegelberg and Vinje 2008, CNLM 2018b).

Status

The number of individuals reported on other actively managed preserves ranges from 2 clumps (number of individuals unknown) to 313 individuals (**Table 9**). Three preserves burned during the Poinsettia Fire in May 2014, and post-fire surveys have not included Del Mar manzanita census counts to determine how many of the burned individuals survived. However, based on transect studies conducted to determine cover of native and non-native species, most Del Mar manzanita shrubs have resprouted at the stump, which is to be expected, as this species is highly adapted to fire.

The species is likely to persist in the Carlsbad with appropriate management of the vegetation community, rather than species-specific management. By protecting and managing the vegetation community as a whole, this species is expected to remain in stable condition.

Major Threats

Primary threats at this preserve are anthropogenic, such as frequent fire, trespass, and vandalism, as well as the introduction of invasive non-native plant species (CNLM 2019b). Several shrubs on the unmanaged Santa Fe Trails Preserve population have been removed to create bike jumps and trails. Prior to the fire, threats to the actively managed Carlsbad populations were considered minimal due to the robustness of woody shrubs (i.e., they are not as vulnerable to drought, invasive plant species encroachment, or edge effects as small annuals) and the inaccessibility of most of the known locations. In burned areas, the major threat to recovery is erosion—many of the plants occur on very steep slopes that now have little to no vegetation holding the soil in place. Generally, wildfire is not considered a major threat to Del Mar manzanita as this species evolved with fire. It typically re-sprouts from a basal burl after it has been burned and the seeds are dependent on fire to germinate (USFWS 2010). However, even with fire-adapted species, if the natural fire regime is altered (e.g., if fires become too frequent or burn too hot), the long-term effect on the species could be detrimental.

Management Actions Conducted to Protect the Species

Management actions include invasive plant species removal, access control, and public outreach. Special attention has been given to the burn areas in Rancho La Costa, Poinsettia Place, and Morning Ridge Preserves to encourage recovery of these populations.

TABLE 9
DEL MAR MANZANITA AT CARLSBAD PRESERVES

	Number of Del Mar Manzanita Individuals																
Preserve	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
La Costa Glen	NS	NS	NS	200[1]	NS	NS	NS	NS	NS	313	Unk[2]	Unk[2]	NS	Unk[2]	NS	NS	NS
Kelly Ranch	NS	NS	NS	NS	NS	2[3]	NS	NS	NS	NS	2	NS	NS	2[3]	5	13	NS
Manzanita Partners	NS	117	NS	NS	NS	NS	NS	NS	NS	117	NS	NS	NS	NS	NS	NS	NS
Morning Ridge	NS	8	NS	NS	8	NS	NS	NS	NS	NS	burned[4]	NS	NS	NS	NS	NS	NS
Poinsettia Place	53	NS	NS	NS	NS	NS	NS	NS	NS	NS	burned[4]	NS	NS	NS	NS	NS	38
Rancho La Costa	NS	>500[5]	NS	NS	9	NS	NS	NS	NS	NS	burned[4]	19	19	19	NS	NS	NS

NS = Not Surveyed

1 Conducted for the MHCP, prior to long-term management

2 Unknown number; survey conducted but exact number of individuals not reported

3 Number of clumps is reported; number of individuals is unknown

4 Pre-fire surveys were conducted on Poinsettia Place. Morning Ridge, and Rancho La Costa in 2014; post-fire counts are presumed to be zero since the entire preserve burned, including above-ground biomass. A post-fire inspection on Rancho La Costa reported seven resprouting shrubs, and one near, but undamaged by the bulldozed fire line.

5 Survey performed prior to long-term management; taxonomic confirmation of subspecies not yet conducted

3.1.5 Encinitas Baccharis

Baccharis vanessae

Status: federally threatened, state endangered

MHCP Critical Locations and Major Populations

The closest MHCP major population is at the southern boundary of Carlsbad. The majority of the population is within Encinitas but may extend into Carlsbad on La Costa Glen Preserve. Within this major population, there are critical locations identified that may occur within Carlsbad; however, presence or absence of these observations has not been confirmed in the field since surveys were conducted in the 1990s for the MHCP, except in the La Costa Glen Preserve, as described below.

Long-Term Monitoring

One Encinitas baccharis locality was reported on the La Costa Glen Preserve in the 1990s during surveys conducted for the MHCP. Long-term management for this preserve was established in January of 2013. Focused surveys were performed by CNLM: two in 2013, two in 2014, and one in 2015. Encinitas baccharis was not observed during these surveys.

Status

The status of populations within Carlsbad, if they exist, is currently unknown.

Major Threats

Major threats to this dioecious (having separate male and female individuals, both necessary for reproducation) species are altered fire regime, low seedling recruitment, low seed viability, reduced reproductive potential at older age classes, fuel modification, trampling, and invasive plant species. Small, isolated occurrences with little connectivity and dioecious life history make this species more vulnerable to changes in environmental conditions (SDMMP 2017a).

Management Actions Conducted to Protect the Species

A management and monitoring approach was developed by SDMMP (2017a) for this species and includes inspecting conserved occurrences every two years, implementing routine management informed by monitoring, surveying historical occurrences to determine status, initiating seed collection and banking, and additional refinement of BMPs. Potentially suitable habitat on actively-managed preserves in Carlsbad is being managed through general invasive plant species removal and access control.

3.1.6 Orcutt's Hazardia

Hazardia orcuttii

Status: state threatened

MHCP Critical Locations and Major Populations

There are no naturally occurring MHCP critical locations or major populations of Orcutt's hazardia in Carlsbad. If the transplanted populations in Carlsbad prove to be self-sustaining, they would be considered critical populations.

Long-Term Monitoring

Orcutt's hazardia was transplanted by CNLM to CNLM's Kelly Ranch and Rancho La Costa Preserves in 2003. Since then, CNLM has been tracking these transplants and documenting flowering adults and recruitment of juveniles and seedlings annually.

Status

By 2004, a total of 146 Orcutt's hazardia individuals were transplanted to Kelly Ranch Preserve and 200 individuals were transplanted to Rancho La Costa Preserve. As of 2020, a total of 137 individuals (85 adults, 50 juveniles, and 2 seedlings) were observed on Kelly Ranch Preserve, and 144 individuals (125 adults and 19 juveniles) were observed on Rancho La Costa Preserve (CNLM 2020d, CNLM 2020e [**Tables 10 and 11**]). Overall, the adult plants on both sites have fared well over time, becoming generally stable within a few years after the initial transplantation. The number of juvenile and seedlings at Kelly Ranch Preserve has dropped, for reasons unknown. Monitoring will continue in future years.

Major Threats

The biggest threat to this species is that it occurs in only a few locations (only one of which is a natural population, located in Encinitas; all others were transplanted), and populations are very small and isolated, making this species highly vulnerable to extirpation by a catastrophic event, such as fire or disease (SDMMP 2017a). Ongoing drought also appears to be a major threat to this species.

Management Actions Conducted to Protect the Species

All known populations, including the single naturally occurring population in Encinitas and transplanted populations in Carlsbad, are under active management by CNLM. Management activities consist of intensive invasive plant species removal, access control, and transplant studies, which have been approved by the wildlife agencies. By better understanding population dynamics, it is hoped that this program will reduce the possibility of local extinction (the species still occurs in northern Mexico) due to unforeseen events.

TABLE 10
COUNTS OF ORCUTT'S HAZARDIA TRANSPLANTED TO KELLY RANCH PRESERVE

	Number of Individuals Counted, by Year																
Life Stage	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Adults (flowering)	121	97	104	104	104	104	104	104	105	103	102	NS	105	105	102	98	85
Juveniles[2]	0	0	0	1	1	4	15	42	119	157	152	NS	141	97	89	91	50
Seedlings	0	0	0	4	17	14	68	77	55	0	0	NS	0	0	0	0	2
Total count	121	97	104	109	122	122	187	223	279	260	254	NS	246	202	191	189	137

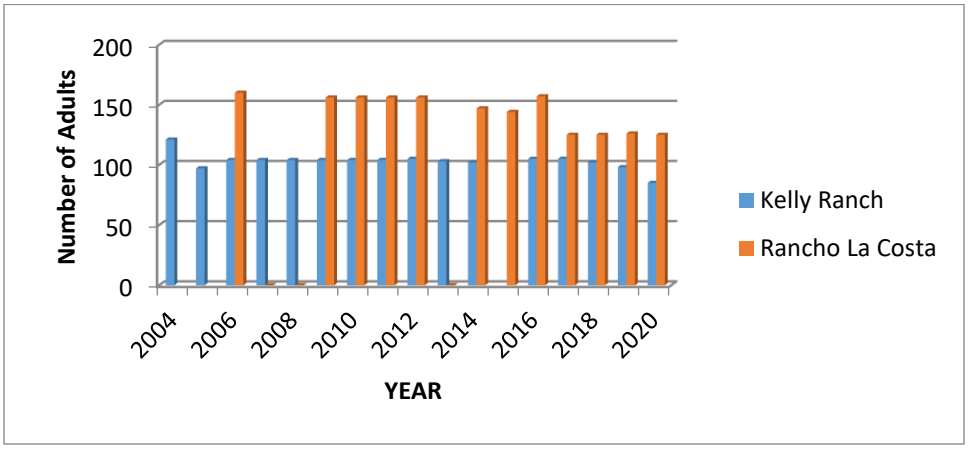
NS = not surveyed; counting was planned in 2015, but could not be completed due to staff attrition

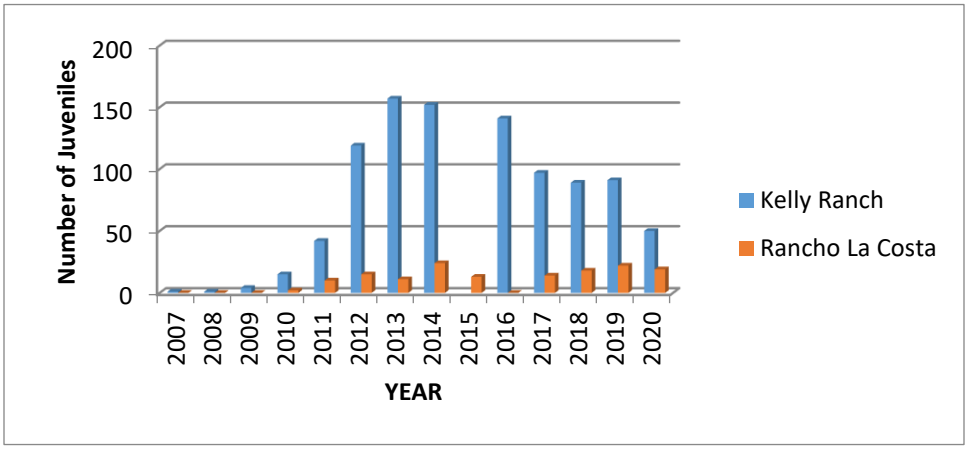
TABLE 11
COUNTS OF ORCUTT'S HAZARDIA TRANSPLANTED TO RANCHO LA COSTA PRESERVE

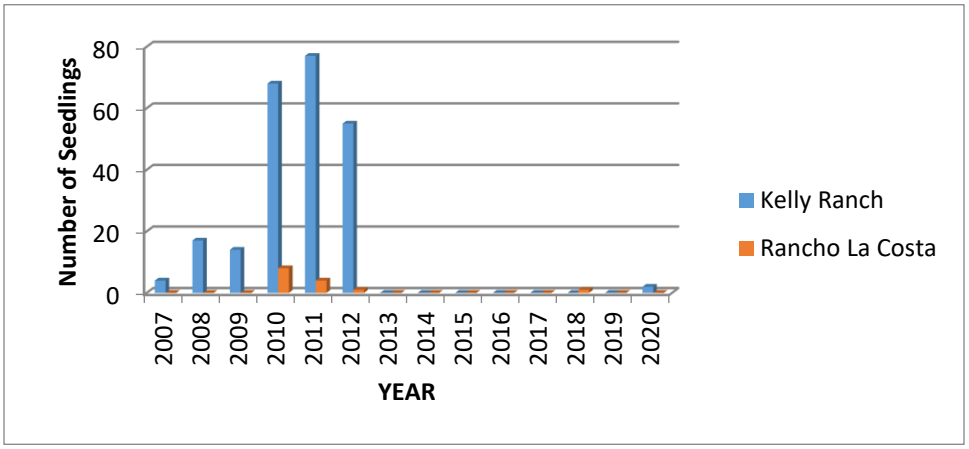
	Number of Individuals Counted, by Year														
Life Stage	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013***	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Adults (flowering)	160	NS	NS	156	156	156	156	NS	147	144	157	125	125	126	125
Juveniles	NS	NS	NS	NS	2	10	15	22	24	13	0	14	18	22	19
Seedlings	NS	NS	NS	NS	8	4	1	0	0	0	0	0	1	0	0
Total count	160	unknown	unknown	156	166	170	172	unknown	171	157	157	139	144	148	144

NS = not surveyed; *= only seedling counts performed

Counts of Adult, Juvenile, and Seedling Orcutt's Hazardia







3.2 Vernal Pool Species

California Orcutt Grass
Orcuttia californica
Status: federally endangered, state endangered

Little Mousetail
Myosurus minimus ssp. *Apus*
Status: CRPR 3.1

San Diego Button Celery
Eryngium aristulatum var. *parishii*
Status: federally endangered, state endangered

Spreading Navarretia
Navarretia fossalis
Status: federally threatened

Riverside Fairy Shrimp
Streptocephalus woottoni
Status: federally endangered

San Diego Fairy Shrimp
Branchinecta sandiegonensis
Status: federally endangered

MHCP Critical Locations and Major Populations

There are three vernal pool complexes in the HMP preserve system: (1) Poinsettia Station, (2) Hieatt property, north of the airport, and (3) Manzanita Partners Preserve, east of El Camino Real and south of the airport (**Figure 6**). The Poinsettia Station vernal pool has been identified as a MHCP critical location and major population for all vernal pool species listed above. The city received HMP coverage for these species in 2019 as a result of taking over long-term management of the site. Neither Hieatt Property nor Manzanita Partners Preserve were identified by the MHCP as critical locations or major populations.

Long-Term Monitoring

Baseline rare plant surveys and hydrological monitoring was conducted by Dudek at the Poinsettia Station pools in 2019 and 2020 when long-term management by the city was initiated. Long-term monitoring at the Manzanita Partners Preserve consists of annual general condition assessments. Although the Hieatt Preserve pools are not under active management, a site visit to evaluate status and threats was conducted by the HMP Preserve Steward and the city in January 2018 following a minor rain.

Status

Poinsettia Station

In 2019 and 2020, 16 vernal pool indicator plant species were observed on site during baseline vernal pool floral surveys. Of these 16 species, 4 are recognized as special-status species by USFWS, CDFW, and/or considered a Narrow Endemic under the MHCP: Orcutt's brodiaea (*Brodiaea orcuttii*), San Diego button celery, spreading navarretia (*Navarretia fossalis*), and California Orcutt grass (*Orcuttia californica*). In addition, two federally endangered fairy shrimp species were detected, including San Diego fairy shrimp and Riverside fairy shrimp (*Streptocephalus woottoni*). In 2019, both pools were visited too late in the season to detect presence of San Diego fairy shrimp; however, San Diego fairy shrimp was detected in both pools in 2020. Riverside fairy shrimp was detected in the southernmost pool in the preserve in 2019 and 2020.

Hieatt Properties

When surveyed in 2006, the pools did not contain any sensitive species, but contained the following vernal pool indicator species: dwarf wooly-heads (*Psilocarphus brevissimus* var. *brevissimus*), water pygmyweed (*Crassula aquatica*), chaffweed (*Centunculus minimus*), and

grass poly (*Lythrum hyssopifolia*). During the January 2018 visit to the Hieatt Properties, there was no sign of ponding; however, there were clear signs of a vernal pool matrix throughout the property, as previously mapped.

Manzanita Partners

Federally endangered San Diego fairy shrimp was observed in four pools during 2019 and 2020 monitoring efforts with thousands to hundreds of thousands of fairy shrimp individuals detected. San Diego button celery (*Eryngium aristulatum*) was documented during 2018, 2019, and 2020 monitoring (HRS 2020). All but two of the vernal pools were full during rain events in the winter of 2019/2020. Site visits conducted in 2020 indicated that non-native grasses and forbs, such as longbeak stork's bill (*Erodium botrys*), are no longer a major issue within the vernal pools due to weed control efforts and increased pooling from adequate precipitation.

Other Locations

Additional vernal pools have been identified to the north of the Poinsettia Lanes site along the same NCTD right-of-way (Rosie 2010), although these are outside of the HMP boundary. Several of these pools are reported to support San Diego fairy shrimp. These pools, which are generally in poor condition (few vernal pool species and dense cover of non-native grasses), are not currently protected by a conservation easement or other open space protection.

Major Threats

Non-native plants, as well as lack of precipitation, remain key threats to vernal pools. However, with adequate precipitation, non-native plants are drowned out and native species adapted for vernal pool conditions are able to dominate. Encroachment of upland shrubs and altered hydrology are the primary threats at the Poinsettia Station Preserve.

Management Actions Conducted to Protect the Species

Poinsettia Station

The city has recently obtained legal control over the protection, management, and monitoring of the Poinsettia Station vernal pools. Intensive weed removal within the pool basins was performed in 2019 and 2020. Future management will focus on annual non-native plant control and control of native shrubs that are encroaching into the pools.

Hieatt Property

The Hieatt property vernal pools are not being actively managed.

Manzanita Partners

Long-term management focuses on invasive species control and access control.

3.3 Lagoon/Coastal Bird Species

3.3.1 Belding's Savannah Sparrow

Passerculus sandwichensis beldingi

Status: state endangered

MHCP Critical Locations and Major Populations

The MHCP critical locations and major populations for Belding's savannah sparrow are located in Agua Hedionda Lagoon and Batiquitos Lagoon, which are managed by CDFW.

Long-Term Monitoring

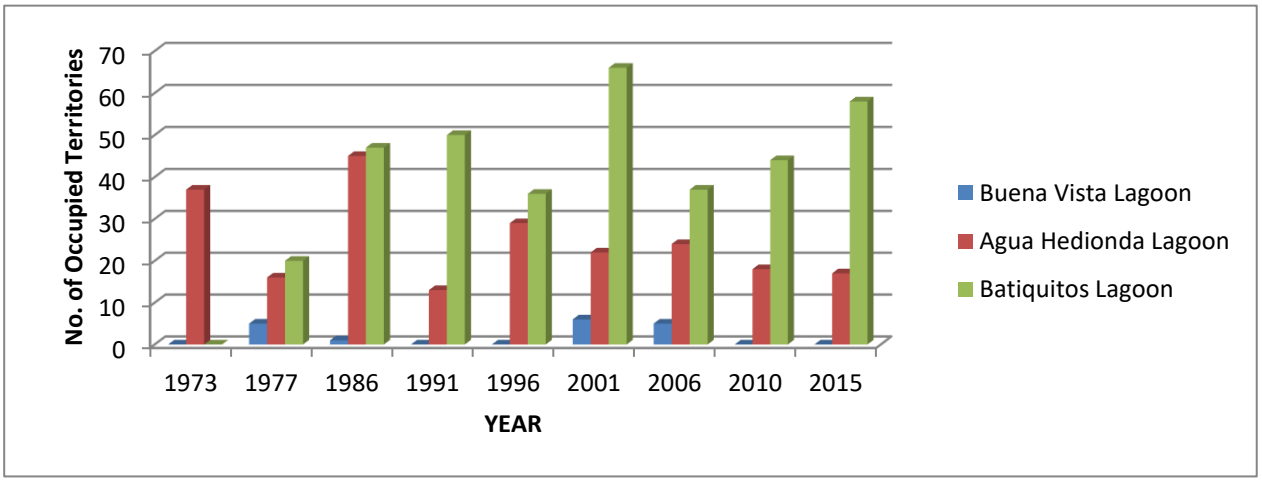
Surveys are conducted approximately every five years as part of an ongoing statewide census effort. The most recent census information available is from 2015; 2020 surveys were postponed due to the COVID-19 stay-at-home order but are planned to occur in 2021 (R. Zembal, personal communication, 2020). In 2015, 27 coastal salt marshes in California were surveyed (Zembal et al. 2015).

Status

The number of territories rose at Batiquitos Lagoon since the 2010 surveys and remained largely the same for both Agua Hedionda and Buena Vista Lagoons (**Table 12**, **Figure 7**). At Agua Hedionda Lagoon, the 2015 surveys revealed one fewer territory than 2010 surveys—a 6 percent decline in territories from 2010. At Batiquitos Lagoon, the 2015 surveys showed a 32 percent increase in territories from 2010 surveys, which revealed there was a 19 percent increase from the 2006 surveys; this was after a 44 percent decrease from the 2001 numbers due to an inundation of brackish marsh habitat (Zembal et al. 2015). At Buena Vista Lagoon, the 2015 surveys revealed that the formerly occupied territories (2006 and prior) did not contain Belding's savannah sparrow.

TABLE 12
NUMBER OF OCCUPIED BELDING'S SAVANNAH SPARROW TERRITORIES BY YEAR

	1973	1977	1986	1991	1996	2001	2006	2010	2015
Buena Vista Lagoon	0	5	1	0	0	6	5	0	0
Agua Hedionda Lagoon	37	16	45	13	29	22	24	18	17
Batiquitos Lagoon	0	20	47	50	36	66	37	44	58



Major Threats

Encroachment of freshwater and the transition of saltwater marsh habitat to brackish marsh, as well as the corresponding rise of territorial song sparrows, proliferation of invasive species, and human disturbances continue to exert pressure upon Belding's savannah sparrow and the habitat necessary to support the species (Zembal et al. 2015).

Human trespass and off-leash dogs continue to be a problem, resulting in habitat that is too heavily trafficked to support this species in much of the lagoon. Although CDFW is actively working to control detrimental species, including invasive algae (*Caulerpa taxifolia*) and Algerian sea-lavender (*Limonium ramosissimum*), much of the previously existing Belding's savannah sparrow habitat has been affected and no longer supports adequate nest cover (Zembal et al. 2015).

Management Actions Conducted to Protect the Species

Past restoration of Batiquitos Lagoon resulted in the expansion of pickleweed, which is a critical component of Belding's savannah sparrow habitat, and likely led to the doubling of the population between the 1996 and 2001 surveys. At Agua Hedionda Lagoon, CalTrans has installed low fencing along the northern edge of the lagoon, which helped minimally to exclude potential trespassers. CDFW's top management priorities are habitat enhancement, protection, and restoration to improve tidal flushing; sediment control; limiting human disturbances; and the continued funding of a statewide census.

3.3.2 California Least Tern

Sterna antillarum browni

Status: federally endangered, state endangered and fully protected

MHCP Critical Locations and Major Populations

MHCP critical locations have been identified in all three lagoons. The population at Batiquitos Lagoon is considered an MHCP major population.

Long-Term Monitoring

Least tern monitoring, funded by CDFW, has been conducted annually at Batiquitos Lagoon from 1973 to 2020 as part of a statewide census (Figure 7).

Status

Estimates of number of breeding pairs, nests, and fledglings are presented in **Table 13**. Data for 2020 surveys were collected but not available during the preparation of this report. Based on 2016 monitoring data, Batiquitos Lagoon was among six breeding sites within the state of California that had over 300 breeding pairs, which represented 72 percent of the state's total (Frost 2017). Measures of productivity, including number of nests, breeding pairs, clutch size, and number of surviving fledglings have been variable over time, and it is difficult to evaluate the overall trends of this subpopulation. However, the precipitous drop in the number of surviving fledglings, which decreased by more than 80 percent between 2010 and 2011 was likely due to the lack of funding

for monitoring and predator control (Foster 2011, Sisson 2011). Another steep drop in number of fledglings occurred between 2017 and 2019, but the reasons are unknown (J. Boland, personal communication, 2021).

Major Threats

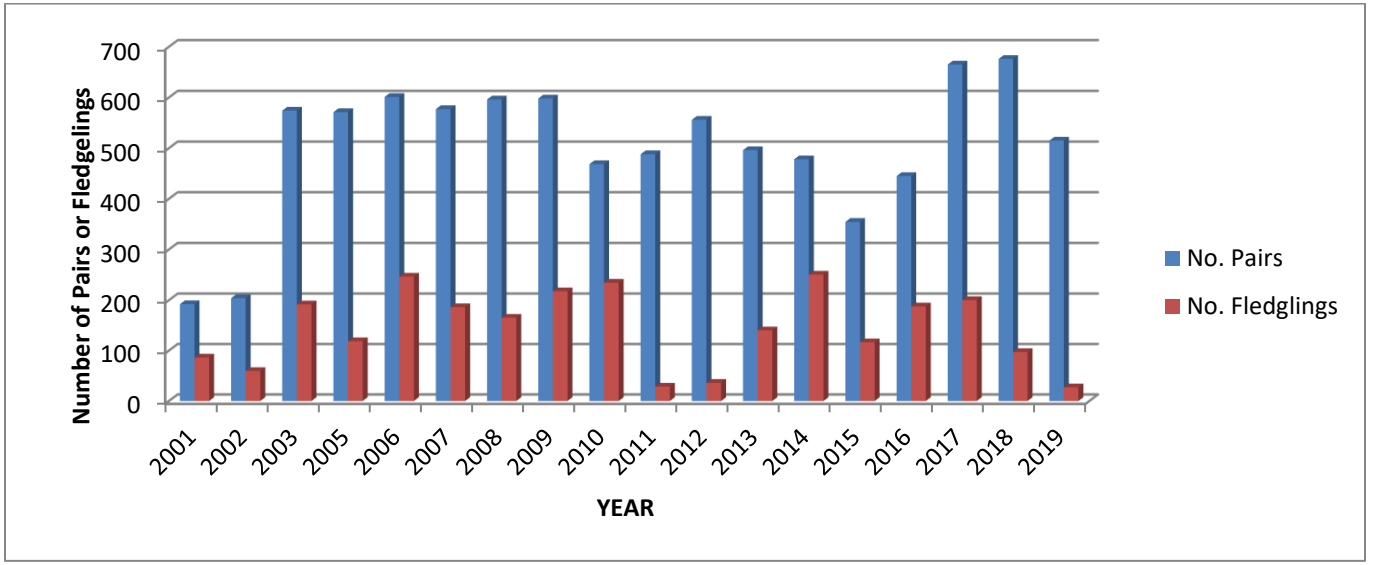
Monitoring reports for 2017–2020, which discuss potential threats to this species, were unavailable during the preparation of this report. As of 2016, the threat of predation from peregrine falcon (*Falco peregrinus*), common raven (*Corvus corax*), northern harrier (*Circus cyaneus*), rat species, and coyote (*Canis latrans*), was an ongoing concern for the species (Frost 2017). However, in 2016, mortality due to non-predation factors was significantly greater than mortality due to predation, with the largest factor being abandonment both prior to hatching and post-term (Frost 2017). A lack of sufficient foraging habitat was thought to be a major limiting factor in California least tern population growth and could be contributing to abandonment.

Management Actions Conducted to Protect the Species

A management and monitoring approach for this species was developed by SDMMP (SDMMP 2017a) and includes predator control at breeding colonies, annual monitoring per CDFW protocols, inspection of habitat and document management needs, and implementation of routine management as necessary. Annual management actions for this species include fencing, interpretative signage, nest marking, chick shelters, vegetation management, and predator management (Frost 2017).

TABLE 13
NUMBER OF CALIFORNIA LEAST TERN NESTS, PAIRS, AND FLEDGLINGS BY YEAR

	2001	2002	2003	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
No. Nests	222	226	615	596	627	594	610	649	480	532	563	558	479	415	451	692	684	548
No. Pairs	192	203-205	574	571	601	575-578	596	576-620	457-480	457-519	550-562	433-559	478	296-413	445	658-671	667-684	481-548
Estimated No. of Fledglings	73-99	53-66	155-228	109-128	223-270	146-226	143-187	212-233	208-261	20-37	34-38	117-163	232-269	90-143	175-200	175-225	94-99	22-31



3.3.3 Light-Footed Ridgway's Rail

Rallus longirostris levipes (*Rallus obsoletus levipes*)

Status: federally endangered, state endangered and fully protected

MHCP Critical Locations and Major Populations

MHCP critical locations and major populations have been identified at all three lagoons in Carlsbad.

Long-Term Monitoring

In 2020, the 41st consecutive annual census of Ridgway's rails in California coastal wetlands was conducted in 25 locations by assessing call counts. This long-term annual monitoring program, which extends from Mugu Lagoon in Ventura County to Tijuana Marsh National Wildlife Refuge on the Mexican border, is funded by CDFW. Ridgway's rails are typically monitored by spring call counts and winter high tide counts.

Status

Three subpopulations occur in Carlsbad in the Buena Vista, Agua Hedionda, and Batiquitos Lagoons, which account for approximately 10 percent of the total California population (Figure 7). Batiquitos Lagoon supports the fourth largest subpopulation in the state and the largest subpopulation in Carlsbad. This subpopulation has shown a steady increase since census monitoring began in 1980. The Agua Hedionda Lagoon and Buena Vista Lagoon populations have been variable over time. Results through the 2020 season are summarized below for areas within Carlsbad (Zembal et al. 2020) (**Table 14**).

Implementation of the management actions described below appear to be successful in protecting and expanding this species within Carlsbad, although it is unclear if the Batiquitos Lagoon, Agua Hedionda Lagoon, and Buena Vista Lagoon subpopulations are stable and self-sustaining without the introduction of captive-bred individuals.

Major Threats

Significant habitat degradation due to increasing tides and ocean inlet closures (as well as invasion by non-native trees and shrubs), development, and predators continue to be the greatest threats to the light-footed Ridgway's rail (Zembal et al. 2020).

Management Actions Conducted to Protect the Species

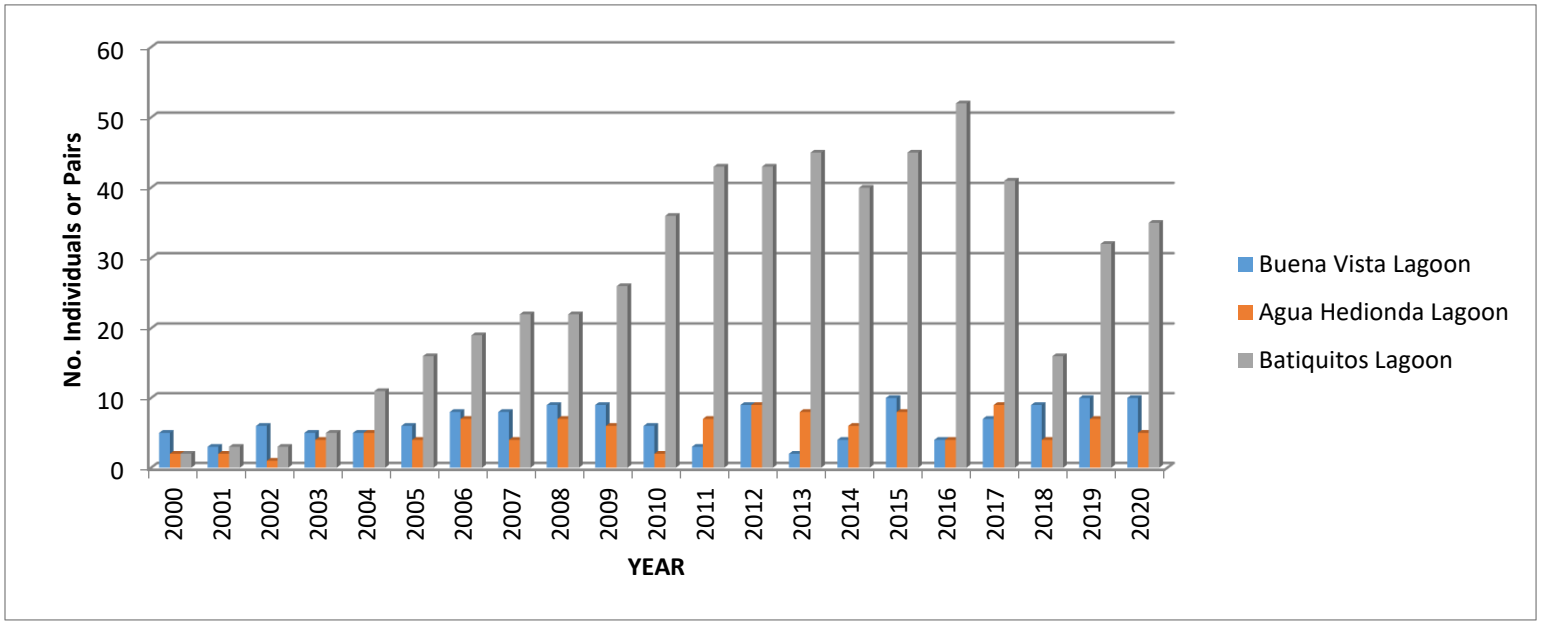
A management and monitoring approach for this species was developed by SDMMP (SDMMP 2017a). It includes monitoring occurrences annually through 2021 to record abundance, threats, and management needs and implementing routine management of habitat and vegetation per the needs of Ridgway's rail. CDFW priorities for the species are continued habitat enhancement/restoration, and funding of the statewide census.

TABLE 14
NUMBER OF PAIRS OR UNPAIRED INDIVIDUALS OF RIDGWAY'S RAILS BY YEAR

Lagoon	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Buena Vista	5[1]	3[1]	6[1]	5[1]	5[1]	6[1]	8[1]	8[1]	9[1]	9[1]	6	3[1]	9[1]	2	4	10	4	7	9[1]	10	10
Agua Hedionda	2	2	1	4	5	4[1]	7[1]	4	7	6	2[1]	7	9	8	7[1]	8	4	9	4	7	5
Batiquitos	2[1]	3[1]	3[1]	5	11	16[1]	19[1]	22	22	26[1]	36[1]	43[1]	43[1]	45	40	45	52	41	16	32	35

[1] represents pairs only but singles were also observed

UR=Currently, data is unreported



Management actions at all three lagoons Buena Vista Lagoon, Agua Hedionda Lagoon, and Batiquitos Lagoon, include habitat restoration and tidal enhancement, predator study and control program, nesting site provision, adaptive management studies, captive breeding, genetic and demographic augmentation of smaller subpopulations, and continued long-term monitoring of population status and effects of management actions (Zembal et al. 2020). A total of 67 rails were released from captive-bred rails in Batiquitos Lagoon between 2004 and 2019; at Agua Hedionda Lagoon, 36 rails were released between 2004 and 2013; and at Buena Vista Lagoon, 20 rails were released between 2011 and 2016 (Zembal et al. 2020).

3.3.4 Western Snowy Plover

Charadrius alexandrinus nivosus

Status: federally threatened

MHCP Critical Locations and Major Populations

MHCP critical locations and major populations have been identified at all three lagoons. The western snowy plover does not nest at Agua Hedionda Lagoon or Buena Vista Lagoon and has not been observed at either location during winter surveys. It nests at Batiquitos Lagoon Ecological Reserve (C. Beck, personal communication, 2018).

Long-Term Monitoring

Western snowy plover monitoring has been conducted annually at Batiquitos Lagoon through 2017 as part of a statewide census (Figure 7).

Status

Monitoring results from 1997 to 2019 are summarized below (**Table 15**). Monitoring data were not obtained for 2018 and 2020. Numbers were obtained for 2019 (M. Burlaza, personal communication, 2021). The numbers of nests, breeding adults, and fledglings at Batiquitos Lagoon plummeted in 2006 and remained low thereafter, which is consistent throughout California (Squires and Wolf 2010). A further decline has occurred at Batiquitos since 2014, which is not consistent with the rest of the state (Feucht et al. 2017). None were observed in 2017. The reason for this is unclear.

Major Threats

Avian predators continue to be a major threat to the western snowy plover, as well as a decline in suitable foraging habitat as loss of salt pan and mud flat areas has reduced typical food sources for this species (C. Beck, personal communication, 2018).

Management Actions Conducted to Protect the Species

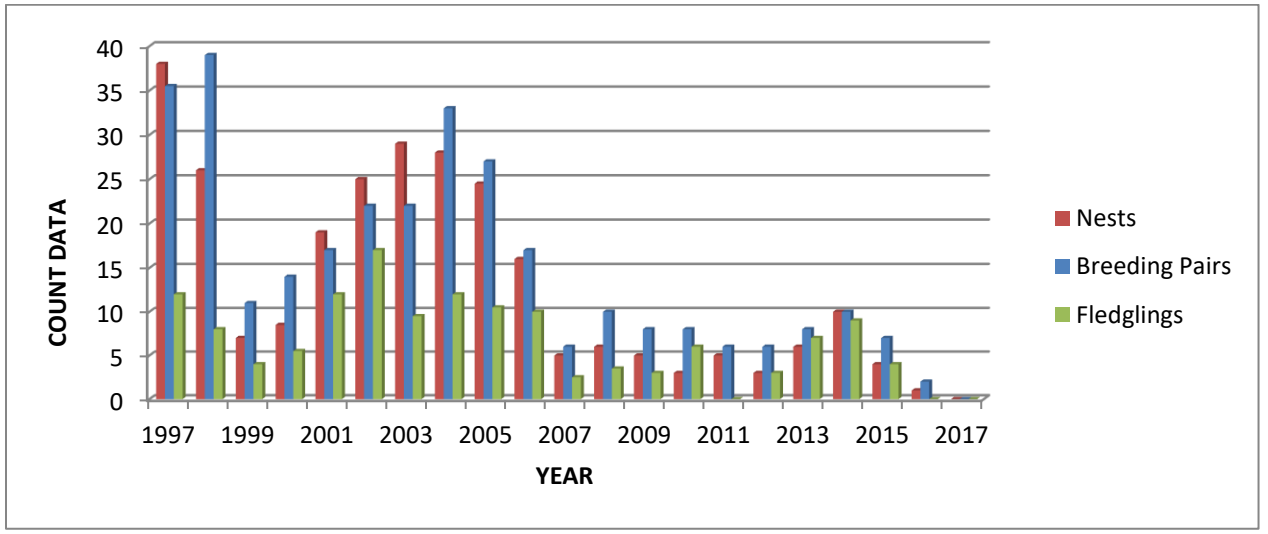
CDFW performs the following activities to encourage western snowy plover nesting: (1) habitat management - maintaining pathways linking the breeding habitat with the north mudflats; (2) predator control - placing wire cages over active nests to protect the eggs; and (3) vegetation management around nesting sites (Beck 2016). In addition, a management and monitoring approach for this species was developed by SDMMP (2017a), which includes monitoring occurrences through 2021 to document abundance, threats, and necessary management actions; refining BMPs based on results; implementing high priority management actions; and monitoring the success of such actions.

TABLE 15
WESTERN SNOWY PLOVER MONITORING RESULTS FOR BATIQUITOS LAGOON

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Breeding Pairs	36	39	11	14	17	22	22	33	27	17	6	10	8	8	6	6	8	10	7	2	0	UR	1
Nests	38	26	7	9	19	25	29	28	25	16	5	6	5	3	5	3	6	10	4	1	0	UR	1
Fledglings	12	8	4	6	12	17	10	12	11	10	3	4	3	6	0	3	7	9	4	0	0	UR	1

NOTE: Averages are displayed for ranges given in original data set

UR = surveyed but unreported



3.4 Riparian Bird Species

3.4.1 Least Bell's Vireo

Vireo bellii pusillus

Status: federally endangered, state endangered

MHCP Critical Locations and Major Populations

There are no MHCP critical locations or major populations of least Bell's vireo in Carlsbad.

Long-Term Monitoring

Focused species surveys were conducted in suitable habitat on several preserves by CNLM between 2008 and 2020. Incidental observations made during other activities were also recorded. The purpose of the surveys is to periodically inspect suitable habitat, map occurrences, and identify threats to inform site-specific management. Figure 8 shows the locations of observations from focused surveys and incidental observations.

Status

Since surveys began in 2008, the number of least Bell's vireo pairs and/or individual males on Buena Vista Creek Ecological Reserve, Calavera Hills/Robertson Ranch, Encinas Creek, and city-owned preserves is variable (**Table 16**). On Buena Vista Creek Ecological Reserve, which has the greatest number of territories as indicated by pairs or territorial males, numbers varied from 3 to 12 over 13 years. On actively managed preserves, least Bell's vireo habitat is well-protected and appears to be in good condition.

Major Threats

Threats to this species include loss of overall riparian habitat, altered hydrological conditions, nest parasitism by the brown-headed cowbird, and habitat degradation through the introduction of tamarisk (*Tamarix* spp.), giant reed (*Arundo donax*), and other invasive species. The shot hole borer (*Euwallacea* spp.) and the associated fusarium dieback disease, which is known to harm, and often kill, many riparian tree species least Bell's vireo depend on for habitat such as willows (*Salix* spp.), is a major threat to this species. Shot hole borer was identified at The Crossings Preserve in 2016.

Management Actions Conducted to Protect the Species

This species is managed through general habitat management (e.g., trash pick-up, access control, patrols, invasive species removal), as well as brown-headed cowbird trapping (CNLM 2020c). Restoration and habitat enhancement activities are performed annually and have occurred on over 5 and 55 acres, respectively (CNLM 2020e).

Many of the riparian trees that were most impacted from shot hole borer at The Crossings Preserve were removed in September 2018. The removal area is monitored annually, with no increase in infected trees since; additionally, about 25% of the cut trees have since re-sprouted (CNLM 2020c). A direct correlation between negative impacts from shot hole borer and a decreased presence of least Bell's vireo has not been observed within Carlsbad.

TABLE 16
ESTIMATED NUMBER OF LEAST BELL'S VIREO PAIRS

Preserve	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Buena Vista Creek Ecological Reserve	3–4 pair	3 pair	7 pair	3 pair[1]	NS	NS	10–12 males[2]	NS	2 pair	NS	10–12 males[2]	NS	Det.[1]
		3 males	3 males	2 males[1]					7 males				
Calavera Hills/ Robertson Ranch	1 pair[1]	1 indv[1]	NS	NS	NS	3 males[1]	2 males[1]	NS	NS	3 males	1 pair[1]	Det.[1]	Det.[1]
	1 male[1]										3 male[1]		
Encinas Creek	1 pair	1 pair	1 male	1 male	0	1 male	0	0	0	0	0	0	NS[4]
		3 males											
Rancho La Costa Preserve	NS	NS	NS	2 indv[1]	NS	NS	0[3]	NS	NS	NS	NS	0	Det.[1]
Quarry Creek Preserve	NA	NA	NA	NA	NA	NA	NA	NA	1 pair[1]	NS	NS	7 indv	2 indv[1]
									1 male				
City Preserves													
The Crossings Golf Course	NS	1 pair	1 pair	0	NS	1 male[3]	NS	NS	0	NS	NS	0	NS
		3 males	3 males										
Lake Calavera	NS	0	0	0	NS	0	1 male[1]	NS	0	NS	NS	0	NS
Poinsettia Park	NS	0	0	0	NS	0	NS	NS	0	NS	NS	0	NS
Lagoon Lane	NS	0	0	0	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS = not surveyed
NA = not applicable because preserve was not acquired yet.
Det. = detected, but number of individuals not confirmed.

1 Incidental observation
2 Territorial
3 Migratory male
4 Survey cancelled/postponed due to COVID-19.

3.4.2 Southwestern Willow Flycatcher

Empidonax traillii extimus

Status: federally endangered, state endangered

MHCP Critical Locations and Major Populations

There are no MHCP critical locations or major populations in Carlsbad and it appears that there are only two nesting colonies within San Diego County—one along the Upper San Luis Rey River and one along the Santa Margarita River (SDMMP 2017a). USFWS proposed critical habitat is located along Agua Hedionda Creek, east of El Camino Real, and along the eastern portion of Agua Hedionda Lagoon, west of El Camino Real (Figure 8).

Long-Term Monitoring

Focused species surveys for the southwestern willow flycatcher are conducted concurrently with least Bell's vireo surveys on CNLM-managed preserves, as these species have similar habitat requirements.

Status

This species does not appear to breed in Carlsbad, and suitable habitat is limited within the preserve system. A migratory southwest willow flycatcher was observed many years ago at The Crossings Preserve (Cotton/Beland/Associates, Inc. 2000), and suitable habitat exists from near Cannon Road up to the old quarry area along Macario Creek and at Lake Calavera (CNLM 2013). One willow flycatcher was also observed at Lake Calavera in 2016, presumed to be a migrant due to the time of year (M. Spiegelberg, personal communication, 2018).

Major Threats

Threats to this species in San Diego County include loss of and modification to natural habitat, predation by the brown-headed cowbird, altered hydrology within habitats, urbanization, agricultural practices, and heavy recreational use (SDMMP 2017a). Loss of habitat from shot-hole borer/Fusarium die back may also be a threat. SDMMP has stated that daily management activities alone will not ensure that this species is protected.

Management Actions Conducted to Protect the Species

Annual non-native species removal and shot hole borer surveillance continue annually to improve riparian habitat onsite (CNLM 2020e).

3.5 Upland Bird Species

3.5.1 Coastal California Gnatcatcher

Polioptila californica californica

Status: federally threatened

MHCP Critical Locations and Major Populations

No MHCP major or critical populations occur in Carlsbad; however, the regional stepping-stone corridor that provides dispersal opportunities between south San Diego County and Camp Pendleton (and into Orange and Riverside Counties) runs through Carlsbad. In addition, several areas of USFWS Critical Habitat have been identified within the city (Figure 9).

Long-Term Monitoring

The city initiated a coordinated long-term monitoring survey effort across approximately 1,500 acres of coastal sage scrub in 2010 to assess the current condition (abundance, status: pair or single, and distribution) of gnatcatchers throughout the HMP preserve system (CNLM and ESA 2013). Follow up surveys were conducted in 2013. Surveys were also conducted on managed preserves and selected unmanaged preserves in the vicinity of the Aviara Master Association. In 2015, due to the stability of the local population (high occurrence, high density, and high habitat quality throughout the preserve system) and occupancy of even the smallest habitat fragments, it was decided to delay triennial monitoring and instead monitor the species at nine-year intervals. The next citywide survey is scheduled for 2022.

Status

A total of 85 pairs and 42 males (127 total territories) were observed in 2010, and 117 pairs and 33 single males (150 territories) were observed in 2013, showing an increase of 23 territories despite little change in survey acreage (CNLM and ESA 2013). Gnatcatchers were observed across the jurisdiction and in all habitat patch sizes. Gnatcatcher territories on both managed and unmanaged preserves that were surveyed in 2010 and 2013 are thriving and appear to be well-protected from unauthorized access and other edge effects. Additionally, long-term coastal sage scrub monitoring has shown the habitat to have adequate shrub cover and high native species diversity.

Major Threats

The largest threats to this species regionally are habitat degradation and loss of habitat due to wildfire (Kus et al. 2017). In May 2014, occupied habitat supporting three documented gnatcatcher locations burned in the Poinsettia Fire. Post-fire monitoring suggests that the habitat is recovering well, although it may take many more years for the coastal sage scrub communities to attain the composition and cover of native shrubs that can support nesting gnatcatchers.

Management Actions Conducted to Protect the Species

Most of the suitable habitat in the city is under active management, or protected by a conservation easement. This species is managed through general habitat stewardship, including invasive plant species removal, patrolling, fence and sign maintenance, erosion control, habitat evaluations, and monitoring, and targeted restoration. Regional goals for this species include maintaining, enhancing, and restoring coastal sage scrub habitat to be resilient to environmental change and catastrophic events (SDMMP 2017b). A regional management strategy, based on long-term monitoring being conducted throughout the species' range, is under development (Kus et al. 2017).

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