Final

TRIENNIAL MONITORING SUMMARY REPORT

Carlsbad Habitat Management Plan (HMP)

2015-2017

Prepared for
City of Carlsbad

February 2018

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TRIENNIAL MONITORING SUMMARY REPORT

Carlsbad Habitat Management Plan (HMP)

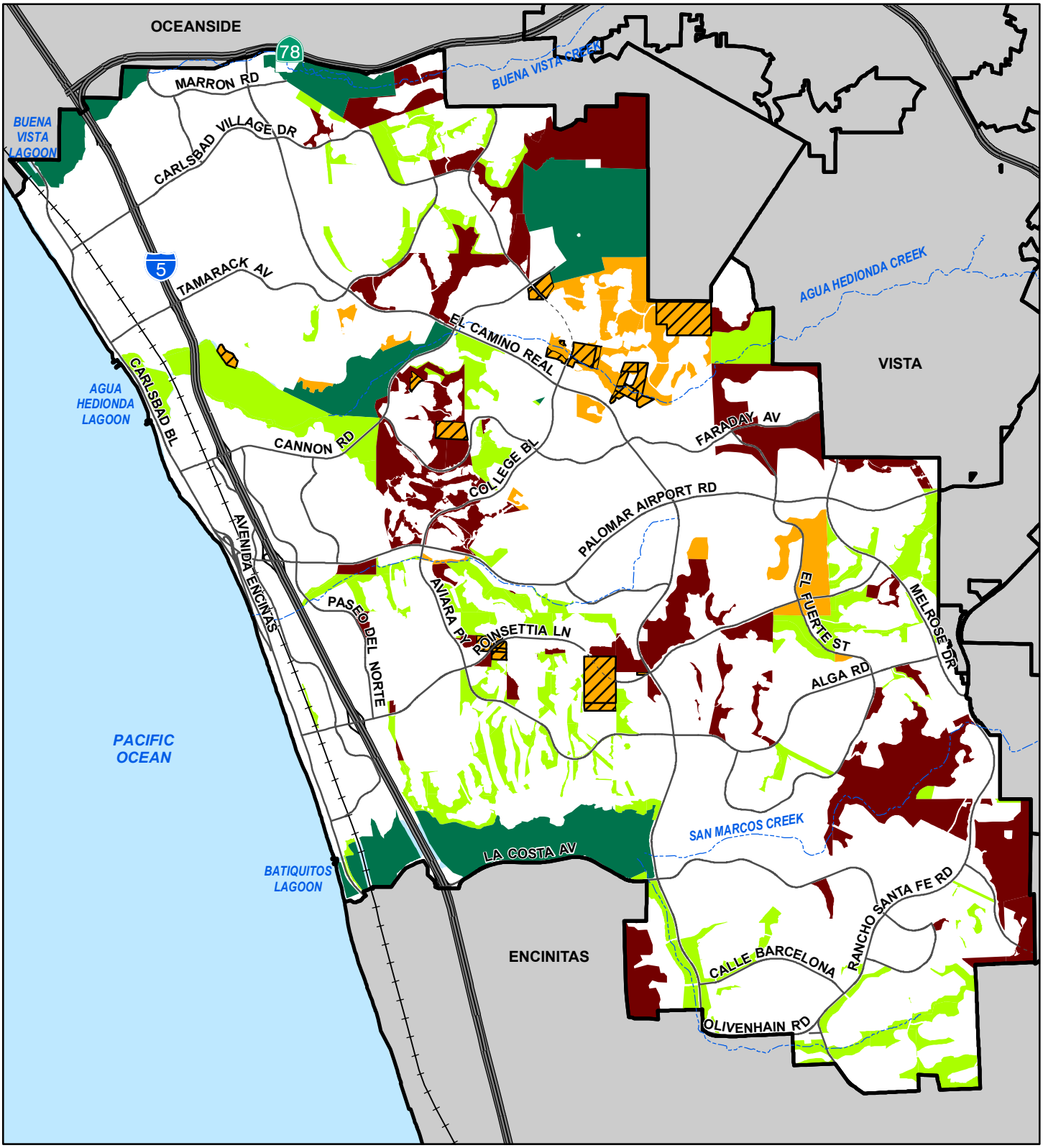
1. Introduction

This report summarizes the results of biological monitoring that has been 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 then submitted through site-specific annual reports and GIS data to the HMP Preserve Steward, who summarizes the data every three years into a triennial monitoring summary report.

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 and managed by private 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.

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 below.



Legend

- Established Private and City-owned Preserve
- California Department of Fish and Wildlife Ecological Reserve
- Pre-existing Natural Open Space Preserve
- Future Preserve Proposed Hardline
- Future Preserve Standards Area

N

0 — Feet — 6,400

City of Carlsbad

City of Carlsbad
Categories of HMP Preserves

Figure 1

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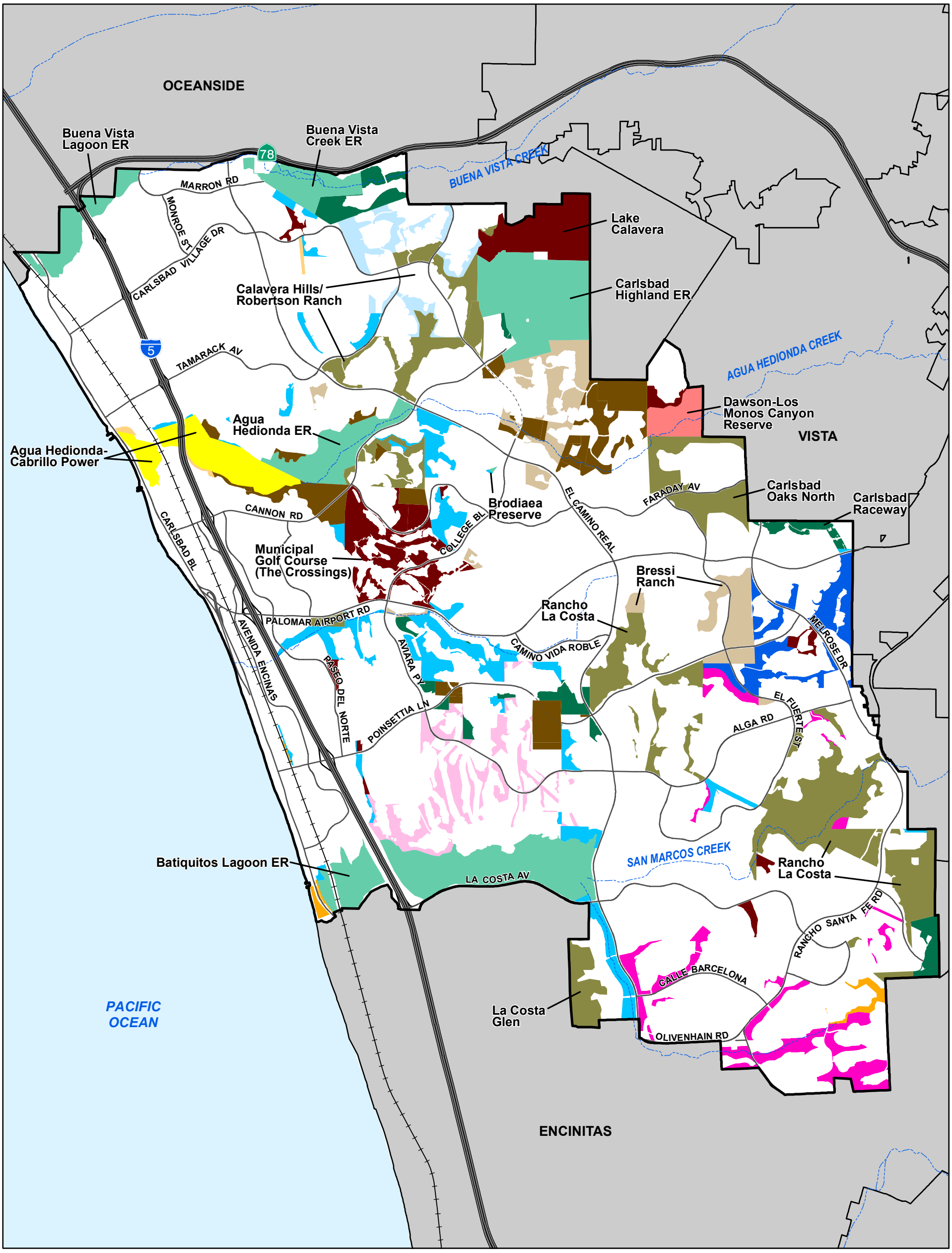

City of Carlsbad
- City Preserves*
  - Batiquitos Drive
  - Carlsbad Village Dr
  - Carrillo Ranch
  - Crossings Golf Course
  - Faraday
  - La Costa Canyon Park
  - La Costa/Romeria
  - Lagoon Lane
  - Lake Calavera
  - Los Monos
  - Macario Canyon
  - Poinsettia Park
  - Veteran's Park

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

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

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

University of California Reserve System
- Dawson-Los Monos Canyon Reserve

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

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

* Managed by Center for Natural Lands Management (CNLM)

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City of Carlsbad
Current Preserve Ownership/Management

Figure 2

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In recent years, 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 wet season, which brought 5.2 and 4.0 inches of rain, respectively (NOAA 2017). The wet season generally occurs October through March. When looking at annual rainfall totals between October and September, the average rainfall in Carlsbad (based on historical weather data from Palomar Airport) is just over 10 inches. Total rainfall in Carlsbad has been below average since the 2011/2012 rainy season, with the exception of this past rainy season, 2016/2017, which received 15.4 inches of rain, nearly 150 percent of the historic rainfall average (NOAA 2017).

The drought conditions helped pave the way for the Poinsettia Fire, which burned over 300 acres in Carlsbad in May of 2014, most of which was within the HMP boundary. 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 almost 100 degrees Fahrenheit. Burned habitats are currently recovering, but not without added threats, such as the presence of invasive species. This is true particularly in the coastal sage scrub habitat, which has historically not recovered from fire as well as chaparral habitats.

2. Vegetation Communities

2.1 Vegetation Mapping

Long-term vegetation monitoring within the HMP is accomplished through periodic mapping 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 have been mapped using Oberbauer-modified Holland classification system (Holland 1986, Oberbauer 2008), which is the classification system used in the MHCP and HMP. The San Diego Association of Governments (SANDAG) commissioned an effort to develop a classification system that conforms to national and statewide mapping efforts. The resulting *Vegetation Classification Manual for Western San Diego County* was completed in 2011 (SANDAG 2011). This system is based on alliances and associations, which are defined by the presence and abundance of diagnostic species. Because this classification is much more fine-scaled, mapping is more time-consuming; however, it provides more information about variation within the habitat. Although not required by the HMP, preserve managers are encouraged to use this newer classification system. Information about preserve-level changes in vegetation mapping is provided in site-specific annual reports.

2.2 Long-Term Coastal Sage Scrub Monitoring

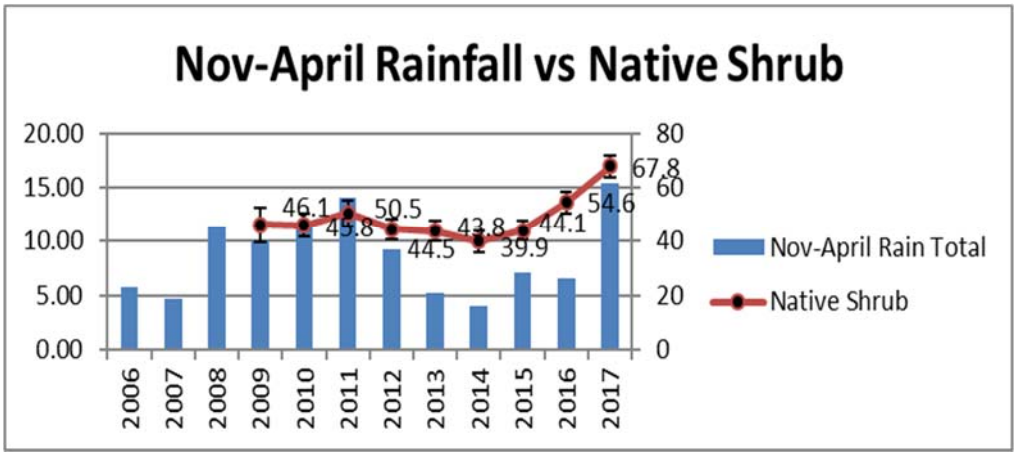
The Center for Natural Lands Management (CNLM) began a long-term monitoring program in coastal sage scrub habitat during the spring of 2009 by setting up modified Whittaker plots (see CNLM 2010a for methods and rationale). CNLM collaborated with Dr. Douglas Deutschman of San Diego State University (SDSU) in 2010 to develop a rotating panel approach to monitoring for a trial period prior to determining the ideal sample replicate size. Various sites in Carlsbad, which are distributed evenly across the landscape, have been visited every year since 2009 on a three-year return interval. Fifty-nine plots have been established across Carlsbad. Of these plots,

one-third 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.

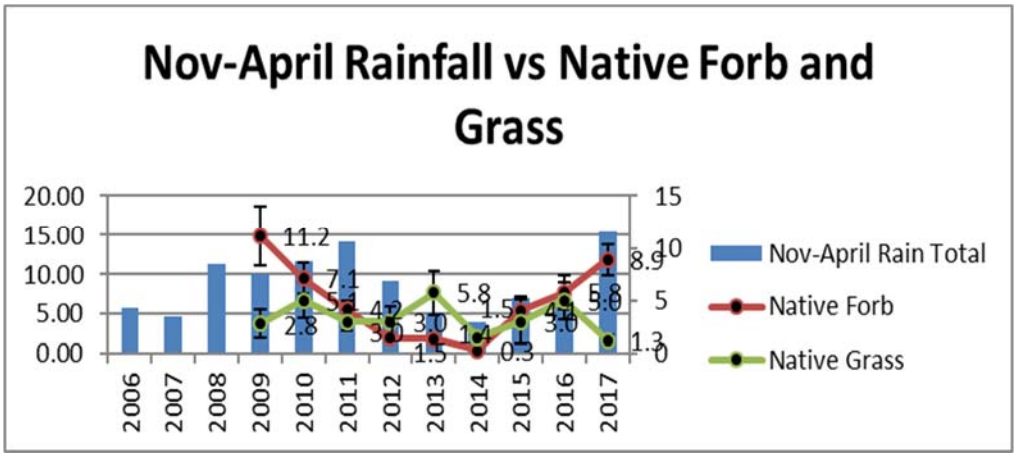
To date, 59 plots have been established within CNLM-managed preserves, CDFW Ecological Reserves and the Aviara Master Association preserve area.

Results

Between 2006 and 2017, average percent cover of all shrubs showed a generally even trend with an increase in 2017. Average percent cover of native forbs trended with the level of rainfall, and average percent cover of native grasses were stable across the period. Average percent cover of non-native (exotic) forbs and grasses were generally low across the period. Native shrubs and forbs appear to have the highest correlation to rainfall. See Appendix I for more information.



Coastal Sage Scrub Shrub Percent Cover Trend-Carlsbad wide (+/- 1 standard error) Note that plots are repeated on a three-year return interval (+/-1s.e). For example, 2009 shrub cover is most similar to 2012 shrub cover because these are the same plots being re-read.



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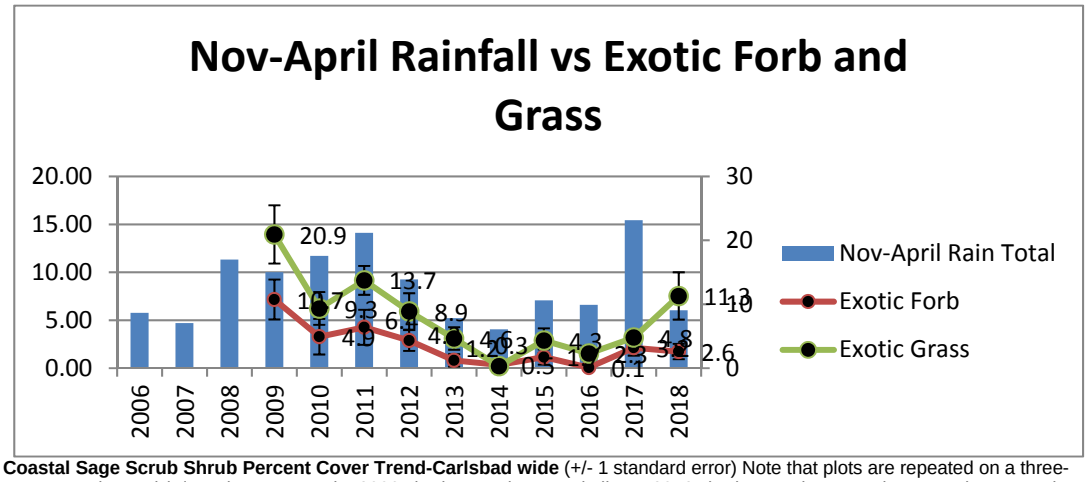


Coastal Sage Scrub Shrub Percent Cover Trend-Carlsbad wide (+/- 1 standard error) Note that plots are repeated on a three-year return interval (+/-1s.e). For example, 2009 shrub cover is most similar to 2012 shrub cover because these are the same plots being re-read.

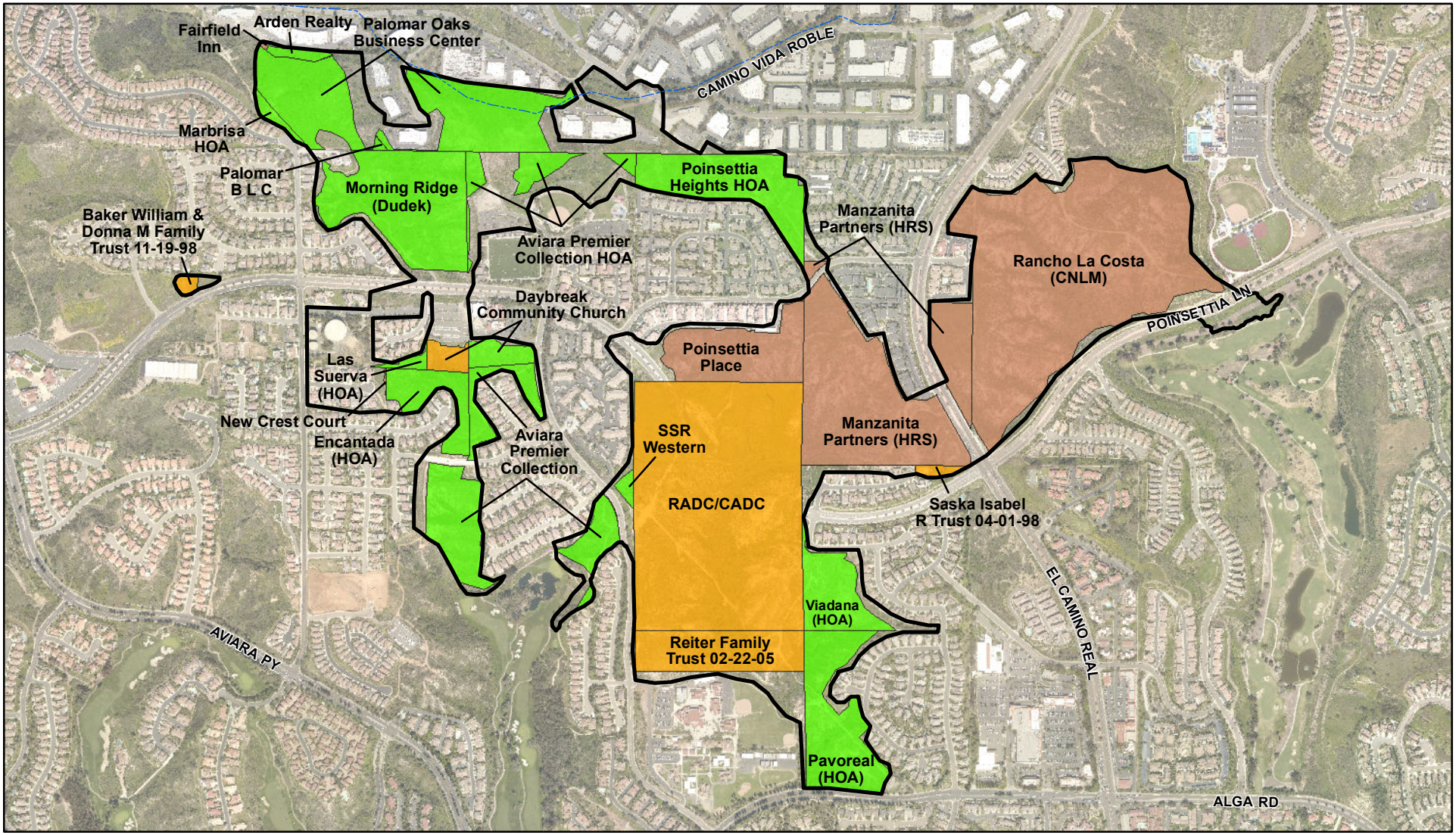
2.3 Post-Fire Monitoring

In May of 2014, approximately 360 acres of habitat burned in the Poinsettia Fire (Table 1). The majority of this habitat (316 acres) was within the HMP preserve boundary in pre-existing preserves (private HOA lands), actively managed preserves (established private and city-owned), and Standards Areas (future preserves) (Figure 3). In order to evaluate the trajectory of habitat recovery, the City of Carlsbad (City), in coordination with the Preserve Steward and CNLM, developed a post-fire monitoring protocol, which consists of a quantitative and qualitative assessment in 26 locations throughout the burn area, stratified by habitat type (southern maritime chaparral, southern mixed chaparral, coastal sage scrub, vernal pools, and oak woodland/forest). The monitoring will be conducted annually for five years, starting in the spring of 2015 to inform preserve managers about adaptive management actions that may be needed to ensure successful habitat recovery.

TABLE 1
VEGETATION TYPES WITHIN THE POINSETTIA FIRE BURN AREA*

Vegetation Type	Acres
Southern Maritime Chaparral	150.3
Chaparral	60.9
Coastal Sage Scrub	27.1
Agricultural	28.3
Disturbed	22.4
Grassland	15.5
Oak Woodland	9.2
Wetlands	1.2
Eucalyptus Woodland	1.0
Riparian Scrub/Woodland/Forest	0.6
TOTAL	**316.5**

* does not include natural lands outside of the HMP boundary



Poinsettia Fire Perimeter

Established Private and City-owned Preserve*

Future Preserve Standards Area

Pre-existing Preserve - Private/HOA*

* Name of preserve manager in parenthesis

N

0 Feet 1,000

City of Carlsbad

City of Carlsbad
Fire Perimeter - Preserves and Preserve Manager

Figure 3

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Overall, the shrublands appear to be recovering as expected, following the trajectory envisioned by conceptual models developed to evaluate post-fire habitat recovery (Spiegelberg 2017a, Tierra Data Inc. 2005). Within coastal sage scrub habitat, native shrub cover did not change between 2015 and 2016, but increased (7.5 to 39.6 percent) from 2016 to 2017. Native herbaceous cover also increased significantly from 15.1 percent in 2015 to 94.3 percent in 2017 (Table 2). Within chaparral habitat, native shrub cover increased from 14.5 to 35.3 percent in southern mixed chaparral and from 4.5 to 20.5 percent in southern maritime chaparral. Native herbaceous cover increased from 13.7 to 114.7 percent in southern mixed chaparral, and from 9.0 to 65.6 percent in southern maritime chaparral. The significant increase in cover of native plants within all habitat types in 2017 was partially due to time (plants become larger, more seedlings have a chance to germinate), but also because there was substantially more rain in 2017 (11.7 inches) than in the previous two years (6.5 and 7.4) (Lynbrook Field, Western Regional Climate Center).

TABLE 2
VEGETATION COMMUNITY PERCENT COVER BASED ON POINT INTERCEPT TRANSECTS

	Average Percent Cover by Vegetation Community[1]								
	Coastal Sage Scrub			Southern Mixed Chaparral			Southern Maritime Chaparral		
Vegetation Type	2015	2016	2017	2015	2016	2017	2015	2016	2017
Herbaceous-Native	15.1	32.3	94.3	13.7	33.1	114.7	9.0	35.9	65.6
Herbaceous-Nonnative	15.1	15.1	17.0	0	2.4	5.2	1.2	0.2	1.6
Nonnative grass	0	2.2	0.9	0	2.4	0.9	trace	0.2	0.9
Native Shrub	7.5	7.5	39.6	14.5	25.8	35.3	4.5	17.3	20.5
Bare Ground	58.1	47.3	33.0	67.7	45.2	35.8	81.7	52.9	47.4
Litter	14.0	0	76.6	6.5	0	50.5	4.5	1.3	15.2

[1] The number of sampling transects are as follows: coastal sage scrub – 3; southern mixed chaparral – 4; southern maritime chaparral - 15 in 2015, and 17 in 2016 and 2017.

Oak woodland habitat is recovering slowly, as evidenced by basal sprouting or branch sprouting, and almost no seedlings were observed in all monitoring years. Of the 47 coast live oaks and 7 Engelmann oaks (*Quercus engelmannii*) monitored on the Rancho La Costa Preserve, only 3 coast live oaks and two Engelmann oaks died by 2017. The remaining trees are fairly healthy and show signs of healthy regrowth. Of the 24 coast live oak (*Quercus agrifolia*) trees monitored on Manzanita Partners Preserve, three dead trees were documented in 2015, one additional dead tree was documented in 2016, and by 2017 a total of 12 trees had died. Although mortality has been high, the 12 remaining trees that were sampled experienced significant growth and appear to be healthy. These trees are likely to survive in the years to come and will add in the regrowth and regeneration of the post-fire oak woodland on this preserve.

The vernal pool habitat at Manzanita Partners Preserve showed significant improvement in 2017. In 2016, the site was dominated by nonnative species, most notably filaree (*Erodium botrys*), which averaged 40 percent cover within the basins. A total of 12 species were observed, including 5 native forbs (42 percent). One vernal pool indicator species, San Diego button-celery (*Eryngium aristulatum* var. *parishii*) was observed. In 2017, non-native forb cover was

substantially reduced to approximately 5 percent. The number of species doubled in 2017 (24), and included 14 native forbs (54 percent). Five vernal pool plant species were observed: water pygmyweed (*Crassula aquatica*), San Diego button-celery, toad rush (*Juncus bufonius*), and two species of woolly-marbles (*Psilocarphus brevissimus* and *P. tenellus*). San Diego fairy shrimp (*Branchinecta sandiegonensis*) was also observed in some of the pools. The positive changes observed in 2017 could have been a result of the wet conditions (e.g., longer periods of pooling), which favor native species over non-natives.

Although not shown in the post-fire monitoring data, one of the biggest potential threats to the post-fire habitat recovery is invasive species, which are especially dense within the bottom of drainages where there were no sampling transects. Weedy species may also be more prevalent in unsampled areas of the preserve, especially in coastal sage scrub areas. Coastal sage scrub often does not recover as well as chaparral after a fire. The City of Carlsbad will continue to work with the preserve managers and HOA land owners to encourage high quality habitat recovery, and continue to support the post-fire monitoring effort over the next two years.

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 being 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 3 below summarizes the years during which focused species surveys have been 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).

Site-specific species monitoring is designed to evaluate preserve-specific status and cannot be used to understand overall species population trends. However, regional monitoring and associated research being coordinated by the San Diego Management and Monitoring Program (SDMMP) will provide information about species population trends, genetic exchange, and best management practices for individual species. To this end, the SDMMP has 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.

Table 3. Priority Species Surveys Conducted on Actively Managed Preserves

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

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

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As part of the MSP Roadmap, a rare plant monitoring protocol (2017) has been 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 is encouraging land managers to participate in the regional Inspect and Manage (IMG) protocol 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 threaded-leaf 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.

3.1 Upland Plants

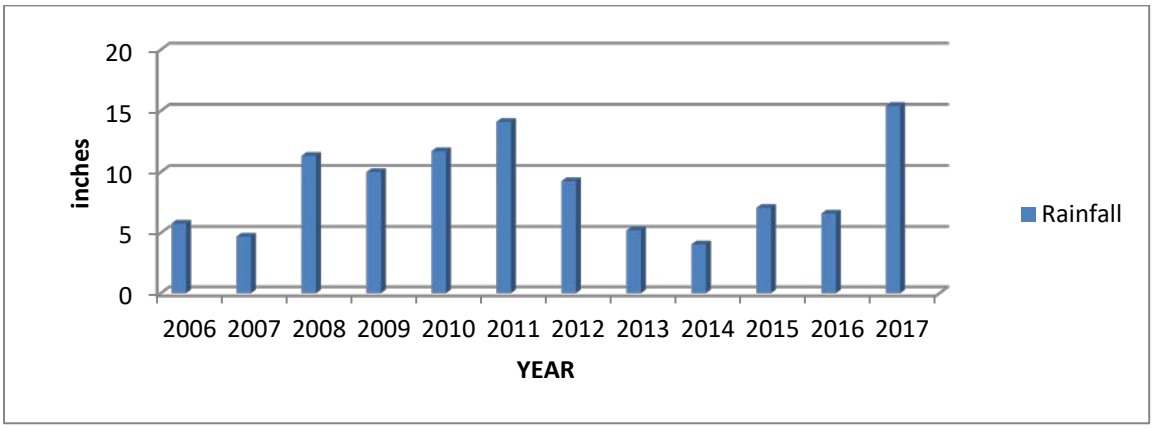
Annual rainfall has varied greatly over that past 12 years, with an average rainfall of approximately 8.8 inches between 2006 and 2017 (see table below). Rainfall from 2006 to 2007 was below average, rainfall from 2009 to 2012 was about average (with a spike in 2011), rainfall from 2013 to 2016 was below average, and 2017 was the highest rainfall across the period. For some species, such as San Diego thornmint, success in the spring seems to largely depend on rainfall from the previous rainy season, or the one before that. However, for other species, such as vegetative counts for thread-leaf brodiaea, the data is less clear and rainfall does not appear to coincide with abundance (yet it does seem to correlate to the species flowering) (Spiegelberg, personal communication, 2018). Other factors such as timing of the rains and subsequent warm-up, the presence of pollinators, and other unrecorded factors may play a significant role in the annual abundance of these species. It is important to continue to monitor these populations and conditions in order to best preserve the species.

TABLE 4 RAINFALL IN CARLSBAD

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Recent Average
Rainfall Total (in)*	5.77	4.69	11.32	10	11.7	14.1	9.25	5.22	4.04	7.07	6.6	15.4	8.8

*Measurements from Palomar-McClellan Airport in Carlsbad, CA (NOAA 2017). Data taken from Nov-April. The year presented coincides with the end of the rainy season (April)

Coastal Sage Scrub



*Measurements from Palomar-McClellan Airport in Carlsbad, CA (NOAA 2017). Data taken from Nov-April. The year presented coincides with the end of the rainy season (April)

San Diego Thornmint

Acanthomintha ilicifolia

Status: federally threatened, state endangered

Critical Locations and Major Populations

The 1999 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.

Management Actions Conducted to Protect the Species

A management and monitoring approach for San Diego thornmint has been developed by SDMMP (2017b) based on the best available science and local knowledge of land managers. This approach includes 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. In addition, CNLM developed a monitoring plan for San Diego thornmint that includes habitat assessments and count methods. Within Carlsbad, this species is under active management within Carlsbad Oaks North, Emerald Pointe, and Rancho La Costa preserves. In coordination with the wildlife agencies, an estimated 750 seeds were collected from plants at Carlsbad Oaks North and approximately 5,000 seeds were collected from Rancho La Costa Greens. The seed from both locations will be used to outseed around the existing occurrence of San Diego thornmint at their respective preserves once habitat enhancement is completed (Godfrey 2017; M. Spiegelberg, personal communication, 2018). Active management on these preserves generally focuses on intensive invasive species removal around thornmint populations (including hand weeding around plants), thatch removal, and access control. HOA-managed properties only include a basic level of management (e.g., trash pick-up and fence maintenance).

Long-Term Monitoring

Long-term monitoring for selected populations of San Diego thornmint in Carlsbad has been ongoing since 2008. Regional monitoring efforts to understand the species as a whole are being coordinated by the SDMMP.

Overall Condition and Major Threats

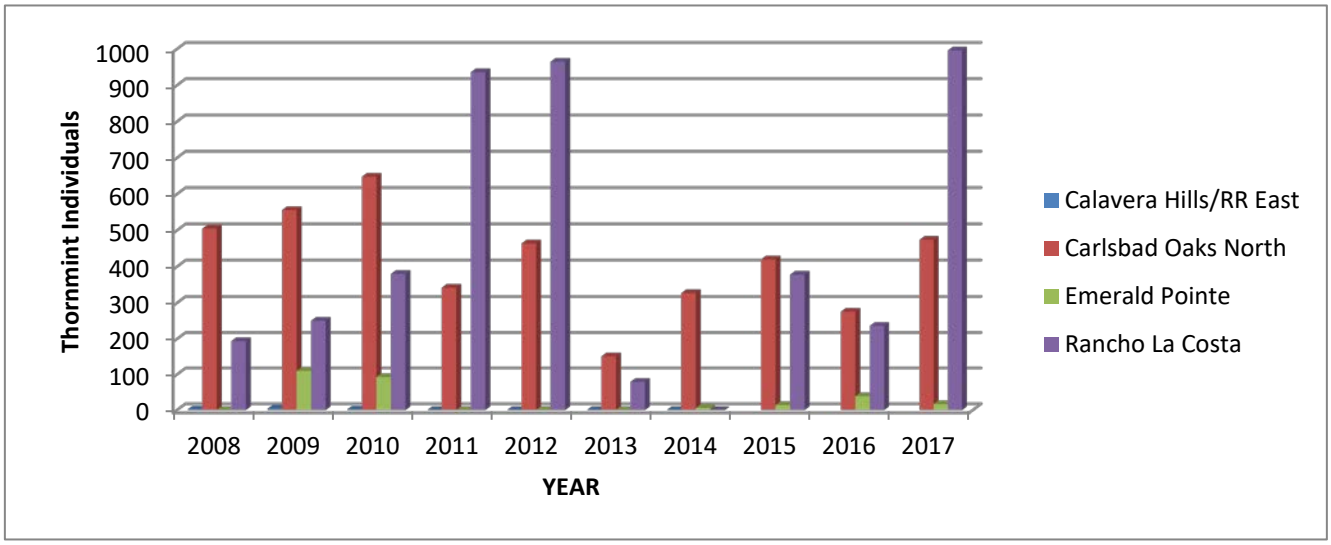
Conservation Biology Institute prepared an Adaptive Management Framework for this species in 2014, which includes site-by-site population evaluations of status, threats, and management recommendations (CBI 2014). Populations of San Diego thornmint at Carlsbad Oaks North, Emerald Pointe, and Rancho La Costa Preserve are regularly monitored by Preserve Managers (Figure 4). Populations monitored in 2017 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). Over 35,000 individuals were counted at Palomar Airport; this population was counted in 2006 and 2010 and remains steady (Vinje et al. 2018). Three individuals were observed at Carlsbad Raceway Preserve in 2017, the first time this species has been recorded at this preserve since 26 individuals were recorded in 2010 (Scoles 2017). As is typical for many annual species, San Diego thornmint counts varied tremendously at each location between 2008 and 2017, mostly due to rainfall, ranging from 151 to 648 plants at Carlsbad Oaks North, 6 to 110 in Emerald Pointe, and 79 to 996 at Rancho La Costa, as shown in the table and graph below. A fourth occurrence at the Calavera Hills/Robertson Ranch Preserve was observed to have two to four individuals between 2008 and 2010, but none were observed in 2011 or 2012, and this location is no longer monitored (McConnell 2012).

TABLE 5
POPULATION OF SAN DIEGO THORNMINT ON CARLSBAD PRESERVES WITH RAINFALL DATA

	Number of Individuals									
Preserve	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Calavera Hills/Robertson Ranch	2	4	2	0	0	NS	NS	NS	NS	NS
Carlsbad Oaks North	505	556	648	342	464	151	327	420	276	474
Carlsbad Raceway	NS	NS	26	NS	NS	NS	NS	NS	NS	3
Emerald Pointe	NS	110	93	NS	NS	NS	6	14	39	17
Palomar Airport	NS	NS	UR	NS	NS	NS	NS	NS	NS	35,107
Rancho Carrillo	NS	NS	NS	NS	NS	NS	NS	NS	NS	23
Rancho La Costa (the Greens)	194	251	380	936	965	79	652	378	237	996
Rainfall total* (inches)	11.3	10.0	11.7	14.1	9.3	5.2	4.0	7.1	6.6	15.4

NS = not surveyed
UR = surveyed but unreported
*Measurements from Palomar-McClellan Airport in Carlsbad, CA (NOAA 2017). Data taken from Nov-April. The year presented coincides with the end of the rainy season

Population of San Diego Thornmint on Carlsbad Preserves



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 has been 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.

The major threats to San Diego thornmint are invasive species, such as tocalote (*Centaurea melitensis*) and Bermuda grass (*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 2017b). Where small numbers of the species were found, such as Carlsbad Raceway, Emerald Pointe, and Rancho Carrillo, hand watering could help ensure that the population does not blink out, as could seed bulking and population augmentation. Bermuda grass is the biggest invasive species threat within the healthy Palomar Airport location; this area should be managed for invasive plants and trespassing. Within Rancho La Costa Preserve, tocalote (posed the biggest threat to this species and was hand clipped to prevent invasion into the thornmint habitat (Godfrey 2017). Wildfire is another important threat. The Poinsettia Fire burned over 60 acres of habitat within Rancho La Costa Preserve in May of 2014. If not for a 4-foot by 1,000-foot containment line that was constructed by CalFire using hand tools to contain the fire, this population would have likely burned (Godfrey 2014).

Overall, this species appears to be well protected on actively managed properties in Carlsbad; it will be critical to continue intensive invasive species removal efforts, as this currently appears to be the largest threat to the species' decline.

Thread-Leaved Brodiaea

Brodiaea filifolia

Status: federally threatened, state endangered

Critical Locations and Major Populations

The 1999 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 2017b).

Management Actions Conducted to Protect the Species

Known populations on CNLM-managed preserves, including Calavera Hills/Robertson Ranch, Carlsbad Oaks North, Rancho Carrillo, and Rancho La Costa, are actively managed mostly through intensive removal of invasive broad leaf species, including fennel (*Foeniculum vulgare*), artichoke thistle *(Cynara cardunculus*), and mustard (*Brassica* spp.); once these species are managed, invasive grass species can be targeted as well. However, at this time it does not seem as if invasive grass species are posing a large threat in the short term (Figure 4). Management within CDFW-managed preserves, are also actively managed through intensive weed removal around clusters of plants. The brodiaea restoration area on the Fox-Miller property (mitigation for project impacts to this species) is still under restoration maintenance. Once the success criteria have been met, this area will fall under long-term management (the long-term manager is still to be determined).

A management and monitoring approach has been developed by SDMMP (2017b), and 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.

Long-Term Monitoring

Long-term census monitoring of thread-leaved brodiaea is being conducted annually using index plots at preserves managed by CNLM and CDFW. Index plots look only at a small sampling of the total number. This species is assessed using index plots because, throughout all the preserves sampled, there are hundreds of thousands of individuals. This method provides an “index,” or sample, of the entire occurrence and how the species is doing form year to year by counting only a percent of flowering individuals. Additionally, CNLM initiated a life-stage study in the winter of 2013–2014 on its preserves; results will be provided after five years of data collection. The goal of the study is to provide information about the life history of thread-leaved brodiaea, including degree of flowering, variance of dormancy, and how these factors relate to flowering. This information can then be used to determine a better method for estimating counts (e.g., whether flowering counts are a suitable replacement for vegetative counts). This study will continue annually into the foreseeable future.

Overall Condition and Major Threats

Vegetative counts of this species appear to be relatively stable but flowering counts of this species vary tremendously year to year depending on timing and amount of rainfall, and the season during which the surveys were conducted. 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. During the monitoring period on Rancho La Costa Preserve, vegetative counts varied from 2,421 in 2014 to 4,833 in 2015 (within Index Plots) (Table 6), while the number of flowering plants varied from 0 in 2013 and 2014 to 835 in 2017 (Table 7). Almost all sites had increases in numbers in 2017, presumably due to the high rainfall. Overall, across the CNLM sites there is in increasing trend in vegetative counts since 2012. Figure 4 shows known locations of thread-leaved brodiaea in Carlsbad and USFWS critical habitat for this species.

TABLE 6
SAMPLE POPULATION OF THREAD-LEAVED BRODIAEA BY VEGETATIVE COUNT ON CARLSBAD PRESERVES WITH RAINFALL DATA

Preserve	2012	2013	2014	2015	2016	2017
Buena Vista Creek	647	817	753	979	1,047	1,338
Calavera/Robertson Ranch	226	628	481	505	784	773
Carlsbad Oaks North	102	224	189	145	217	325
Rancho La Costa	NS	3,457	2,421	4,833	2,946	3,293
Rainfall total* (inches)	9.3	5.2	4.0	7.1	6.6	15.4

NS = not surveyed
*Measurements from Palomar-McClellan Airport in Carlsbad, CA (NOAA 2017). 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)

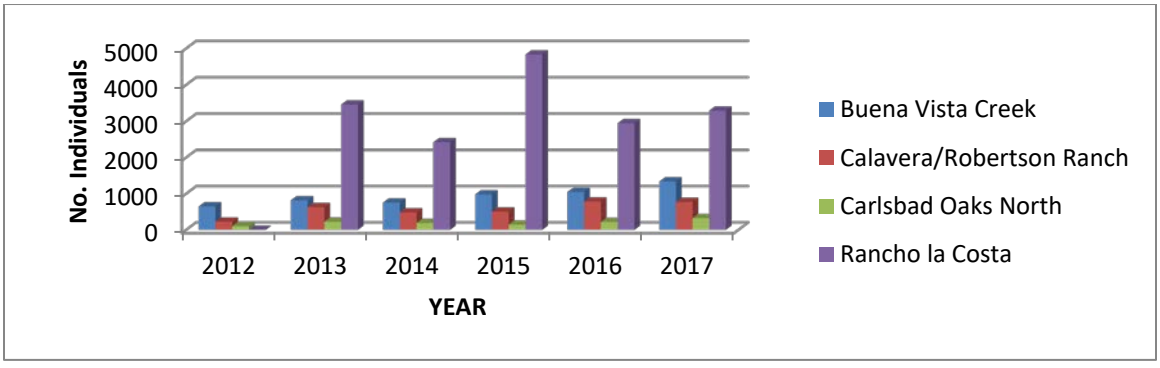


TABLE 7
SAMPLE POPULATION OF THREAD-LEAVED BRODIAEA BY FLOWERING COUNT ON CARLSBAD PRESERVES WITH RAINFALL DATA

Preserve	2012	2013	2014	2015	2016	2017
Buena Vista Creek	0	13	2	6	25	48
Calavera/Robertson Ranch	1	3	0	22	3	26
Carlsbad Oaks North	14	1	4	30	15	67
Rancho La Costa	NS	0	0	29	90	835
Rainfall total* (inches)	9.3	5.2	4.0	7.1	6.6	15.4

NS = not surveyed

*Measurements from Palomar-McClellan Airport in Carlsbad, CA (NOAA 2017). Data taken from Nov-April. The year presented coincides with the April date

Major threats to this species within Carlsbad are broad leaf invasive species; off-trail activity, as well as trespass and vandalism; and erosion (M. Spiegelberg, personal communication, 2018). In Carlsbad, the major threat appears to be invasive species and thatch build-up. At Rancho La Costa Preserve, Italian thistle *(Carduus pycnocephalus*), bristly ox-tongue (*Helminthotheca echioides*), black mustard (*Brassica nigra*), Sahara mustard (*Brassica tournefortii*), and artichoke thistle (*Cynara cardunculus*) were either weed whipped or hand-cut to prevent invasion into the thread-leaved brodiaea habitat (Godfrey 2017). 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.

Del Mar Manzanita

Arctostaphylos glandulosa ssp. *crassifolia*

Status: federally endangered

Critical Locations and Major Populations

The 1999 MHCP identified critical locations/major populations on preserve lands owned by the City, the County, private HOAs, and La Costa Villages.

Management Actions Conducted to Protect the Species

Management actions include invasive species removal, access control, and public outreach. In addition, 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. Regionally, this species has been designated by SDMMP as a VF species, which means that this species is likely to persist in the Management Strategic Plan Area (MSPA) with appropriate management of the vegetation community. VF species are those with limited distribution in the MSPA and/or those that have specific vegetation characteristics that need to be managed for persistence in the MSPA

(SDMMP 2013). What this means to the land manager is that by protecting and managing the vegetation community as a whole, this species is expected to remain in stable condition.

Long-Term Monitoring

Surveys for Del Mar manzanita have been conducted periodically on the following preserves: La Costa Glen, Kelly Ranch, Manzanita Partners, Morning Ridge, Poinsettia Place, and Rancho La Costa Preserve (see table below for dates) (Figure 5). No other surveys for this species in Carlsbad have been conducted. Identification of individuals to the subspecies level of on Rancho La Costa and Kelly Ranch has been conducted by CNLM and confirmed by taxonomic experts. Because the non-sensitive Eastwood manzanita (*Arctostaphylos glandulosa* ssp. *glandulosa*), also occurs on Rancho La Costa, Del Mar manzanita was re-mapped on the property pursuant to taxonomic confirmation (Spiegelberg and Vinje 2008). Both subspecies occur on Kelly Ranch, and future monitoring should include a determination of subspecies (Spiegelberg 2017b).

Overall Condition and Major Threats

Prior to the initiation of long-term management, it was reported that Rancho La Costa supported over 500 individuals; however, this number was greatly reduced (to nine individuals) after the shrubs were re-identified to subspecies by CNLM (M. Spiegelberg, personal communication, 2011). The number of individuals reported on other actively managed preserves ranges from 2 clumps (number of individuals unknown) to 313 individuals (Table 8). 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 that have been conducted to determine cover of native and non-native species, most Del Mar manzanita shrubs are stump sprouting, which is to be expected, as this species is highly adapted to fire.

TABLE 8
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**
La Costa Glen	NS	NS	NS	200[1]	NS	NS	NS	NS	NS	313	Unk[2]	Unk[2]	NS	Unk[2]
Kelly Ranch	NS	NS	NS	NS	NS	2[3]	NS	NS	NS	NS	2	NS	NS	2[3]
Manzanita Partners	NS	117	NS	NS	NS	NS	NS	NS	NS	117	NS	NS	NS	NS
Morning Ridge	NS	8	NS	NS	8	NS	NS	NS	NS	NS	burned	NS	NS	NS
Poinsettia Place	53	NS	NS	NS	NS	NS	NS	NS	NS	NS	burned	NS	NS	NS
Rancho La Costa	NS	>500[4]	NS	NS	9	NS	NS	NS	NS	NS	burned	19	19	19

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

5 Pre-fire surveys were conducted on Poinsettia Place and Rancho La Costa in 2014; post-fire counts are presumed to be zero if 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.

At Kelly Ranch Preserve, some mortality and leaf dieback has been observed among individuals since the 2014 fire; however, the species exhibiting stress appears to be the more common subspecies. The population at Kelly Ranch will continue to be watched and surveyed again in 2019. Primary threats at this preserve are erosion and the non-native natal grass (*Melinis repens*). The condition of the La Costa Glen population was assessed in 2017 and determined to be stable and free of powdery mildew (*Podospaera xanthii*), a fungal disease that has been observed on this species within some Carlsbad preserves. All of the Del Mar manzanita shrubs on the Morning Ridge and Poinsettia Place Preserves were burned in 2014 in the Poinsettia Fire, which burned all habitat on both preserves. Del Mar manzanita have not been specifically monitored on these preserves; however, the occurrence of powdery mildew at Morning Ridge on individuals has decreased since it was first noticed after the 2014 fires (A. Sullivan, personal communication 2017). Powdery mildew does not appear to be killing or significantly harming this species. Many of the Del Mar manzanita shrubs on Rancho La Costa Preserve have resprouted from burned stumps and new individuals have been observed since the 2014 fire.

Post-fire monitoring will continue annually within the burned areas for two more years, for a total of five years. During post-fire monitoring, Del Mar manzanita shrubs within the sampling transects are monitored for survival (alive or dead), presence or absence of seedlings, and specific threats to each population. Long-term monitoring of non-burned Carlsbad populations should include this information as well.

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 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; this species evolved with fire, and typically resprouts from a basal burl after it has been burned. Additionally, the seeds are dependent on fire to germinate (USFWS 2010). Therefore, the burned populations in Carlsbad are expected to recover and have been observed resprouting throughout burned preserves. As of 2017, 19 manzanita were resprouting in an area of Rancho La Costa Preserve where only two had previously been documented (Godfrey 2017). 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 effect on the species could be negative.

Del Mar Mesa Sand Aster

Corethrogyne filaginifolia var. *linifolia*

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

Critical Locations and Major Populations

There are no critical locations in Carlsbad, according to the 1999 MHCP. The closest major population is at the southern boundary of Carlsbad, according to the 1999 MHCP. The majority

of the population within the MHCP Subregion is in the City of Encinitas but may extend into Carlsbad on private HOA lands.

Management Actions Conducted to Protect the Species

The La Costa Collections and Manzanita Partners populations are being managed through general habitat management (e.g., invasive species removal, trash removal, access control, etc.) (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 will not be developed for this species.

Long-Term Monitoring

Long-term monitoring was initiated in 2014 for the La Costa Collections population of Del Mar Mesa sand aster, which was established in 2013. 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). Individual plant counts will be conducted at La Costa Collections in 2018 (G. Cummings, personal communication, 2018). Long-term monitoring for the Manzanita Partners 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 since the fire. A survey for this species will be performed in 2018 in Manzanita Partners. Figure 4 shows the locations of Del Mar Mesa sand aster on actively managed preserves. No other populations of this species are being monitored within Carlsbad.

Overall Condition and Major Threats

The greatest threat to the La Costa Collections population appears to be unauthorized access, including trails, encampments, and other edge effects, such as trash and invasive species (specifically Russian thistle *(Salsola tragus*)). Locks have been placed on all gates and illegal trespass seems to be decreasing. This population is located immediately on the eastern edge of the preserve, adjacent to El Camino Real. Over the last four years, density data has been collected from 20, stratified, random 0.25 square meter plots. 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. The preserve manager estimates that numbers have increased from this count and will conduct a complete census in 2018. The status of other populations of Del Mar Mesa sand aster in Carlsbad is unknown.

Encinitas Baccharis

Baccharis vanessae

Status: federally threatened, state endangered

Critical Locations and Major Populations

The closest major population is at the southern boundary of Carlsbad, according to the 1999 MHCP. The majority of the population is within Encinitas but may extend into Carlsbad on private HOA lands. Within this major population, there are critical locations identified that may occur within Carlsbad; however, presence or absence of these observations have 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.

Management Actions Conducted to Protect the Species

A management and monitoring approach has been developed by SDMMP (2017b) for this species and includes inspecting conserved occurrences every two years, implementing routine management as determined when 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 species removal and access control.

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. Since then, two focused species surveys were performed by CNLM in 2013, two were conducted in 2014, and one was conducted in 2015. Encinitas baccharis was not observed during these recent surveys.

Overall Condition and Major Threats

The status of populations within Carlsbad is currently unknown. Major threats to this dioecious species are altered fire regime, low seedling recruitment, low seed viability, reduced reproductive potential at older age classes, fuel modification, trampling, and invasive species. Additionally, small, isolated occurrences with little connectivity and dioecious life history make this species more vulnerable to changes in environmental conditions (SDMMP 2017b).

Orcutt's Hazardia

Hazardia orcuttii

Status: state threatened

Critical Locations and Major Populations

There are no naturally occurring critical locations or major populations in Carlsbad, according to the 1999 MHCP. However, if the transplanted populations in Carlsbad prove to be self-sustaining, they would be considered critical populations.

Management Actions Conducted to Protect the Species

A management and monitoring approach has been developed for this species by SDMMP (2017b) and includes implementing a seed banking and bulking plan, inspecting conserved occurrences on an annual basis, developing a study to determine population dynamics in response to natural and

altered fire regimes, and additional refinement of BMPs. 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 species removal, access control, and transplant studies, which have been approved by the wildlife agencies. The transplant studies, which have been ongoing since 2003, consist of transplanting Orcutt's hazardia to new locations and studying reproduction and survival as part of a population viability analysis. 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.

Long-Term Monitoring

Orcutt's hazardia were transplanted by CNLM to the CNLM's Kelly Ranch and Rancho La Costa preserves in 2003. CNLM has been tracking these transplants and documenting recruitment annually (Tables 9 and 10).

TABLE 9
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**
Adults (flowering)	121	97	104	104	104	104	104	104	105	103	102	NS	105	105
Juveniles[2]	0	0	0	1	1	4	15	42	119	157	152	NS	141	97
Seedlings	0	0	0	4	17	14	68	77	55	0	0	NS	0	0
Total count	121	97	104	109	122	122	187	223	279	260	254	NS	246	202

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

TABLE 10
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**
Adults (flowering)	160	NS	NS	156	156	156	156	NS	147	144	157	139
Juveniles	NS	NS	NS	NS	2	10	15	11	24	13	0	14
Seedlings	NS	NS	NS	NS	8	4	1	0	0	0	0	0
Total count	160	unknown	unknown	156	166	170	172	unknown	171	157	157	139

NS = not surveyed

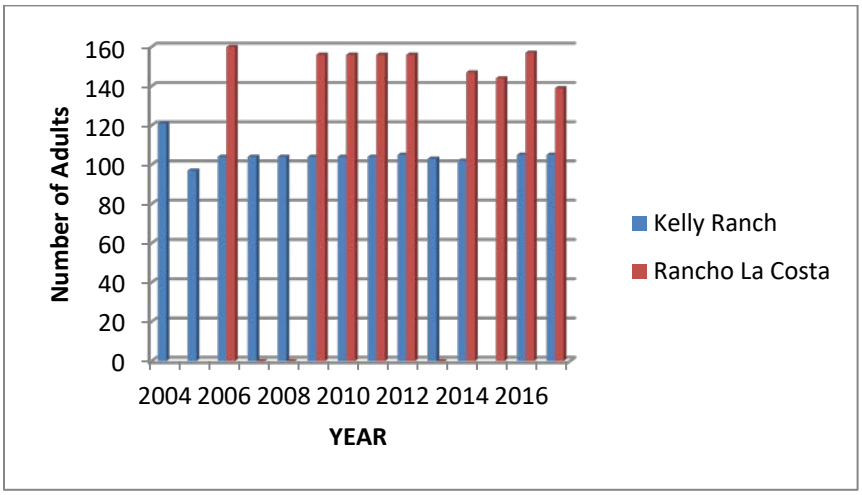
Overall Condition and Major Threats

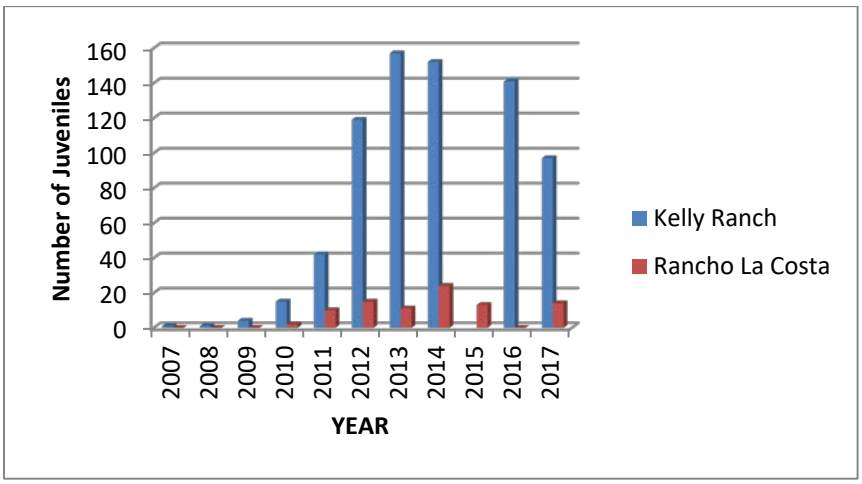
By 2004, a total of 125 Orcutt's hazardia individuals were transplanted at Kelly Ranch and 200 individuals were transplanted at Rancho La Costa. As of 2017, a total of 202 individuals (105 adults and 97 juveniles) were observed on Kelly Ranch and 139 individuals were observed on Rancho La Costa (125 adults and 14 juveniles) (CNLM 2017, Spiegelberg 2017b) (see graphs below). Overall, the adult plants on both sites have fared well over time, becoming stable within a few years after the initial transplantation. The number of total plants did drop from 2016 to 2017 at both sites (from 246 to 202 at Kelly Ranch and from 157 to 139 at Rancho La Costa. This was largely due to a drop in juveniles and no documented seedlings at either site since 2013. Because of increased rainfall in the 2016/2017 rainy season, seedlings were anticipated in 2017; however, previous observations of this species have indicated a lag between high seed production, rainfall, and seedling establishment. Although the drop in total individuals is concerning, the cause is likely drought conditions prior to 2017, a natural phenomenon, and importantly, adult individuals are persisting. Monitoring will continue in future years.

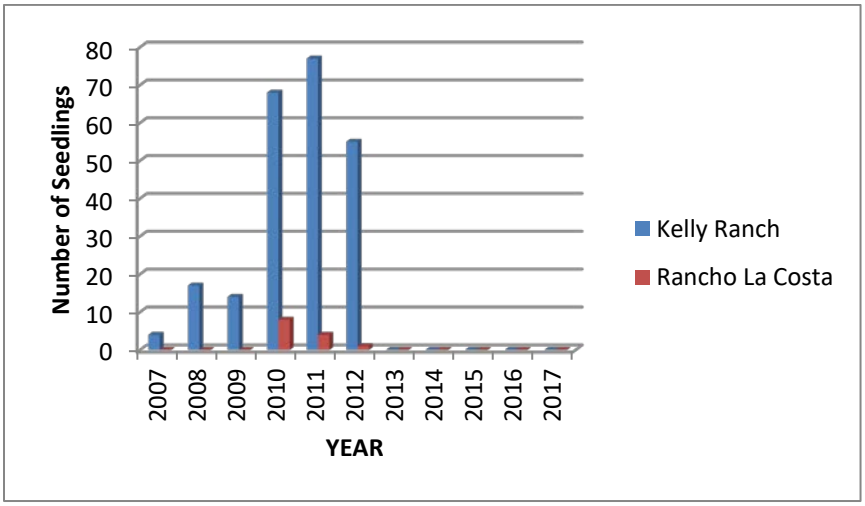
It is interesting to note that, although there were nearly double the number of adults transplanted on Rancho La Costa (200) than on Kelly Ranch (125), the number of juveniles on Kelly Ranch (maximum annual count of 157) is consistently significantly higher than on Rancho La Costa (a maximum annual count of 24). This is likely due to the high clay content soils and non-native grasses, such as purple false brome, at Rancho La Costa. These factors make this area less suitable for Orcutt's hazardia recruits than Kelly Ranch, which has more suitable soil and fewer non-natives.

The biggest threat to this species is that it occurs in only a few locations (only one of which is a natural population; 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 2017b). Ongoing drought appears to be a major threat as well based on the results of the transplant studies, as discussed above.

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

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 critical location and major population for all vernal pool species listed above by the MHCP; however, none of these species are currently covered by the HMP. Neither of the two other vernal pools were identified by the MHCP as critical locations or major populations.

Management Actions Conducted to Protect the Species

Long-term management was initiated by Habitat Restoration Sciences Inc. (HRS) on the Manzanita Partners Preserve in 2012 to preserve the quality of the vernal pool habitat through invasive species control. The vernal pools on this preserve were burned in the Poinsettia Fire. Post-fire management will focus on invasive species removal.

Management of the Poinsettia Lanes Vernal Pools is the responsibility of North County Transit District (NCTD), and presumably consists of mowing within the railroad right-of-way as part of regular maintenance. The adjacent upland watershed buffer area, which is a semicircular area of coastal sage scrub between the vernal pools and residential development, is being managed by the Water's End HOA. This upland area has been fenced and signed to protect it from unauthorized access and to provide public education. The Hieatt property vernal pools are not being actively managed.

Long-Term Monitoring

Long-term monitoring is only being conducted at the Manzanita Partners pools, as the other two preserves are not under active management. Due to the 2014 wildfire, five-year monitoring will continue until 2019 or later, as deemed necessary by the City. The pools at Poinsettia Station and Hieatt Properties will be checked by the City to obtain information on the overall health and major threats to these pools.

Overall Condition and Major Threats

Non-native weeds, as well as lack of rainfall, remain a key threat to vernal pools. However, with adequate rainfall, non-native plants are drowned out and native species adapted for vernal pool conditions are able to dominate.

Poinsettia Station vernal pools. All of the vernal pool species that require species-specific reporting by the MHCP, as well as Orcutt's brodiaea (*Brodiaea orcuttii*), were observed on the Poinsettia Station vernal pools during 2008 surveys conducted by Dudek (A. Hayworth, personal communication, 2011). The area was most recently surveyed by ESA on March 31, 2016, to evaluate the overall condition of the vernal pool habitat, map any observed sensitive species, and conduct a baseline California Rapid Assessment Method (CRAM) assessment to quantify the wetland conditions.

Two vernal pool indicator species were observed on site: San Diego button celery (*Eryngium aristulatum*) and woolly marbles (*Psilocarphus brevissimus* var. *brevissimus*). No other vernal pool species were observed. San Diego button celery, a state and federally endangered plant species had a large presence on site, occurring as a dense carpet in some areas and as scattered individuals in other areas, while woolly marbles were very sparse and were only observed in tiny depressions in the southernmost portion of the preserve area. The main threats to the vernal pool habitat and associated species on the Poinsettia Station Preserve appear to be invasive species and encroachment of upland shrubs and altered hydrology.

Manzanita Partners. The Manzanita Partners vernal pools were enhanced/restored in 2000, and five years of maintenance and monitoring was conducted by Dudek. Seven existing degraded pools were enhanced, seven suspected historic vernal pools were restored, and adjacent native upland habitat was enhanced (Dudek 2005). In 2008, the condition of this restored vernal pool was determined to be good (A. Hayworth, personal communication, 2011); at project completion, all vernal pools held water during the rainy season, all pools had at least one of four vernal pool target plant species present, San Diego fairy shrimp were detected at five of the pools, coastal sage scrub habitat surrounding the pools was mature and healthy, and non-native species were under control and did not pose a threat to the vernal pools (Dudek 2005). A follow-up visit was made by the City HMP Coordinator and HMP Preserve Steward in April 2011 to assess the condition of the pools. The pools appeared to be in good condition overall, although there was a fairly high cover of non-native grasses. Beginning in 2013, active invasive species control was initiated as part of long-term management of the preserve.

In May 2014, a wildfire consumed the entire preserve, burning the vegetation on-site completely. Post-fire monitoring is currently being performed annually to determine the trajectory of the recovery of this habitat and associated species. HRS has performed two years of post-fire transect monitoring at the vernal pools, and will continue to monitor the pools recovery via vegetation transects for total of five years or longer. Federally endangered San Diego fairy shrimp and state and federally endangered San Diego button celery (*Eryngium aristulatum*) were both documented during 2017 monitoring (HRS 2017). San Diego fairy shrimp had not been observed since 2005, and San Diego button celery had only been observed once since 2005, in 2016. The presence of these and other indicator species are the result of a higher than average rainfall during the 2016/2017 wet season and shows that these can operate as successful pools when rain is adequate. However, longbeak stork's bill (*Erodium botrys*), an invasive weed, currently dominates the vegetation in these pools. Control of weeds will continue to be an issue at Manzanita Partners Preserve.

Hieatt Property. The vernal pools on the Hieatt Property were restored by Helix Environmental Planning Inc. (Helix). The restoration plan was initiated on March 2, 2006, and was to last two years. Restoration monitoring reports have not been submitted to the City or Wildlife Agencies, and no request has been made for sign-off on the success of the restoration. Prior to restoration, 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*). A site visit was conducted by ESA and the City of Carlsbad in January 2018 following a minor rain, and although there was no sign of ponding, there were clear signs of a vernal pool matrix throughout the property, as previously mapped.

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.

3.3 Lagoon/Coastal Bird Species

Belding's Savannah Sparrow

Passerculus sandwichensis beldingi

Status: state endangered

Critical Locations and Major Populations

The 1999 MHCP identified critical locations and major populations in Agua Hedionda Lagoon and Batiquitos Lagoon, which are managed by CDFW.

Management Actions Conducted to Protect the Species

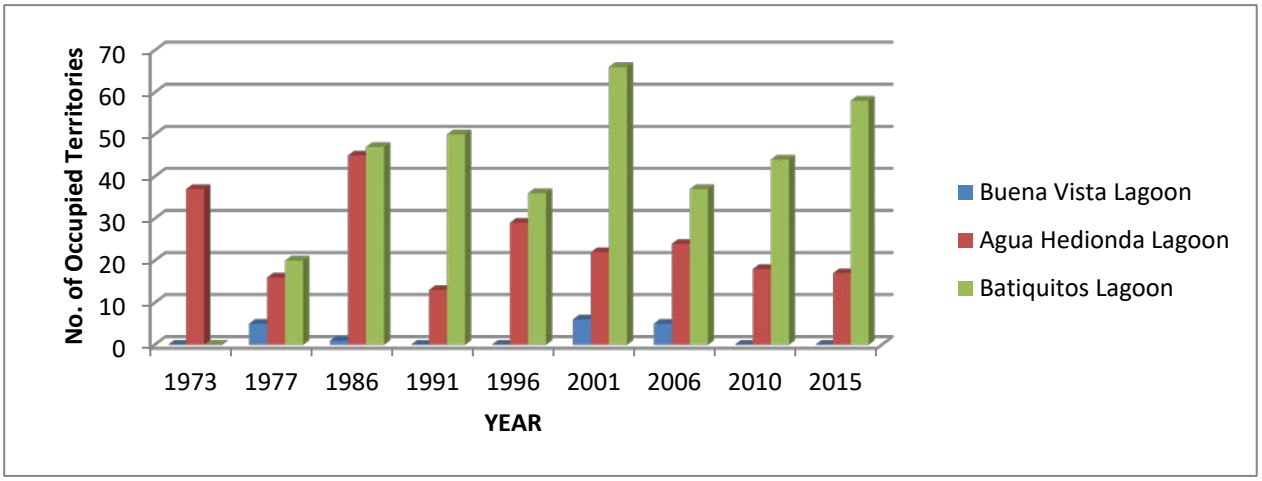
Management actions include habitat management through invasive species control. Algerian sea-lavender (*Limonium ramosissimum*), as well as the unnatural inundation of freshwater via urban runoff, have been actively converting native upper marsh habitat, which the Belding's savannah sparrow inhabits, to brackish marsh. The top priorities for CDFW to protect this species are habitat enhancement, protection, and restoration in the form of improved tidal flushing, sediment control, limiting human disturbances, and the continued funding of a statewide census.

Long-Term Monitoring

Surveys are conducted approximately every five years as part of an ongoing census effort. The most recent census information available is from 2015, during which 27 coastal salt marshes in California were surveyed (Zembal et al. 2015). Results of surveys conducted within Carlsbad are summarized below (Table 11). See Figure 7 for a location map.

TABLE 11
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



Overall Condition and Major Threats

Approximately 3,740 pairs of Belding's savannah sparrow were detected in California during the 2015 census. This is the highest total since counts began in 1973 and 11.3 percent higher than the last count of 3,372 in 2010 (Zembal et al. 2015). 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. Encroachment of freshwater marsh habitat and 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). Due to considerable restoration efforts at Point Mugu, this lagoon in Ventura County accounts for over 30 percent of the Belding's savannah sparrow population in California.

Buena Vista Lagoon. The 2015 surveys revealed that the formerly occupied territories (2006 and prior) did not contain Belding's savannah sparrow. Encroachment of freshwater marsh habitat and song sparrows has contributed to the decline of this species within Buena Vista Lagoon, in addition to human disturbance. Potential for restoration of the territories exists, and is highest on the islands and the north-east portion of the inner lagoon. Additional improvements to the habitat could be made by the cleanup of trash and homeless encampments, as well as invasive species control. However, the transition to brackish marsh habitat limits the potential of the Buena Vista to support Belding's savannah sparrow (Zembal et al. 2015).

Agua Hedionda Lagoon. The 2015 surveys revealed one fewer territory than 2010 surveys, a 6 percent decline in territories from 2010. The territories were concentrated along a picklweed (*Salacornia* spp.) belt on the inland edges of the inner lagoon, which is threatened by encroaching

freshwater marsh. Regular dredging maintains a connection to the ocean, resulting in good potential for habitat restoration in this lagoon; however, flow is constricted due to the narrowness of the opening. Human disturbances continue to be an issue in the lagoon, although CalTrans has installed low fencing along the northern edge of the lagoon, which has helped minimally to exclude potential trespassers. 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, much of the previously existing Belding's savannah sparrow habitat has been affected and no longer supports adequate nest cover (Zembal et al. 2015).

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). 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 numbers found between the 1996 and 2001 surveys. The 44 percent reduction in Belding's savannah sparrow found in 2006 was presumably influenced by the reverting of much of the habitat back to brackish marsh due to inflow of urban freshwater runoff at the eastern edge of the lagoon (Zembal et al. 2015). Much of the remaining pickleweed dominated marsh habitat is too narrow to support Belding's savannah sparrow (Zembal et al. 2015).

California Least Tern

Sterna antillarum browni

Status: federally endangered, state endangered and fully protected

Critical Locations and Major Populations

The 1999 MHCP identified critical locations in all three lagoons. The population at Batiquitos Lagoon is considered a major population.

Management Actions Conducted to Protect the Species

A management and monitoring approach for this species has been developed by SDMMP (SDMMP 2017b), 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.

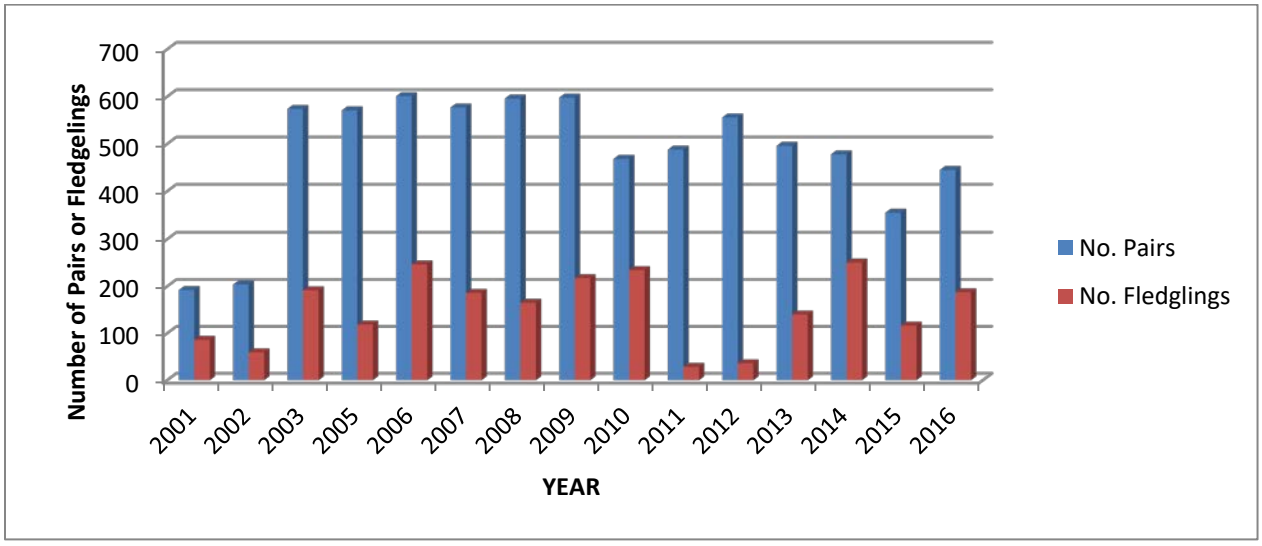
Current annual management actions for this species includes the use of shelters to protect chicks from predators and weather, decoys to attract adults, interpretive signage, vegetation management, and fencing (Frost 2014). Because least terns nest on the ground, this species, especially its fledglings, is highly vulnerable to predators. Management of the species at Batiquitos Lagoon is currently being conducted by CDFW staff. Management actions at Batiquitos Lagoon include fencing, interpretative signage, nest marking, chick shelters, vegetation management, and predator management (Frost 2017). Annual monitoring and management at Batiquitos Lagoon is conducted by local CDFW staff.

Long-Term Monitoring

Annual least tern monitoring, funded by CDFW, has been conducted annually at Batiquitos Lagoon from 1973 to 2017 (Figure 7). Biological data were collected in the following categories: estimation of breeding pairs (based on number of nests, less the number of re-nests), and productivity (total number of nests, number of eggs, number of chicks hatched, number of chicks reaching fledgling age, and number of fledglings surviving to disperse). Mortality and predation data were also collected (Table 12). Nest and fledgling data for 2017 were not available during the preparation of this report.

TABLE 12
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
No. Nests	222	226	615	596	627	594	610	649	480	532	563	558	479	415	451	Unreported
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	671
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	Unreported



Overall Condition and Major Threats

Based on 2016 monitoring data, Batiquitos Lagoon was among six breeding sites within the state of California that each had over 300 breeding pairs, which represented 72 percent of the state 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. Most notable, however, is the precipitous drop in the number of surviving fledglings, which decreased by more than 80 percent between 2010 and 2011. This was likely due to the lack of funding for monitoring and predator control (Foster 2011, Sisson 2011). In 2012, the number of fledglings increased only slightly, but rebounded significantly (almost quadrupling) by 2013, and was back up to 2010 levels by 2014 (Frost 2014).

2015 saw a significant decrease in both the number of pairs and fledglings, but in 2016 numbers bounced back up to 2014 numbers, which seem to be approximately average at Batiquitos Lagoon.

Continued threat of predation from many species, including peregrine falcon (*Falco peregrinus*), common raven (*Corvus corax*), northern harriers (*Circus cyaneus*), rats, and coyotes (*Canis latrans*), is a 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 is thought to be a major limiting factor in California least tern population growth, and could be contributing to abandonment.

Ridgway's Rail (previously Light-Footed Clapper Rail*)

Rallus longirostris levipes (*Rallus obsoletus levipes*)

Status: federally endangered, state endangered and fully protected

*Taxonomic Note

Taxonomic changes to the light-footed clapper rail have been made recently due to an analysis of genetic data. The clapper rail species *Rallus longirostris*, which included the light-footed clapper rail and two additional California subspecies, was split into three separate species (AOU 2014). Based on this analysis, the three California subspecies have become subspecies of Ridgeway's rail (*Rallus obsoletus*), resulting in a taxonomic reclassification from *Rallus longirostris levipes* to *Rallus obsoletus levipes*.

Critical Locations and Major Populations

The 1999 MHCP identified critical locations and major populations at all three lagoons in Carlsbad.

Management Actions Conducted to Protect the Species

A management and monitoring approach for this species has been developed by SDMMP (SDMMP 2017b), and includes monitoring occurrences annually through 2021 to record abundance, threats, and management needs, and implement routine management of habitat and vegetation per the needs of Ridgway's rail.

Management actions at all three lagoons 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. 2014). Priorities for CDFW are continued habitat enhancement/restoration, and funding of the statewide census. Release of captive-bred rails in Carlsbad has been conducted by a team of state, federal, and zoological organizations to contribute genetic diversity and support recovery of this species (CDFW 2014). In 2015, seven rails were released into Batiquitos Lagoon in July and six additional rails were released in November. Previous releases in Batiquitos Lagoon were performed in 2004 (8 rails), 2005 (8 rails), 2013 (6 rails), and 2014 (12 rails). Rails were also

released in Agua Hedionda Lagoon in 2004 (5 rails), 2011 (6 rails), 2012 (16 rails), and 2013 (9 rails), and in Buena Vista Lagoon in 2011 (15 rails) and 2016 (3 rails) (Zembal et al. 2016).

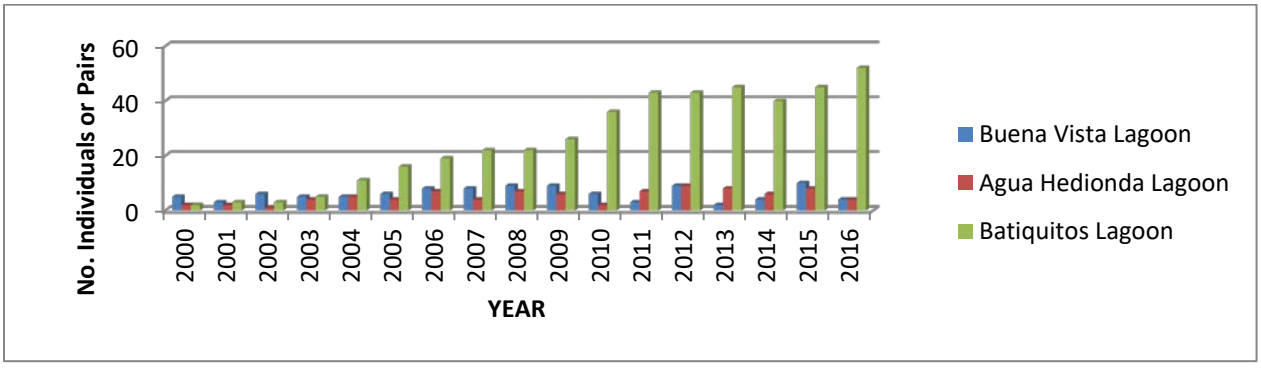
Long-Term Monitoring

In 2016, the 37th consecutive annual census of light-footed clapper rails in California coastal wetlands was conducted in 30 locations by assessing call counts. This long-term annual monitoring program, which extends from Carpinteria Marsh in Santa Barbara County to Tijuana Marsh National Wildlife Refuge on the Mexican border, is funded by CDFW. Clapper rails are typically monitored by two methods: spring call counts, and winter high tide counts. Results through the 2016 season are summarized below for areas within Carlsbad (Zembal et al. 2016) (Table 13). Surveys were performed in 2017 but data from these surveys has not yet been released. These areas are shown on Figure 7.

TABLE 13
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
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	UR
Agua Hedionda	2	2	1	4	5	4[1]	7[1]	4	7	6	2[1]	7	9	8	7[1]	8	4	UR
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	UR

[1]includes unpaired individuals (all others are pairs)
UR=Currently, data is unreported



Overall Condition and Major Threats

Statewide, 2016 was the second time in 40 years that the California population exceeded 600 pairs (Zembal et al 2016). For the last three years (2012-2014), more than 500 breeding pairs of light-footed clapper rail were documented throughout their range in California. A total of 528 breeding pairs were recorded in 2014, which is the highest number recorded to date. In 2007, a total of 443 breeding pairs were documented which, at that time, was the highest number recorded since the surveys began in 1980. Up until then, the population had been steadily increasing. The population crashed to 234 pairs in 2008, presumably due to weather-related

causes, but recovered by 37 percent in 2009 to 320 breeding pairs, and has shown a steady increase ever since (Zembal et al. 2011, 2014, 2016). 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. Batiquitos Lagoon supports the third largest subpopulation in the state and the largest subpopulation in Carlsbad. This subpopulation has shown a steady increase ever since census monitoring began in 1980. In 2008, when many other subpopulations crashed, this subpopulation remained stable from the previous year. The only exception was in 2014, when the number of rails decreased from 45 to 40. The reason for this dip is unclear (Zembal et al. 2014). However, the population recovered to 45 in 2015 and reached a new record in 2016 of 52 pairs (Zembal et al. 2016). The success of this population has been supported by the release of captive-bred rails released into Batiquitos Lagoon in 2004, 2005, 2013, 2014, and 2015.

Agua Hedionda Lagoon. Agua Hedionda Lagoon supports the second largest subpopulation in Carlsbad. In 2016, four breeding pairs were recorded. The size of this subpopulation has varied over time from one pair in 2002 to an all-time high of nine pairs in 2012. In 2013, there were eight pairs and in 2014, six pairs and one advertising female were observed in this lagoon. As in Batiquitos Lagoon, this subpopulation has been augmented by the release of captive-bred rails, here in 2004, 2011, 2012, and 2013. Although none of these captive-bred rails, which are banded, have been observed since their release, rails are being observed around the edges of the lagoon in previously unoccupied areas (Zembal et al. 2014). Recently, drought has affected the habitat and two of the regularly inhabited marsh areas are being impacted by increased recreational use such as off-leash dogs, paddle boarders, and beachgoers (Zembal et al. 2016).

Buena Vista Lagoon. The size of the Buena Vista Lagoon subpopulation has been variable over time. A high of nine pairs was detected in 2008, 2009, and 2012. Only two pairs were observed 2013 and four pairs in 2014, a new high was set with 10 pairs in 2015, but the population decreased to four pairs in 2016 (Zembal et al. 2016). To augment this population, captive-bred rails were released in 2011 and 2016.

Despite the crash in 2008, which reduced the number of pairs by almost 50 percent, the population of light-footed clapper rails in California has recovered well, and has exceeded the maximum population size recorded prior to 2008. Habitat degradation (e.g., invasion by non-native trees and shrubs), development, and predators continue to be the greatest threats to the light-footed clapper rail. Implementation of the management actions described above appear to be successful in protecting and expanding this species within Carlsbad and across California, although it is unclear if the Agua Hedionda Lagoon and Buena Vista Lagoon subpopulations are stable and self-sustaining without the introduction of captive-bred individuals. Additionally, recent evidence has pointed strongly to the fact that there is movement between marshes, contributing to higher resiliency of the species.

Western Snowy Plover

Charadrius alexandrinus nivosus

Status: federally threatened

Critical Locations and Major Populations

The 1999 MHCP identified critical locations and major populations at all three lagoons. However, this species does not nest at Agua Hedionda Lagoon or Buena Vista Lagoon and has not been observed at either location during winter surveys; western snowy plover has been found to nest at Batiquitos Lagoon Ecological Reserve (C. Beck, personal communication, 2018).

Management Actions Conducted to Protect the Species

A management and monitoring approach for western snowy plover has been developed by SDMMP (2017b), and includes monitoring occurrences through 2021 to document abundance, threats, and necessary management actions; refine BMPs based on results; implement high priority management actions; and monitor the success of such actions.

The following management activities have been conducted on Batiquitos Lagoon Ecological Reserve to encourage snowy plover nesting: (1) Habitat management—paths linking the breeding habitat with the north mud flats that had been created in 2008 were maintained; (2) Predator control—exclosures (wire cages) were placed over active nests to protect the eggs from predators; (3) vegetation management around nesting sites (Beck 2016).

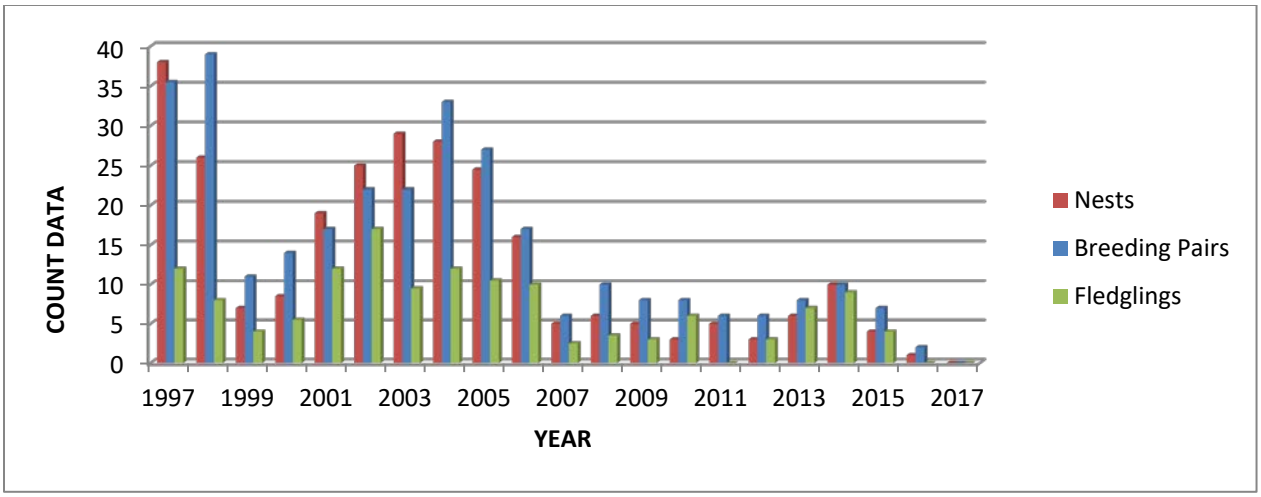
Long-Term Monitoring

Western snowy plover monitoring has been conducted annually at Batiquitos Lagoon through 2017 as part of a statewide census. Currently, annual surveys are conducted by local CDFW staff. Monitoring results from the past 20 years, from 1997 to 2017, are summarized below (Table 14). See Figure 7 for a location map.

TABLE 14
WESTERN SNOWY PLOVER MONITORING RESULTS FOR BATIQUITOS LAGOON

Year	'97	'98	'99	'00	'01	'02	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13	'14	'15	'16	'17
Breeding Pairs	36	39	11	14	17	22	22	33	27	17	6	10	8	8	6	6	8	10	7	2	0
Nests	38	26	7	9	19	25	29	28	25	16	5	6	5	3	5	3	6	10	4	1	0
Fledglings	12	8	4	6	12	17	10	12	11	10	3	4	3	6	0	3	7	9	4	0	0

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



Overall Condition and Major Threats

The numbers of nests, breeding adults, and fledglings at Batiquitos Lagoon plummeted in 2006 and 2007. The numbers remained relatively steady between 2007 and 2009, but showed a decrease in 2010 with a small rise in 2014. This trend was consistent throughout California (Squires and Wolf 2010, Squires 2010). However, the decrease after 2014 is not consistent with the rest of the state (Feucht et al. 2017). The recent decline in snowy plover numbers within Batiquitos Lagoon may be due to avian predator activity, which continues to be a major threat to this species, as well as a decline in suitable foraging habitat as loss of salt pan and mud flat has reduced typical food sources for this species (Beck 2018).

3.4 Riparian Bird Species

Least Bell's Vireo

Vireo bellii pusillus

Status: federally endangered, state endangered

Critical Locations and Major Populations

There are no critical locations or major populations of least Bell's vireo in the City of Carlsbad, according to the 1999 MHCP.

Management Actions Conducted to Protect the Species

This species is managed indirectly through general habitat management (e.g., trash pick-up, access control, patrols, and invasive species removal). On Buena Vista Ecological Reserve, roughly five acres of least Bell's vireo habitat have been restored (native cuttings/container planting and targeted invasive species removal within the riparian habitat) and approximately 55 acres have been enhanced over the last decade. Additional management actions include brown-headed cowbird trapping from 2011–2013. The invasive bird species is no longer observed on Buena Vista Ecological Reserve.

Long-Term Monitoring

Focused species surveys were conducted in suitable habitat on several preserves by CNLM between 2008 and 2017, as summarized below (Table 15). 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.

TABLE 15
ESTIMATED NUMBER OF LEAST BELL'S VIREO PAIRS

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

NS = not surveyed
[1] incidental observation
[2] territorial
[3] Migratory male

Overall Condition and 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.) and giant reed (*Arundo donax*). In addition, 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 (see Appendix II from more information on this species' presence within Carlsbad). Since the initial observation of this species in 2016, impacts from the shot hole borer have increased by approximately 50%, totaling roughly 1 acre of impacted habitat at the preserve. However, a direct correlation between negative impacts from shot hole borer and a decreased presence of least Bell's vireo has not been made within Carlsbad.

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 has been somewhat variable. In Buena Vista Creek Ecological Reserve the number of territories, as indicated by pairs or territorial males, has varied from 3 to approximately 12 over the course of 10 years. The number of potential territories on the other preserves has varied from 0 to 3. In surveys occurring within this triennial period on Encinas Creek and The Crossings, no least Bell's vireo were observed, whereas in previous years the greatest occurrences at both these preserves were 1 pair and 3 males in 2009 and 2010, respectively.

On actively managed preserves, least Bell's vireo habitat is well-protected and appears to be in good condition.

Southwestern Willow Flycatcher

Empidonax traillii extimus

Status: federally endangered, state endangered

Critical Locations and Major Populations

There are no critical locations or major populations in the City of Carlsbad, according to the 1999 MHCP 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, which occur during the breeding season (SDMMP 2017b). 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).

Management Actions Conducted to Protect the Species

This species does not appear to breed in Carlsbad, and suitable habitat is limited within the preserve system. The regional management and monitoring approach for this species includes conducting breeding surveys through 2019 to determine the presence within western San Diego County, to prepare a management plan with provisions for impacts from the shot-hole borer (*Euwallacea* spp.) and/or Fusarium infestation in potential or occupied habitat, implement high priority management actions, and monitor the success of the management actions taken.

Long-Term Monitoring

Focused species surveys for the southwestern willow flycatcher are generally conducted concurrently with least Bell's vireo surveys, as these species have similar habitat requirements (see the Table 2 for survey dates).

Overall Condition and Major Threats

A migratory southwest willow flycatcher was observed many years ago at The Crossings Golf Course (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 (Spiegelberg 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). All available survey data indicate that the southwestern willow flycatcher does not currently nest in Carlsbad.

The greatest threat to this species in San Diego County could be loss of habitat from shot-hole borer/Fusarium die back. Other threats 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 2017b). SDMMP has stated that daily management activities alone will not ensure that this species is protected.

3.5 Upland Bird Species

Coastal California Gnatcatcher

Polioptila californica californica

Status: federally threatened

Critical Locations and Major Populations

No major or critical populations have been identified in the MHCP. 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).

Management Actions Conducted to Protect the Species

Regional goals for this species include maintaining, enhancing, and restoring coastal sage scrub habitat (SDMMP 2017c). In Carlsbad, this species is managed through general habitat stewardship, including invasive species removal, patrolling, fence and sign maintenance, erosion control, habitat evaluations, and monitoring. In addition, restoration of coastal sage scrub habitat has proven a successful management action. Restoration for species management has occurred at The Crossing (five acres), Lake Calavera (six acres), and Calavera Hills, Village H and R, all of which are now occupied by coastal California gnatcatcher. A formal regional California gnatcatcher management strategy is still being developed based on data analysis from the region-wide study (Kus et al. 2017).

Long-Term Monitoring

Regional Monitoring. Regional monitoring efforts to understand the species as a whole are being coordinated by the SDMMP. A regional study that looked at the genetic structure of coastal California gnatcatchers found that there were no gene flow limitations amongst the species throughout its range, suggesting that this species is able to move freely across its range (Vandergast et al.). Another regional coastal California gnatcatcher study was performed in 2015 and 2016 to examine the effect of fire and climate change on the species, as well as how and where to rehabilitate coastal sage scrub. Conclusions from this study indicate that post-fire recovery may take six to seven decades, but that gnatcatcher detection and occupancy are increasing in previously burned areas. The study also concluded that the following have a positive effect on gnatcatcher occupancy: the presence of California sagebrush *(Artemisia californica*), California buckwheat (*Eriogonum fasciculatum*), and sunflower species, as well as shrub height and bare ground. The presence of grasses, laurel sumac, and increased herbaceous cover, correlate to a negative effect on gnatcatcher occupancy, as does time since fire. Burned areas, and

associated grasses that tend to flood coastal sage scrub areas after a fire, result in a decreased presence of coastal California gnatcatcher.

Regional monitoring is planned again for 2021 to determine occupancy, among other data. Participating land managers within the Carlsbad preserve system are scheduled to monitor for presence or absence in 2021 to contribute to the gathering of local data and accumulation of knowledge on this species presence countywide.

Citywide Monitoring. The City initiated a coordinated long-term monitoring survey effort in 2010 to assess the current condition (abundance, status: pair or single, and distribution) of the gnatcatchers throughout the City's HMP preserve system. See the 2007 triennial report for more details (ESA 2007). Surveys were then conducted citywide in 2013 among preserve managers to ensure consistency. In addition to actively managed preserves, surveys were also conducted on selected preserves within privately owned open space lands in the vicinity of the Aviara Master Association. Note that not all areas of suitable habitat within the HMP boundary were included in the survey effort due to financial and staffing constraints. 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 citywide at nine-year intervals. This would fall to 2022; however, it was decided to perform the surveys in 2021 to coincide with countywide efforts led by SDMMP. Resources preserved from less frequent monitoring are rolled into increased preserve management, such as non-native species removal, wildlife monitoring, and trash removal.

Overall Condition and Major Threats

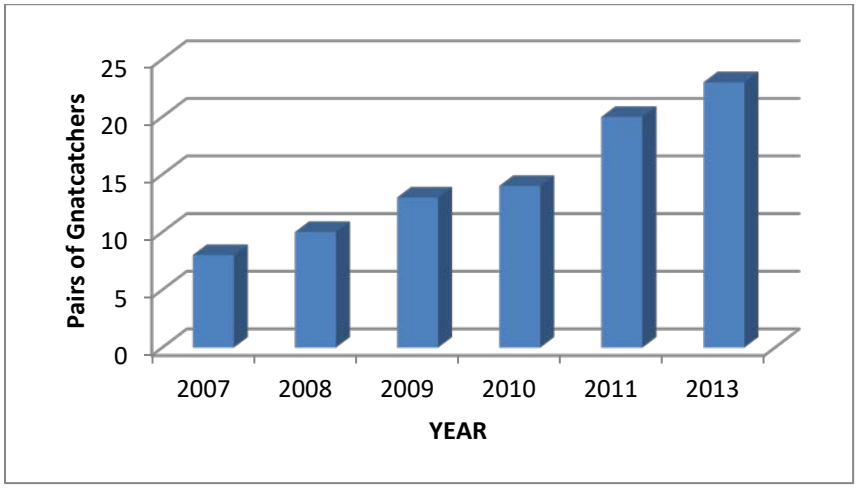
Citywide Monitoring: Approximately 1,500 acres of suitable habitat was surveyed in 2010 and 2013. A total of 122 pairs and 33 single males (155 territories) were observed in 2013 in comparison to 85 pairs and 42 males (127 total territories) observed in 2010. This is an increase of 28 territories despite little change in survey acreage (CNLM and ESA 2013). Areas with notable year-to-year differences include The Crossings Golf Course, which increased by 9 pairs (14 to 23), Agua Hedionda Lagoon Ecological Reserve, which increased by 6 territories (4 to 10), Calavera Mountain, which increased by 5 territories (6 to 11) and Kelly Ranch, which decreased by 6 territories (8 to 2). The newly preserved La Costa Glen had 5 pairs, which were observed using the preserve and adjacent slopes.

The 2010 and 2013 survey season results have provided a useful snapshot of gnatcatcher abundance, status, and distribution in Carlsbad. Gnatcatchers are observed across the jurisdiction and in all unit and vegetation patch sizes. Therefore, continued management of all unit and vegetation patch sizes is considered important for this species within the city. Small habitat patches will continue to play an important role in Carlsbad, especially during a catastrophic event, such as fire that burns some of the larger patches of coastal sage scrub (e.g., in La Costa Villages and Calavera), by serving as refugia. These small patches could be a source of CAGN recolonization after such an event occurs. In addition, the smaller patches are likely to be important stepping stones for gnatcatcher movement within and beyond the City.

Additional surveys have been performed around the city at Calavera Hills and Robertson Ranch, Encinas Creek, La Costa Glen, and Manzanita Partners. All preserves have shown steady presence throughout survey years.

The Crossings Preserve: Surveys were conducted within the Crossings Preserve from 2007–2013 as part of the restoration monitoring program associated with the construction of the golf course. In 2013, a total of 23 gnatcatcher pairs were observed within The Crossings Preserve foraging and nesting in mature coastal sage scrub creation/restoration areas. This greatly exceeds the total number of gnatcatchers observed prior to construction when a total of 17 observations were documented; it is unknown if these were pairs or unpaired individuals (Merkel and Assoc. 1998). This preserve has seen a steady increase in the number of pairs since habitat restoration was initiated, from 8 in 2007 to 10 in 2008, 13 in 2009, 14 in 2010, 20 in 2011, and 23 in 2013, as shown in the graph below.

Pairs of California Gnatcatchers at The Crossings Preserves



Threats: Currently, the largest threats to this species regionally are habitat degradation and wildfire (Kus et al. 2017). In May of 2014, occupied habitat supporting three documented gnatcatcher locations, based on 2013 gnatcatcher monitoring results, burned in the Poinsettia Fire. These locations were on the eastern and western borders of the Rancho La Costa Preserve, and on private HOA open space south of Poinsettia Lane. Post-fire monitoring has been performed annually since the 2014 fire and the habitat is recovering, although coastal sage scrub may take six or seven years to fully recover (Kus et al. 2017).

Most of the suitable habitat in the City is under active management, or under a conservation easement or other type of open space protection. The open space on HOA lands that were surveyed in 2010 and 2013 appear to be well protected from unauthorized access and other edge effects, and the suitable gnatcatcher habitat was generally in moderate to excellent condition. Post-fire monitoring will continue to be conducted in burned areas to aid in the determination of management actions necessary to recover the coastal sage scrub habitat lost in the Poinsettia Fire (approximately 27 acres).

3.6 Wildlife Movement

The MCHP was designed to "maintain connections between each of the major lagoon and estuary systems with larger blocks of inland habitats to allow movement for wildlife species" and allow for "demographic and genetic exchange by all species between preserve areas … to facilitate access by larger predators … between upland scrub and chaparral habitats and coastal habitats" (MHCP 2003). In order to evaluate the effectiveness of preserve design, the MHCP identifies several priority monitoring locations to establish where major constraints to mammal movement exist; some of these locations are within the HMP area. Tiering off the MHCP, a key objective of the HMP is to "maintain functional wildlife corridors and habitat linkages within the city and to the region," which is considered one of the HMP's primary contributions to regional biodiversity.

To evaluate the City's progress toward this objective, the City, in partnership with the preserve steward and CNLM, initiated a wildlife movement corridor and pinchpoint assessment in June 2013. This assessment was funded by a CDFW Natural Community Conservation Planning Local Assistance Grant. The purpose of the project was to:

1. Provide a baseline inventory of movement corridors and potential pinch points
2. Monitor selected locations to evaluate movement through potentially constrained areas
3. Provide recommendations for adaptive management

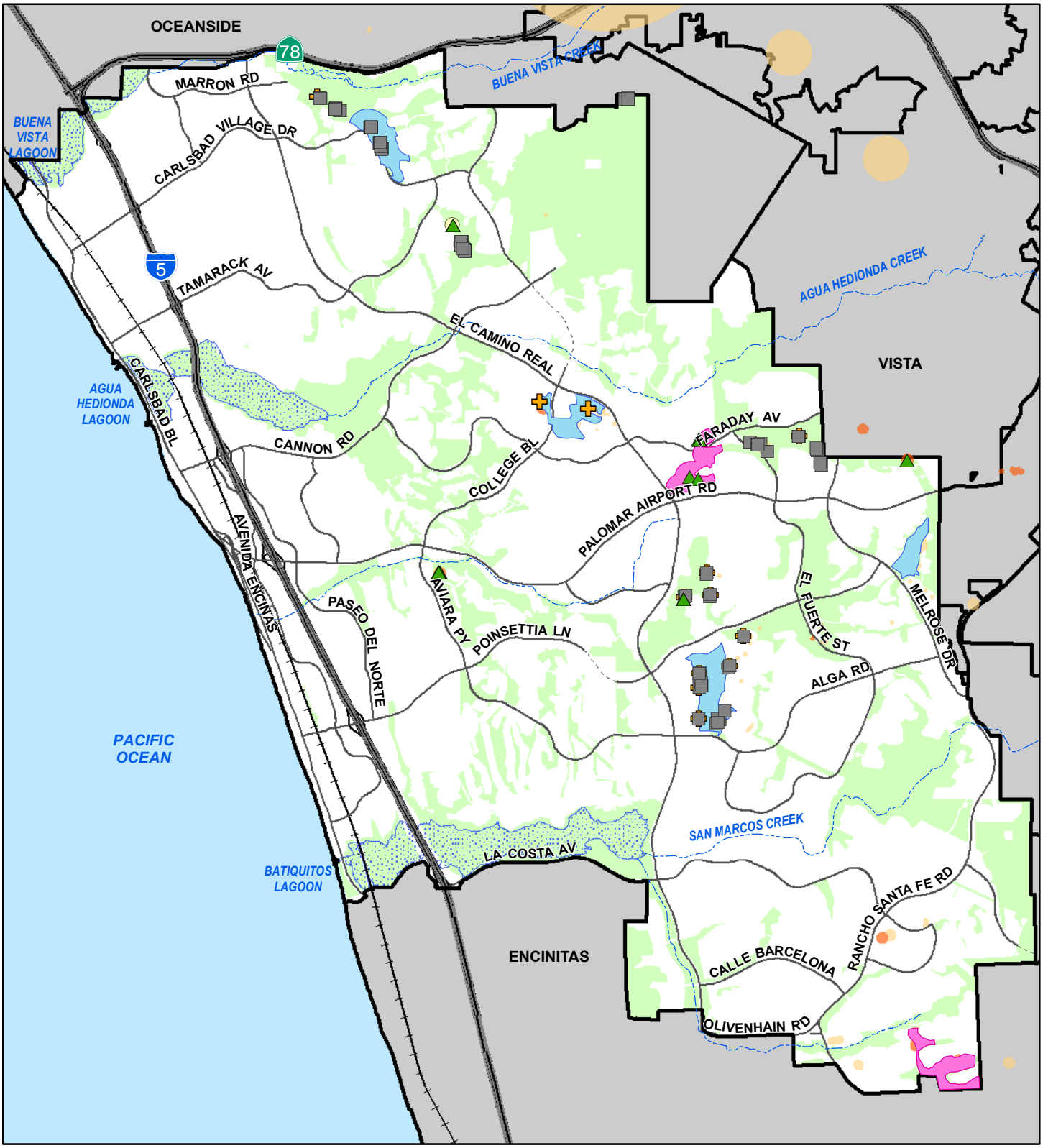
The entire pinchpoint inventory, including aerial imagery, street view imagery, field visit photos, and field data is included in the final report (City of Carlsbad et al. 2015). The report also includes the results of initial camera monitoring. Subsequently, the City, in partnership with CNLM and ESA, conducted additional trail camera monitoring and pinchpoint prioritization for adaptive management, and CNLM conducted focused deer tracking at many locations throughout the preserves they manage. The City prepared a report detailing all of these activities to date (Appendix III) and summarizes regional connectivity monitoring relevant to the HMP preserve system.

Overall, there appears to be a substantial number of small to medium-sized mammals using the undercrossings throughout the city. Many of these mammals, including bobcat, appear to be fairly well-adapted to the urban environment and travel around the city even in areas with daytime presence of humans. This is consistent with a study conducted by Tigas et al. (2002) in which the behavior of bobcats and coyotes in a fragmented urban area northwest of Los Angeles was compared the species' behavior in an unfragmented reference area. This study found that home range sizes were not significantly different in fragmented areas, and that both species adjusted behaviorally by changing their movement patterns temporally and spatially. Although corridors and culverts were used, both species were willing to travel through developed areas between habitat patches, often traveling across well-travelled roads rather than using culverts.

Deer are more restricted than smaller mammals because of their large size and preference for open crossings with a high openness ratio. Restricted movement may lead to insufficient genetic exchange to maintain a healthy population. Southern mule deer, the subspecies that occurs in our region, has been found to have less overall genetic diversity than subspecies elsewhere in the state (Pease et al 2009). Genetic sampling from scat samples in southwest SD County found evidence

of limited dispersal, population structure that corresponds to major freeways, and population bottlenecks within the past 60 years (Sommer and Mitelberg 2014). Because southern mule deer does not migrate, it does not have the opportunity to move to less developed areas during part of the year, and therefore, urbanization can have a greater effect on the southern mule deer than migratory deer elsewhere in the state (Sommer et al. 2007). It is expected that the southern mule deer will experience greater inbreeding effects as population decreases as a result of continued development in the southern California region (Bohonak and Mitelberg).

Overall, the greatest threats to functional wildlife movement throughout the HMP preserve system are: extensive network of roads and heavy traffic, habitat fragmentation from development, and homeless people who are often active at night under bridges when many native mammals are most active. Other threats include sedimentation and hydrological issues that discourage use of undercrossings, and structurally insufficient culverts or undercrossings, as these were not designed with wildlife movement in mind. Adaptive management actions that can improve functional movement include vegetation clearing or thinning at covered entrances, but encouraging adequate native vegetation cover for prey animals to feel safe; sufficient and properly placed directional fencing to direct wildlife into culverts and away from roadways; better access control and patrolling to discourage use of undercrossings or habitat by unauthorized people; and dredging out excess sediment clogging culverts. Constraints to implementing some of the adaptive management strategies includes high cost, insufficient resources, extensive wetland permitting process, obtaining access permission and/or encroachment permits, and complex social issues leading to long-term homelessness or itinerant encampments.



CNLM Occurrence:

- San Diego Thornmint
- Thread-leaved Brodiaea

USFWS Occurrence:

- San Diego thornmint
- thread-leaved brodiaea

USFWS Critical Habitat:

- San Diego thornmint
- Thread-leaved brodiaea

CNDDB Occurrence:

- San Diego thorn-mint
- thread-leaved brodiaea

- Existing and Proposed Hardline Preserve

N

0 Feet 6,400

City of Carlsbad

City of Carlsbad
Current Status of Upland Herbs

Figure 4

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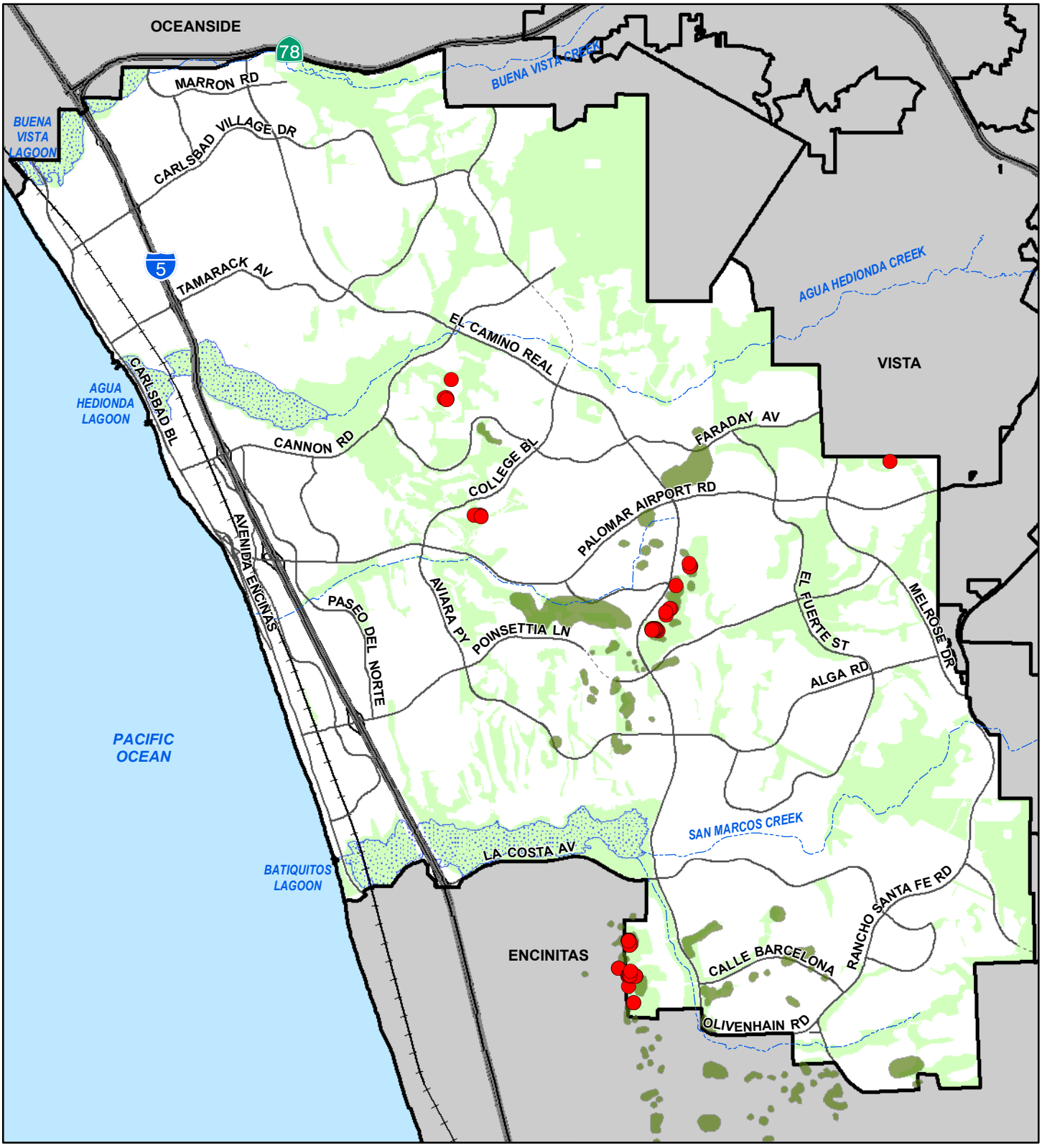
Date: 02/05/2018



CNLM Occurrence:

- Del Mar Manzanita

CNDDB Occurrence:

- 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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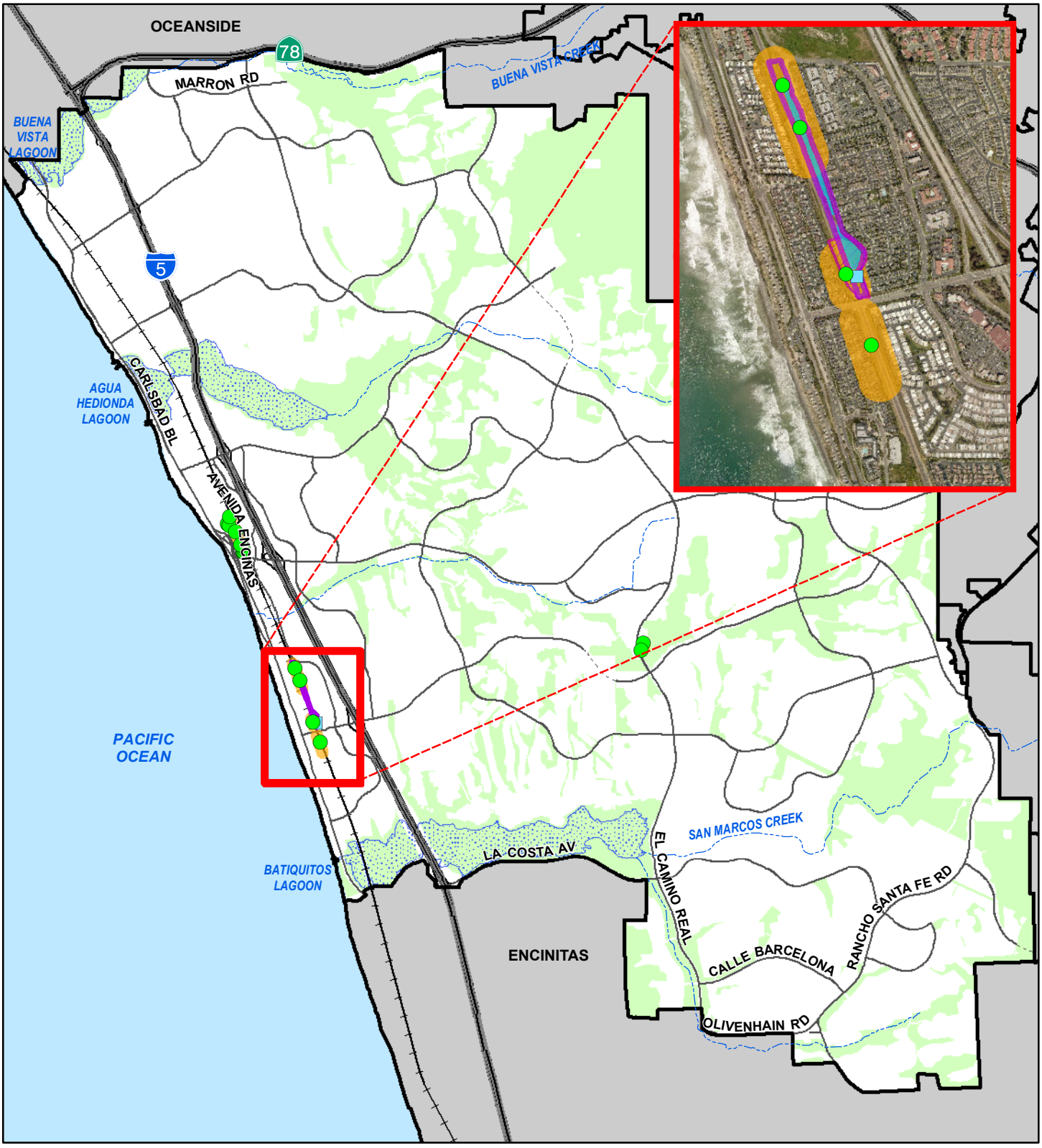
Date: 02/05/2018



Existing and Proposed Hardline Preserve

USFWS Occurrence:

- Riverside fairy shrimp
- San Diego fairy shrimp

USFWS Critical Habitat:

- Riverside fairy shrimp
- San Diego fairy shrimp

CNDDB Occurrence:

- Riverside fairy shrimp
- San Diego fairy shrimp

N

0 Feet 6,400

City of Carlsbad

City of Carlsbad
Current Status of Vernal Pool Species

Figure 6

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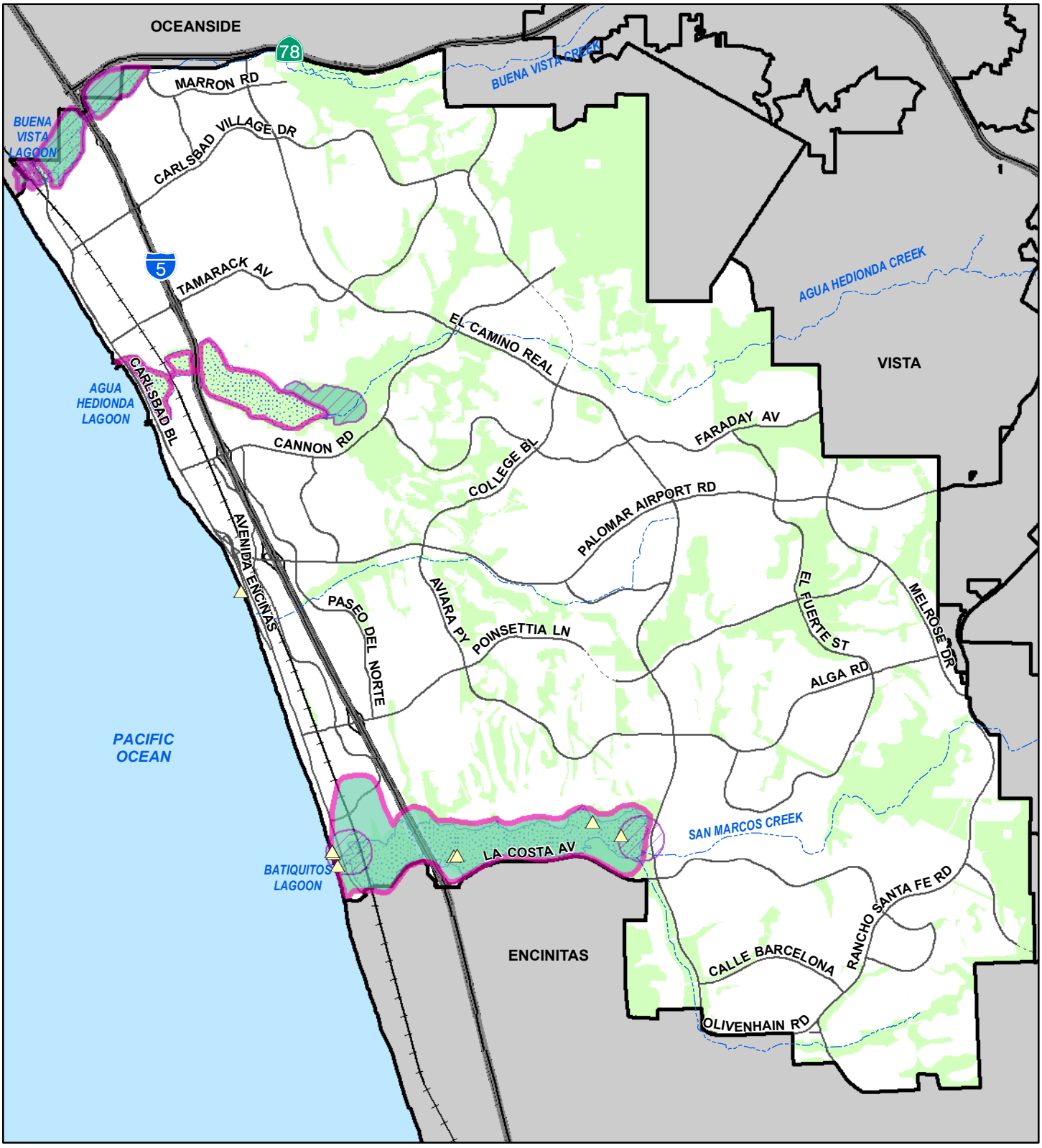
Date: 02/05/2018



USFWS Occurrence:

- △ western snowy plover

CNDDB Occurrence:

- western snowy plover
- Belding's savannah sparrow
- California least tern

Existing and Proposed Hardline Preserve

N

0 Feet 6,400

City of Carlsbad

City of Carlsbad
Current Status of Lagoon Species - Birds

Figure 7

Document Path: J:\RequestsMarch2015\PublicWorks\PEM\Stormwater\RITM0011265_18\Figure_7_LagoonBirdSpecies.mxd

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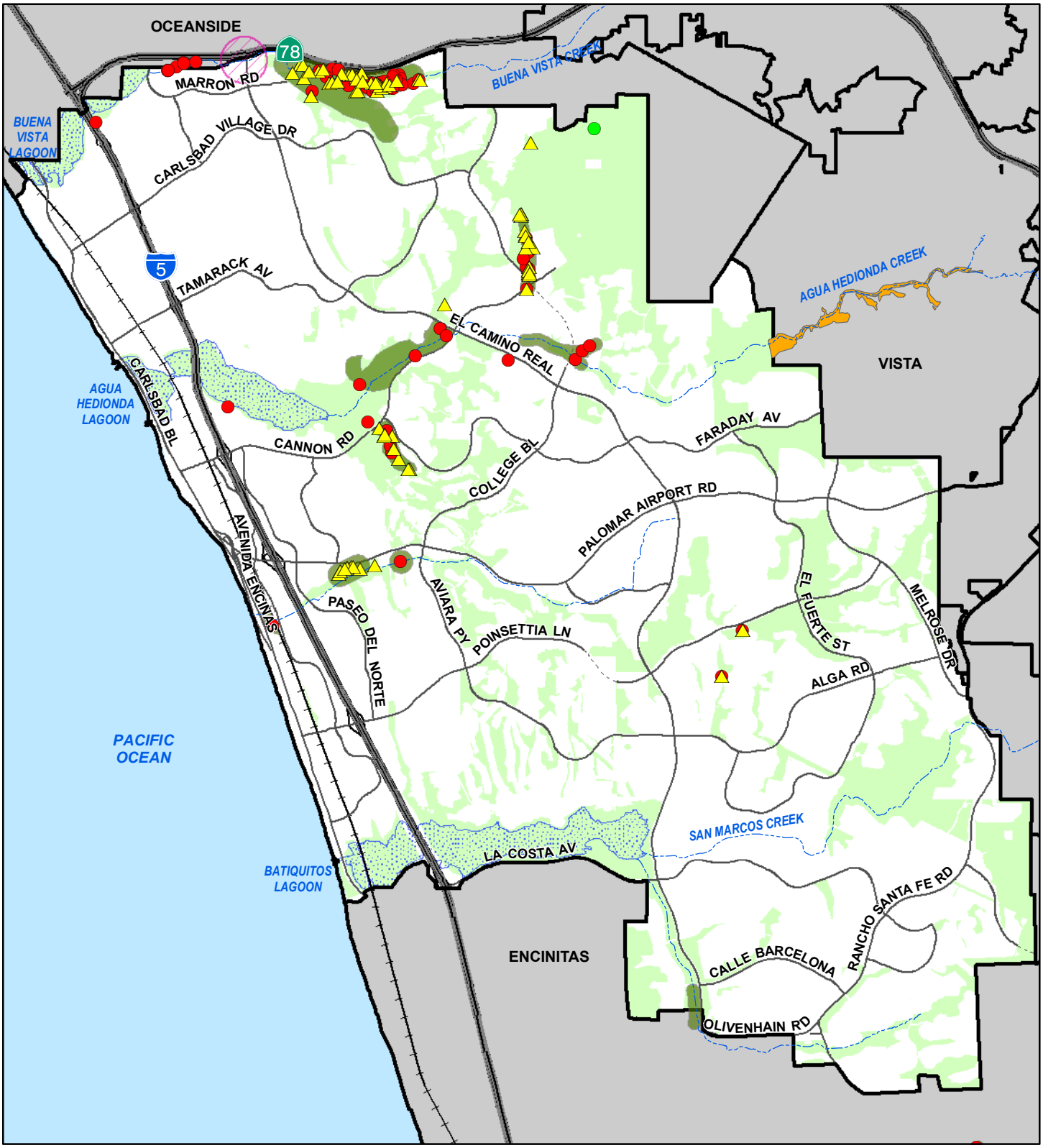

City of Carlsbad

City of Carlsbad
Current Status of Riparian Birds

Figure 8

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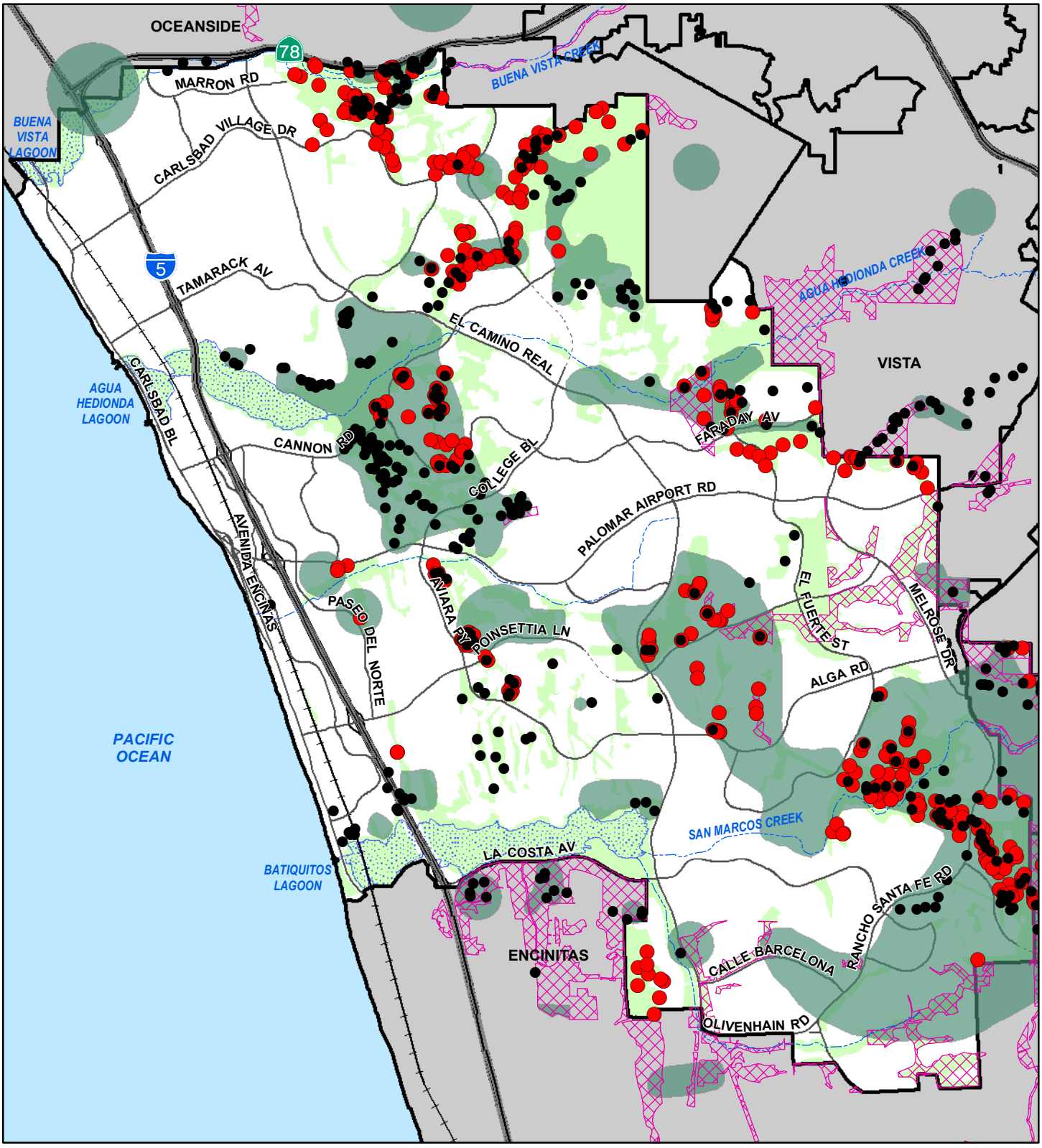

USFWS Occurrence:

- coastal California gnatcatcher

USFWS Critical Habitat:

- Coastal California gnatcatcher

CNLM Occurrence:

- Coastal California Gnatcatcher

CNDDB Occurrence:

- coastal California gnatcatcher

- Existing and Proposed Hardline Preserve

Feet
0
6,400

City of Carlsbad

City of Carlsbad
Current Status of Coastal California Gnatcatcher

Figure 9

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Date: 02/05/2018

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Appendix I.

Coastal Sage Scrub Long-term Monitoring Program Summary 2009-2017

Center for Natural Lands Management (CNLM) 2018

Coastal Sage Scrub Program Summary 2009-2017
(summarized by Markus Spiegelberg, CNLM, January 2018).

The Center for Natural Lands Management (CNLM) began a long-term monitoring program in Carlsbad's coastal sage scrub (CSS) habitat during the spring of 2009 to track and evaluate changes in the structure and composition of CSS over time. After several years of data collection and analysis, the desired approach was determined which includes 56 plots spread out across Carlsbad at various preserves (and a few in San Marcos and the County of San Diego). This approach allows for Carlsbad-wide data collection and information, but also provides Preserve-level detail. One-third of the plots are monitored each year in what is called a "rotating panel" approach, which allows for more plots to be monitored across time and realized cost efficiency. This approach is consistent with the recommendations made by Dr. Douglas Deutschman of San Diego State University (SDSU) who was contracted by the Department of Fish and Wildlife Service to develop an approach for CSS monitoring (Deutschman *et al.,* 2007 and 2008) for the San Diego region.

Results

The 2017 monitoring season saw the end of the third cycle of the rotating panel (i.e. each plot monitored three times across nine years). Rainfall from 2009 to 2012 was about average, rainfall from 2013-2016 was below average, and 2017 was the highest rainfall across the period.

Average percent cover of all shrubs showed a generally even trend with an increase in 2017 (Figure 1). Average percent cover of native forbs trended with the level of rainfall and average percent cover of native grasses were stable across the period (Figure 2). Average percent cover of nonnative (exotic) forbs and grasses were generally low across the period (Figure 3).

A total of 236 plant species were detected within the quadrats of all plots (Table 1). This included 46 native shrubs (and sub-shrubs), 12 native grasses, 127 native forbs, 15 nonnative (exotic) grasses and 31 nonnative (exotic) forbs. The percent of each functional group's richness varied between preserves (Table 2).

Discussion

CSS within the City of Carlsbad has high quality, native structure and composition with low cover of nonnative species. The stable cover of shrubs is a good indicator of habitat quality for sensitive wildlife species, such as the coastal California gnatcatcher (*Polioptila californica californica*). This species has been detected at almost peak density across Carlsbad. The total number of plant species observed is remarkable.

After nine years of monitoring, CNLM, decided to only focus on the point-intercept portion of the data collection for the next decade or so. Richness trends showed no positive or negative trend (per quadrat or per plot), nor where they expected across the time period. However, the nine years of data is an excellent "baseline" period, from which future data collected can be compared to. The removal of the richness plots in the short-term reduces data collection costs by over 75%. Point-intercept will continue on the rotating panel schedule.

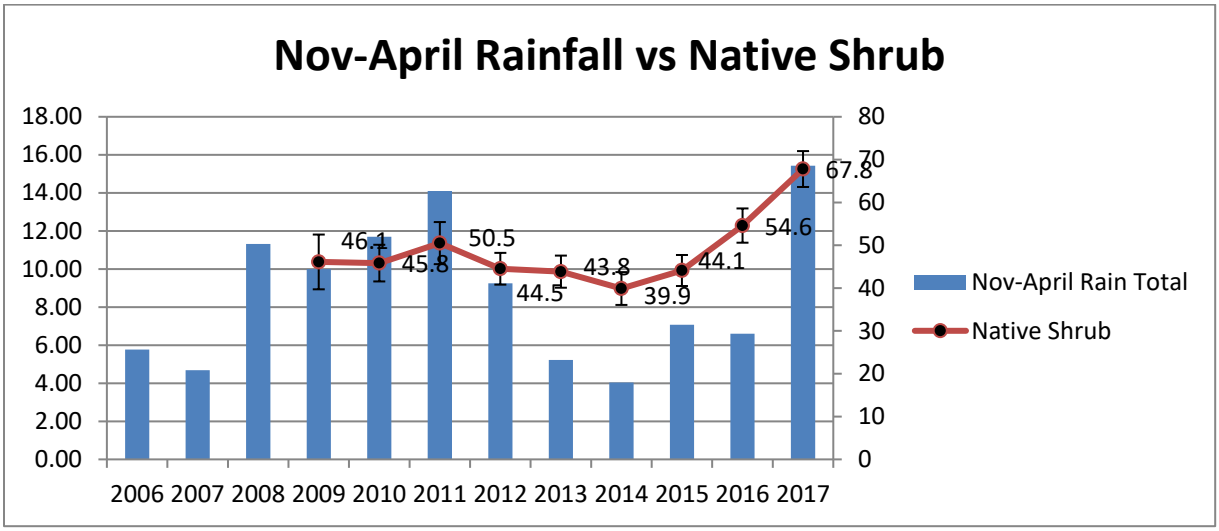

Figure 1. CSS Shrub Percent Cover Trend-Carlsbad wide
(+/- 1 standard error)

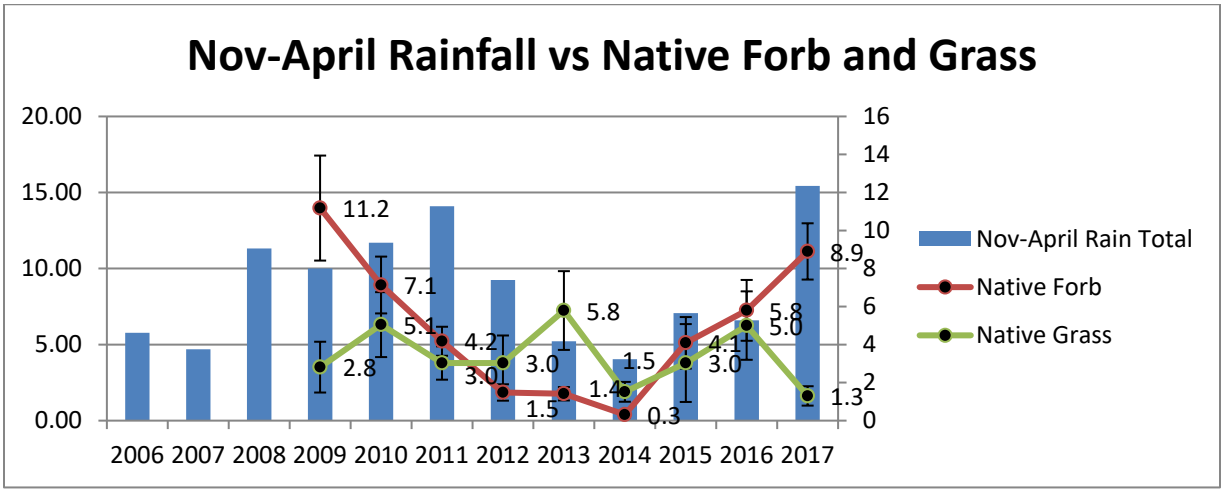

Figure 2. CSS Native Forb and Grass Percent Cover Trend-Carlsbad wide
(+/- 1 standard error)

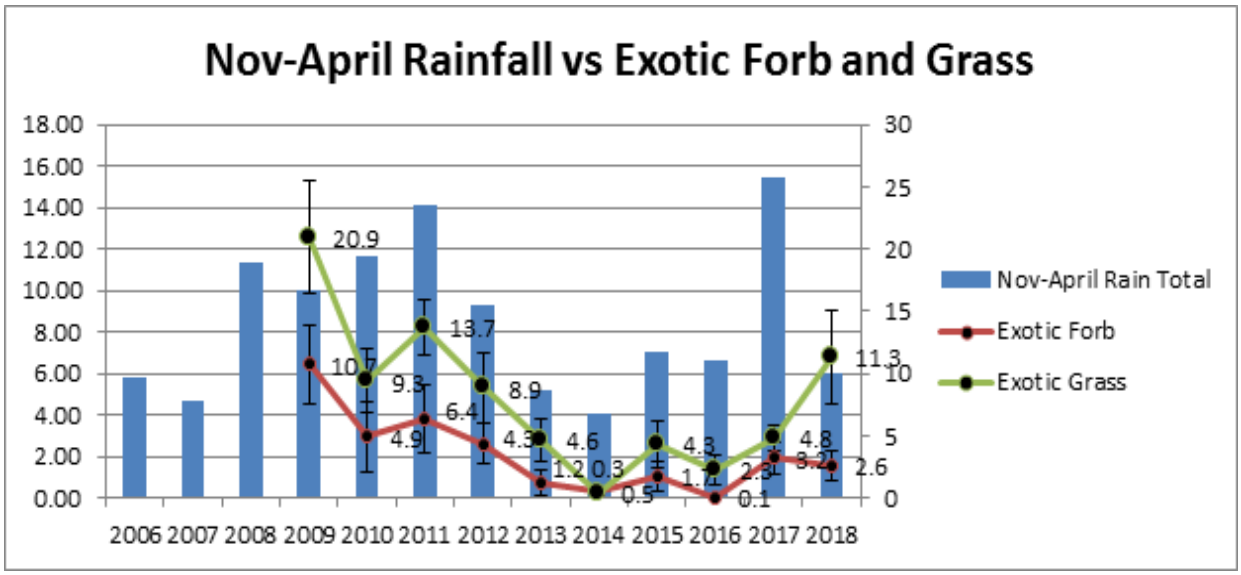

Figure 3. CSS-Exotic Forb and Grass Percent Cover-Carlsbad wide
(+/- 1 standard error)

Table 1. Species Richness by Function Group

Functional Group	**# of species (based on quadrats)**	**% of total**	**# of species (based on 50 m transect)**	**% of total**
Total # of species (2009-2016)	236		129	
Exotic Grass	15	6	12	9
Exotic Forb	31	13	17	13
Native Forb	127	54	44	34
Native Grass	12	5	8	6
Native Shrub	46	20	43	33
Native Tree	1	0.004	0	
Native Succulent	3	1		

Table 2. Species Richness by Preserve

	Aviara		Calavera Hills		City of Carlsbad Preserves		Carlsbad Oaks North		DFW-Highlands		Rancho La Costa	
Functional Group	#	%	#	%	#	%	#	%	#	%	#	%
Exotic Forb	6	**9**	20	**15**	14	**12**	13	**12**	12	**13**	22	**11**
Exotic Grass	3	**4**	14	**10**	10	**8**	6	**6**	9	**10**	11	**6**
Native Forb	35	**50**	66	**49**	56	**47**	54	**50**	44	**48**	119	**62**
Native Grass	4	**6**	10	**7**	8	**7**	9	**8**	7	**8**	8	**4**
Native Shrub	21	**30**	23	**17**	29	**24**	25	**23**	18	**20**	33	**17**
Native Tree	0	**0**	1	**1**	0	**0**	0	**0**	0	**0**	0	**0**
Native Succulent	1	**1**	0	**0**	2	**2**	0	**0**	2	**2**	0	**0**

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Appendix II.

Current Status of Shot Hole Borer and Gold Spotted Oak Borer Surveys within Carlsbad HMP Preserve System

Environmental Science Assoc. (ESA), November, 2017

ESA

550 West C Street
Suite 750
San Diego, CA 92101
619.719.4200 phone
619.719.4201 fax

www.esassoc.com

memorandum

date	November 6, 2017
to	Rosanne Humphrey, City of Carlsbad
from	Alanna Sullivan, Environmental Science Associates
subject	Current Status of Shot Hole Borer and Goldspotted Oak Borer Surveys within Carlsbad Habitat Management Plan Preserve System

This memorandum summarizes the results of 2017 surveys performed within the Carlsbad Habitat Management Plan (HMP) preserve system for the shot hole borer (*Euwallacea* spp.) and goldspotted oak borer (*Agrilus coxalis*). Both beetles have been known to decimate tree populations within San Diego County and beyond.

Shot hole borers and the associated fusarium dieback disease, are known to harm, and often kill, 138 species of trees (and are known to attack 303 species). The affected species include natives such as cottonwood (*Populus fremontii*), red willow (*Salix laevigata*), black willow (*Salix gooddingii*), coast live oak (*Quercus agrifolia*), and California sycamore (*Platanus racemosa*). Within Carlsbad, riparian woodland, oak woodland, and riparian scrub habitats are susceptible to impact. Two types of shot hole borers have been found in Southern California. Polyphagus shot hole borer (PSHB) carries three different types of harmful fungi: *Fusarium euwallaceae*, *Graphium euwallaceae*, and *Paracremonium pembeum*, and has been found in Los Angeles, Orange, San Bernardino, Riverside, and Ventura Counties, but has not yet been detected in San Diego County. Kurushio shot hole borer (KSHB), which carries two types of harmful fungi from both the *Fusarium* and *Graphium* genera, has been found in San Diego and Orange Counties.

The name shot hole borer alludes to the fact that the hole it bores resembles a shot gun hole. The harmful fungi are actually passed to the tree by the mycangia in the mouths of female shot hole borers; males, however, are often carriers of the fungi. Shot hole borers seek out healthy trees to feed within and lay eggs. The beetles bore deep into the trunk making a “gallery” of many passageways in the wood. They then lay eggs and inoculate the fungi onto wall of the gallery. Once the larvae develop, it feeds on the fungi in the gallery. The young adults then mate with siblings and move within the host tree to create a new gallery and repeat the process. The fungi continue to colonize the plant, resulting in branch dieback and, in some cases, tree mortality.

In 2016, the estimated number of trees throughout Southern California that were confirmed to have been killed by KSHB and PSHB (collectively SHB) and their associated fungus was more than 100,000, but the actual number is likely much higher (Jones 2017). Although a dependable remedy to this harmful pest has not yet been determined, pest management strategies should involve identification of vulnerable habitat and surveys for signs of shot hole borer presence.

Tree symptoms are unique to each host, but can include wet staining, thick gumming, or white, powdery exudate around the entry hole. Signs of SHB infection include brown to black staining on the wood (underneath the bark) near entry holes and branch dieback in more severe cases. If a tree is confirmed to be infested, it is recommended to chip the tree to less than one inch and solarize the chips with a clear, plastic tarp for six weeks to more than six months, depending on the temperature and time of year.

Signs of the goldspotted oak borer (GSOB), a borer native to southeastern Arizona, were first observed in Cuyamaca Rancho State Park in 2004. However, the beetle was not identified and confirmed in San Diego County until 2008. GSOB has since devastated local oak populations (Coleman 2008). Locally, the borer attacks coast live oak, California black oak (*Q. kelloggii*), canyon live oak (*Q. chrysolepsis*), and, on rare occasions, Engelmann oak (*Q. engelmannii*). GSOB larvae live and feed beneath the tree bark, damaging the xylem and phloem, which conducts water and nutrients within the tree. GSOB also harms the cambium, which is responsible for radial growth of the tree. After multiple generations of beetle infestation, the infested oak will die. In San Diego County alone over 100,000 trees have been recorded as killed and roughly 75,000 are estimated as infested by GSOB (Jones 2017); however, this number is likely much higher. Oak death has resulted in loss of sensitive habitat, increase in fire fuel load, and loss of aesthetic value.

GSOB is continuing to spread throughout Southern California's oak populations. Currently, GSOB infestations and associated oak mortality have been most prevalent in the eastern portions of San Diego County. This species has not yet been recorded in Carlsbad; however, early monitoring of oak trees will help in efforts to monitor and manage the pest. Oak symptoms include crown thinning and dieback, bark staining on the main stem, bark injury from woodpecker foraging, and D-shaped emergence holes on the main stem and larger branches of the tree (UCIPM 2013). An infested tree is likely to die within three years.

Treatment options are limited, and are similar to that of SHB. Recommendations for managing an infestation include cutting infested trees to the ground (leaving no stump), and covering cut wood with a tarp for at least two years. Wood may also be chipped to less than three inches (UCIPM 2013). Although a dependable solution to this harmful pest has not yet been determined, pest management strategies should involve identification of vulnerable habitat and surveys for signs of shot hole borer presence. Early detection of this species, as well as for SHB, is crucial in management and monitoring of both borers.

At the quarterly preserve manager meeting on November 2016, Preserve Steward Alanna Sullivan and HMP Coordinator Rosanne Humphrey requested that preserve managers survey all preserves with habitat or tree species that could potentially be threatened by SHB or GSOB. Preserve managers were asked to document all signs and symptoms of these species, as well as negative results. Surveys were performed by Center for Natural Lands Management (CNLM), San Diego Habitat Conservancy (SDHC), and San Diego Urban Corps (Urban Corps) during spring 2017. Preserve managers surveyed for both SHB and GSOB when the appropriate species for both were present in a preserve. If appropriate SHB or GSOB habitat or target species for SHB or GSOB were not present at a preserve, that species was not considered surveyed for (**Table 1**; **Figures 1 and 2**).

Table 1. SHB and GSOB surveys within Carlsbad HMP Preserve System

Area Surveyed[1] (Land Owner)	Surveyed For	Date surveyed	PM	Results
Buena Vista Creek Ecological Reserve (CDFW)	SHB	Spring 2017	CNLM	No sign of SHB. One area showing stressed trees is difficult to access, but the stress is likely attributed to a fire from a few years ago.
Carlsbad Oaks North (CNLM)	GSOB and SHB	GSOB: winter and spring of 2017; trapped June to July 2017 KSHB surveyed January 2017	CNLM	Trapping completed, no signs of GSOB; approx.10 dead or dying coast live oak likely died of other causes.
Carlsbad Raceway Preserve	GSOB and SHB	Spring 2017	SDHC	No signs or symptoms
Carrillo Ranch (City)	GSOB	Surveyed winter and spring of 2017; trapped June to July 2017	CNLM	Trapping completed, no signs of GSOB
La Costa Canyon Park (City)	SHB	Spring 2017	CNLM	No signs or symptoms
Lagoon Lane (City)	SHB	Spring 2016 and spring 2017	CNLM	No signs or symptoms
Muroya	GSOB and SHB	Spring 2017	SDHC	No signs or symptoms
Poinsettia Park (City)	SHB	Spring 2017	CNLM	Assessed crown-die off across site in mid spring; site looks good; some willow trees look suspicious but no indication of SHB.
Poinsettia Place	SHB	Spring 2017	Urban Corps	No signs or symptoms
Encinas Creek (CNLM)	SHB	Site is visited monthly and general assessments are continuously made (2016-2017)	CNLM	Assessed willow trees for crown die off and removed bark on some trees with suspicious trunk staining. Results did not indicate SHB (i.e. no bore holes beyond bark layer/no staining in the vascular tissue).
Lake Calavera (City)	GSOB and SHB	Winter and spring 2017 (and previous years)	CNLM	Oaks look healthy; one tree had one suspicious hole similar in size to a GSOB exit hole—it will continue to be monitored. Assessed crown-die off (for SHB). Most of the site looks good, but there were suspicious trees near Tamarack. Samples were sent to the lab; results were negative for SHB/Fusarium.
Quarry Creek	GSOB and SHB	Spring 2017	SDHC	Willow dieback but no SHB signs No signs or symptoms of GSOB

Crossings Golf Course (City)	SHB	Spring 2017	CNLM	Assessed Macario Canyon, a known location of KSHB since 2016; area of infestation has increased by approx. 50%. Working with City to possibly remove trees; total impact area approx. 1 acre. Crown die-off observed in a few other locations.
Calavera Hills II/Robertson Ranch (CNLM)	SHB	Spring 2017	CNLM	KSHB was confirmed in 2016. Assessed willows in locations known to have KSHB; willows re-sprouting or not dying; generally seems ok, but not vibrant.

[1] Green: no signs or symptoms, Orange: watch (some signs/symptoms), Red: confirmed

Of the 15 preserves surveyed, 9 preserves had confirmed absence of the target borer (SHB and/or GSOB) within the preserve (see table 1). Three preserves showed some signs or symptoms of one or both pests. The preserves that showed some signs or symptoms of either pest were Encinas Creek, Lake Calavera, and Quarry Creek. Willows at Encinas Creek showed some signs of crown die-off and trunk staining; however, on further investigation, the holes did not appear to resemble SHB and will continue to be watched by preserve managers. Oak trees at Lake Calavera appeared healthy but one hole was observed that resembled that of GSOB—it will continue to be watched. Willow trees at Lake Calavera were assessed for crown die-off and samples were sent to the lab. The samples came back negative for SHB or the Fusarium fungus, but the trees at Lake Calavera will continue to be watched for signs and symptoms. Quarry Creek was assessed for both SHB and GSOB; the oaks looked healthy; however, willows at Quarry Creek experienced some dieback and will continue to be watched for additional signs or symptoms.

SHB, specifically Kurushio, was confirmed on two preserves within the HMP preserve system: The Crossings golf course and Calavera Hills II/Robertson Ranch. Both preserves confirmed the occurrence of KSHB in 2016 and are continuing to monitor the spread of the pest. The infestation at The Crossings has spread by about 50% over the last year, to roughly one acre. CNLM is working with the City of Carlsbad to potentially remove the infected trees. Infected willows at Calavera Hills II/Robertson Ranch are alive and in fair health since the 2016 infestation. Both preserves are monitored regularly by CNLM staff. All other preserve managers are aware of the occurrence of both pests in the areas and have been informed of the importance of regular monitoring and early detection. Figures 1 and 2 show the results of the 2017 SHB and GSOB surveys, respectively.

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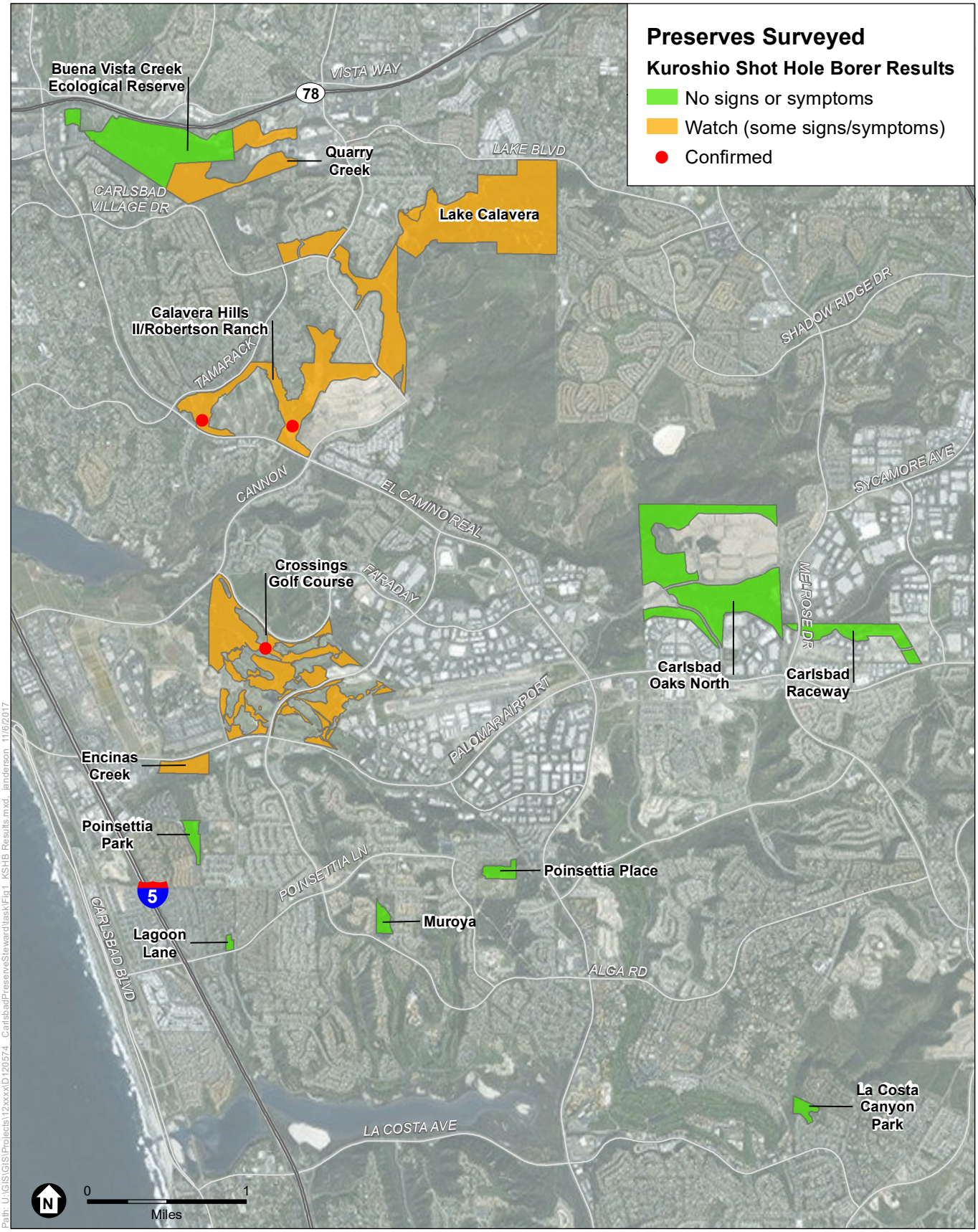
University of California Integrated Pest Management (UCIPM). 2013. How to Manage Pests: Goldspotted Oak Borer. University of California Agriculture and Natural Resources. http://ipm.ucanr.edu/PMG/PESTNOTES/pn74163.html. January 2013.

Attachments

Figure 1 – Results of 2017 Shot Hole Borer Surveys
Figure 2 – Results of 2017 Goldspotted Oak Borer Surveys

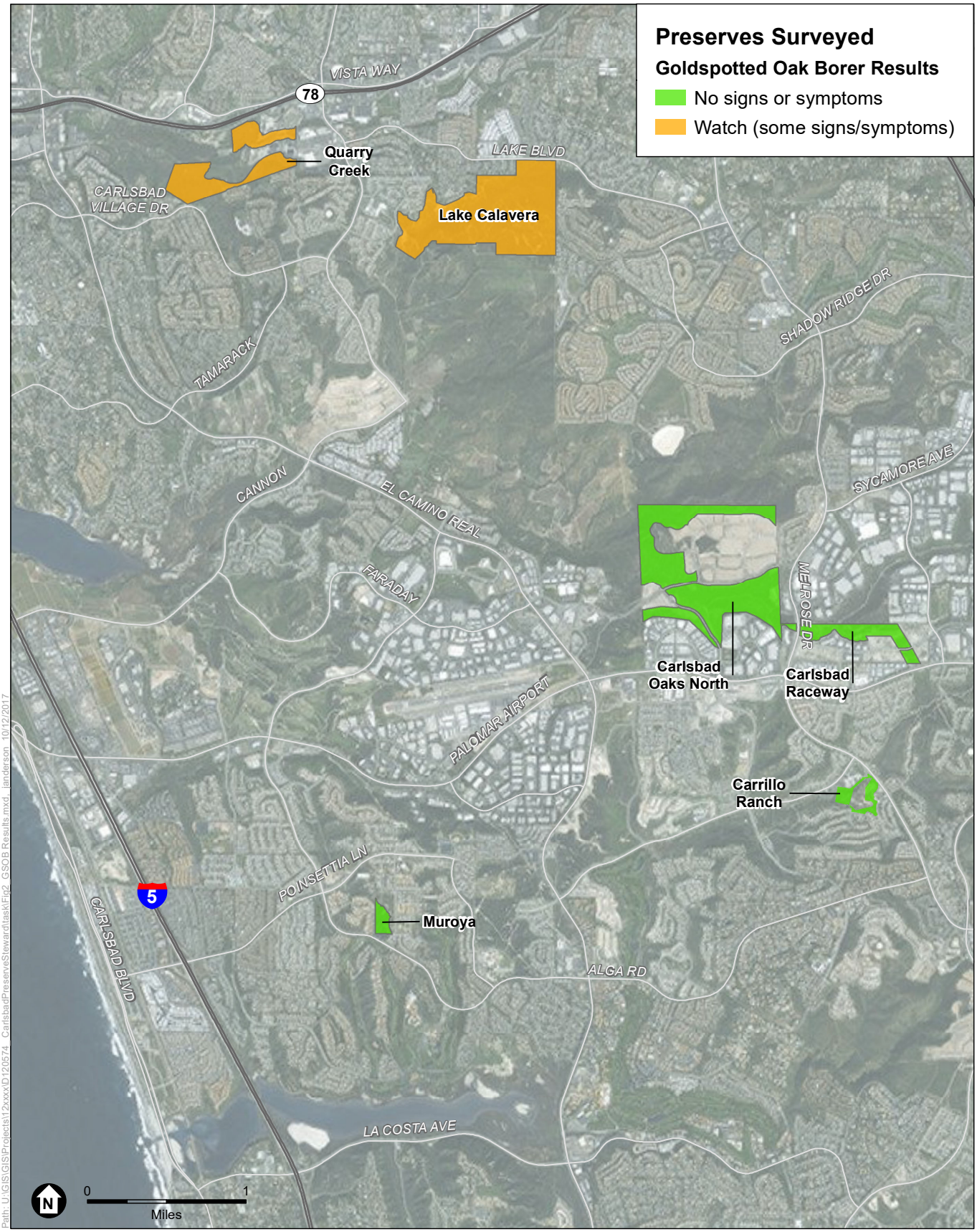


SOURCE: ESRI; City of Carlsbad

Carlsbad Preserve Steward Year 5

Figure 1
Results of 2017 Shot Hole Borer Surveys

ESA



SOURCE: ESRI; City of Carlsbad

Carlsbad Preserve Steward Year 5

Figure 2
Results of 2017 Goldspotted Oak Borer Surveys

ESA

Appendix III.

Summary of Wildlife Movement Monitoring Activities in Carlsbad

City of Carlsbad, February 2018

Memorandum

Date: February 12, 2018

From: Rosanne Humphrey, HMP Coordinator

Re: Summary of Wildlife Movement Activities in Carlsbad

This memorandum summarizes the results of wildlife movement monitoring that occurred between 2006 and 2017 within the Carlsbad Habitat Management Plan (HMP) preserve system (Figure 1).

1.0 Background

The MHCP was designed to "maintain connections between each of the major lagoon and estuary systems with larger blocks of inland habitats to allow movement of wildlife species" and allow for "demographic and genetic exchange by all species between preserve areas…to facilitate access by larger predators…between upland scrub and chaparral habitats and coastal habitats." (MHCP, 2003). In order to evaluate the effectiveness of that design, the MHCP identifies several priority monitoring locations to establish where major constraints to mammal movement exist; some of these locations are within the HMP area. Tiering off of the MHCP, a key objective of the HMP is to "maintain functional wildlife corridors and habitat linkages within the city and to the region" (HMP, 2004). The design of the preserve system is based upon the HMP Focus Planning Area, which identified eight core habitat areas connected by six linkage areas (Figure 2). Currently 6,143 of the target 6,478-acre preserve (95%) has been conserved.

The restriction of wildlife movement has been demonstrated to negatively affect the health of wildlife populations by fragmenting existing habitat areas and isolating local populations (Wilcox and Murphy 1985). Urbanized areas (open space areas within a matrix of development) are especially constraining to wildlife because of the high levels of edge, poorer quality habitat, and increased human use (George and Crooks 2006). Therefore, the maintenance of linkage areas is vital to sustaining overall wildlife populations within a region. As local populations naturally fluctuate based on a variety of factors, the maintenance of linkage areas allows for movements between local populations, strengthening the genetic diversity of the overall population. Habitat quality within core areas tends to be higher than within linkage areas, as linkage areas are generally more restricted and subject to increased pressures from surrounding areas (e.g., invasive species, human occupancy, roadway traffic, etc.). Thus, depending upon the species, the use of linkage areas by wildlife is typically restricted to movement between core areas. Elements defining the quality of a given linkage area are varied and tend to be species-specific (Rosenberg et al. 1995). Additionally, the relative restrictiveness of a given restriction (pinchpoint) is generally variable by species, meaning that pinchpoints may restrict the movement of certain species, while allowing for movement of other species. Restricted linkage areas not offering reliable connectivity between core areas may still be used by a species for foraging.

Within highly developed areas such as Carlsbad, channelized and narrow natural drainages often function as corridors. Pinchpoints often exist where these corridors intersect roadways and are further constricted within structures such as underpasses or culverts. Sometimes the undercrossing restrictions are so severe or even nonexistent such that at-grade crossing of the roadway is necessary. Although generally not designed to support wildlife movement, these structures and/or surrounding areas may sometimes be altered to improve wildlife movement. For example, shelving can be placed in culverts to allow movement of medium and small animals if the undercrossing is frequently flooded. If these culverts are large enough, fencing can be provided to help guide wildlife away from the roadway and through the undercrossing. Components common to functioning wildlife pinchpoints include native vegetation, high quality adjacent habitat, natural bottom substrates, limited inundation, and natural lighting (Carr et al. 2003).

2.0 Wildlife Monitoring Activities in Carlsbad

2.1 Linkage and Pinchpoint Evaluation

To understand the current status of wildlife movement in the preserve system, the city partnered with the Center for Natural Lands (CNLM) Management and Environmental Science Associates (ESA) in 2013 to conduct an inventory of possible wildlife movement corridors and constraints throughout the City. This baseline assessment, funded by a California Department of Fish and Wildlife (CDFW) Local Assistance Grant, consisted of three tasks: (1) Linkage/Pinchpoint Inventory; (2) Wildlife Movement Monitoring; and, (3) Analysis and Report (City of Carlsbad et al. 2015).

In the early stages of study design, the team decided to focus on large and medium sized animals, most notably southern mule deer (*Odocoileus hemionus fuliginatus*) and bobcat (*Lynx rufus*), as these species are often considered indicators of functional connectivity (SDMMP 2011). Larger animals typically require larger ranges, thereby needing to move freely through the landscape. In addition, both deer and bobcat are thought to be less adapted to the urban environment and provide a good indication of the functionality of a movement corridor for all other species. Therefore, the criteria used for evaluating the level of constraint posed by a particular pinchpoint and its suitability for inclusion in subsequent camera monitoring was based on the needs of larger and medium sized animals. The methods and results of this analysis are summarized below.

2.1.1 Linkages

The first step in the study involved identifying possible wildlife movement corridors through the city. The MHCP identified three regional corridors extending from each of the city's lagoons (Buena Vista, Agua Hedionda, and Batiquitos) eastward to inland upland areas within and beyond the city boundary. On a more local scale, the HMP Focused Planning Area (FPA) identified five generalized linkages between core areas (Figure 2). The current HMP preserve system configuration is fragmented in some areas, and functional connectivity relies upon narrow movement corridors between habitat patches. There are also riparian areas, drainages, or other open areas such as golf courses that are located outside of the HMP preserve system that enhance wildlife movement throughout the city.

Using the city's open space Geographic Information Systems (GIS) data layer and aerial imagery,

the regional and more local-scale corridors were identified and ranked according to scale and potential function. As shown in Figure 3, the wildlife corridors were grouped into three categories: (1) primary - regional east-west corridors identified in the MHCP [EW]; (2) secondary - core to core corridors between major habitat areas [CC]; and, (3) minor - corridors between non-core habitat areas [M]. A total of three primary corridors, three secondary corridors, and 11 minor corridors were identified.

2.1.2 Pinchpoints

Once the possible wildlife movement corridors were defined and mapped, the next step in the study identified potential constraints to movement. Roads are one of the most important constraints to wildlife movement in Southern California; therefore, this type of constraint was the focus of this analysis. Many of the roads in Carlsbad, which bisect habitat throughout the city, are wide (two to four or more lanes in each direction) with dense, fast-moving traffic during many hours per day. Mortality risks are high for wildlife that travel across roads. Traveling under roads through culverts and bridges that have an adequate configuration is much safer.

The purpose of this task was to create an inventory of all potential pinchpoint, which could be used for future study. First, an in-office assessment was conducted following the methodology used by USGS in a linkage evaluation performed in southwestern San Diego County (Rochester and Fisher 2012). City of Carlsbad GIS data layers (HMP and non-HMP open space) and aerial imagery were used to identify potential movement pathways along the previously identified corridors. A point was placed at every location in which a road crossed the corridor, which might serve as an impediment to movement (i.e., potential pinchpoint). Points generally consisted of culverts and bridges, but at-grade road crossings were also included. Each point was given a unique identification number (104 in all). Each point was then further evaluated by zooming in to the aerial imagery and using Google Street View to assess the type of crossing. Screenshots of aerial imagery and/or Street View were prepared for all pinchpoints. When it was possible to detect fencing that could impact wildlife movement, colored lines were added to the image.

The next step was to visit each of the 104 potential pinchpoints, take photographs of each entrance and surrounding area, collect data describing the condition and characteristics of that location, and input the data into a database. The datasheet was developed in consultation with U.S. Geological Society (USGS) biologists. Examples of data collected include nearest creek, nearest road, road conditions, structure type, bottom type, structure measurements (length, height, width), nearby fencing description, vegetation (type, thickness, cover) at each undercrossing entrance, and specific threats to movement. The entire pinchpoint inventory, including aerial imagery, street view imagery, field visit photos, and field data is included in the final report (City of Carlsbad et al. 2015). An example of the information collected for each pinchpoint is provided below (pinchpoint EW3-6).

Example of pinchpoint inventory information included in 2015 final report (EW3-6 shown)

Example of pinchpoint inventory information included in 2015 final report (EW3-6 shown)

HMP Wildlife Movement Pinchpoint Description

LOCATION DESCRIPTION

Corridor	EW3	**Point Code:**	EW3-6a	**Assessment Date**	8/19/2013	**Surveyors:**	M. Spiegelberg
Latitude:	33.09309000000	**Longitude:**	-117.22457900000	**GPS Datum:**	WGS 84		
Nearest River:	San Marcos Creek						
Nearest Road	Rancho Santa Fe Road, S of Avenida Soledad	**Road Conditions:**	Divided roadway with two or more lanes each				
Structure Type:	arch culvert	**Multi Chambers?**	no	**Structure Material**	Metal		
Bottom Type:	dirt, hard armored						
Height(m):	3.93	**Width (m)**	5.25	**Length (m):**	91.40	**Openness Ratio:**	0.2
Constraints	No						
Description of Constraints	Arch wildlife tunnel						
Access Logistics	Not good for tracking.						
Fencing:	Chain link on each side of RSF Rd. Extends over 100 feet in each direction						
Camera Options:	CNLM mounted cameras in tunnel and outside of tunnel						
Tracking Potential	Not good, hard surface						
Species/Sign Observed:	None						

DESCRIPTION OF VEGETATION EW3-6a

N or E Entrance	**Veg. Thickness**	none	**Dominant Vegetation Type**	short grasses/forbs			
Cover Classes at 20	**Shrubs**	1 (1-5%)	**Grass/Herbs**	1 (1-5%)	**Trees:**	1 (1-5%)	
	Bare/Rock:	5 (76-100%)	**Native Species:**	1 (1-5%)	**Exotic Species**	1 (1-5%)	
S or W Entranc	**Veg. Thickness**	open	**Dominant Vegetation Typ**	shrubs			
Cover Classes at 20	**Shrubs**	2 (6-25%)	**Grass/Herb**	1 (1-5%)	**Trees:**	2 (6-25%)	
	Bare/Rock:	3 (26-50%)	**Native Species:**	2 (6-25%)	**Exotic Species**	1 (1-5%)	
Veg. Comments:	Open on east side, mostly open on south side, some willows block a portion of opening on west side						

THREATS AND MANAGEMENT RECOMMENDATIONS EW3-6a

Primary Threat:	busy roadway	**Severity**	3 (moderate/not imminen
Secondary Threat:	Long tunnel	**Severity**	3 (moderate/not imminen
Mgmt Recommendations	Patrol and keep people out		
Comments:	Unclear why deer are not using tunnel; radio collar deer for study in this area		
	MHCP Monitoring Priority		

2.2 Trail Camera Studies

After analyzing the information collected during the pinchpoint inventory, the team identified selected pinchpoints for further study with trail cameras and tracking. It was determined that trail cameras would provide the best information with the most efficient use of time; therefore, camera monitoring was the primary focus, and tracking was used to supplement camera data. Prioritization was based on MHCP priorities and suitability for camera monitoring as determined in Phase 1 of the pinchpoint assessment. The purpose of pinchpoint camera monitoring was to gain a basic understanding of the presence of wildlife species at certain pinchpoints throughout the city. Generally, only one or two cameras were installed at a given location, mostly within a culvert or under a bridge. Although still or video images of animals would not definitively show that an animal was traversing all the way through an undercrossing, it would provide information about how prevalent certain species are within the city and help determine next steps in wildlife movement monitoring. Between January 2014 - January 2015, a total of 27 cameras were used at various times in 19 locations. Prior to collecting these data, CNLM had been collecting camera data at a number of their preserves since 2010 or earlier. After the study, most of the cameras were taken down, but some were kept running for additional monitoring, and some were moved to new locations, including Lake Calavera Preserve and Agua Hedionda Lagoon Ecological Reserve (Figure 4, Table 1). Details about camera mounting, camera operation, and video review are included in the Wildlife Movement Analysis Report (City of Carlsbad et al. 2015).

2.3 Tracking

Starting in 2000, tracking surveys were initiated by The San Diego Tracking Team (SDTT) using standard SDTT methodology (Figure 4). Transects T38 and T50, located on the eastern side of Carlsbad Highlands Ecological Reserve, were run from 2000 – 2016. These transects were retired because of the heavy mountain biking traffic, making it difficult to find sign. SDTT also assisted CNLM by conducting tracking at Rancho Santa Fe Road near Fire Station #6 near pinchpoint EW3-6 in 2016, visiting the transects quarterly. Tracking was conducted along transects outside and through the tunnel at this location. SDTT also assisted with transects established by the City/CNLM in the Calavera Hills area. Specifically, the transects (T1-T6) were established to document movement between what is known as “Village H” through “Village K” and then to Lake Calavera/Calavera Mountain (Figure 4). Transects were visited ten times between September 9, 2014 and January 23, 2015. To augment the tracking, a wildlife movement camera was installed in the middle of “Village K” to document movement in this parcel.

Between 2015 – 2017, CNLM conducted intensive focused tracking surveys for southern mule deer. The purpose of the surveys was to look for any type of sign, primarily scat or tracks to better understand deer movement within and across the city boundary. Surveys were conducted in Rancho La Costa Preserve at Denk Mountain, Ridgeline and East Ridgeline trail areas, and along a corridor west of Southern Preserve. Surveys were also conducted on Southern Preserve, Carlsbad Oaks North, and on both sides of Palomar Airport Road (at Carrillo Ranch and Raceway Preserves). Karen Merrill assisted CNLM with surveys on Carlsbad Oaks North and Raceway Preserves in 2015 and 2016.

3.0 Monitoring Results

3.1 Linkage Functionality

The general functionality of the linkages identified in Carlsbad were discussed in the 2015 wildlife movement analysis report, and are summarized below.

EW1 is the northern-most corridor that runs along Buena Vista Creek. This is the least functional EW corridor, especially west of the Carlsbad Golf Center, which is just east of the El Camino Real/SR 78 intersection. The biggest threat to wildlife movement along EW1 is the abundance of homeless that are present under most of the bridges. Cameras were not installed along this corridor because the risk of theft or vandalism was high. Other impediments to movement include perennial standing water in many locations, restrictive fencing, and very busy roadways. The east end might be impacted by the new Quarry Creek Master Community, and many new residents will be moving into that area; however, the creek was widened, restored, and conserved as part of project mitigation, which should facilitate movement in this area. Movement beyond the city boundary into Oceanside is further constrained by dense commercial and residential development.

EW2 connects Agua Hedionda Lagoon to the Lake Calavera Preserve/Carlsbad Highlands Ecological Reserve area (northern branch) and to Carlsbad Raceway preserve along Agua Hedionda Creek/La Mirada Creek. The northern branch appears to have fairly good connectivity except where the corridor crosses El Camino Real and College Boulevard. The culvert at EW2-3 (west of El Camino Real/Cannon intersection) has perennial standing water and is impassable; however, camera monitoring has shown that the bridges under Cannon (EW2-4) and El Camino Real south of Cannon (EW2-5) are well-used by all types of small and medium sized wildlife, including bobcats and coyotes, which can then travel along La Mirada Creek to Carlsbad Highlands Ecological Reserve. EW2-3, which connects Robertson Ranch East to Calavera Hills II Preserve appears to function adequately for small to medium sized animals, although bobcats were not observed during the 10-day monitoring period. The southern branch, which extends along Agua Hedionda Creek and Sunny Creek to core habitat on the eastern border of the city appears to be relatively unimpeded for small to medium sized animals.

EW3 connects Batiquitos Lagoon to Rancho La Costa Preserve. The northern branch extends along San Marcos Creek, and the southern branch extends along Encinitas Creek. Along the northern branch, movement under El Camino Real (EW3-3) could be difficult because there may be standing water during high tide, and there is consistent use by the homeless. Movement is likely unimpeded beyond El Camino Real, where the corridor traverses an open golf course all the way to Ranch La Costa Preserve, until Rancho Santa Fe Road. Rancho Santa Fe Road is a busy divided roadway with a 4 x 5 meter arch culvert, approximately 91 meters long. The culvert is regularly used by small to medium mammals, including bobcat, but deer do not use this culvert. Movement along the southern branch appears to be constrained at La Costa Avenue (EW3-7; lack of directional fencing), El Camino Real (EW3-10a; long, low, and muddy), and Rancho Santa Fe (EW3-13; low tunnel). EW3-7 and EW3-10a might also be impacted by human presence – both cameras were stolen within three months.

Other Corridors (Core to Core and Minor) generally run north to south along narrower habitat corridors, and often these corridors consist of upland habitat rather than riparian drainages such as the EW

corridors. Pinchpoints along riparian corridors often require larger bridges and culverts for water conveyance, which are more appropriate for wildlife movement than smaller culverts or ground-level crossing. The core to core and minor linkage functionality is described in detail in the 2015 report. There are a variety of conditions along these corridors, including vegetation cover, bottom type, structure configuration, width of roadway and density of traffic density, and type of human use, time of day of use by humans and/or dogs, directional fencing, etc. High levels of habitat fragmentation, dense residential and commercial development, and an extensive network of roads impede wildlife movement in all directions. It is clear that the biggest barriers to north-south movement within and beyond Carlsbad are SR 78, Palomar Airport Road, and La Costa Avenue.

3.2 Cameras and Tracking

Table 1 below includes a comprehensive list of camera monitoring that has occurred throughout the HMP system, when the cameras were active, and the species observed. As discussed above, mapping and general tracking locations are shown on Figure 4. Figure 5 shows the locations of deer sign that were observed during the 2015-2017 intensive focused tracking surveys, and locations where no deer or sign were observed during tracking or camera monitoring. Camera observations are also shown in Figure 5. Table 2 shows the results of focused deer tracking/monitoring conducted by CNLM. Selected photos are included in the attached photo pages.

General tracking surveys conducted by SDTT were fairly consistent with the camera monitoring in terms of species observed. Results of camera and sign tracking can be summarized as follows.

- The most common mammals observed by camera monitoring are bobcat, coyote, raccoon, opossum, rabbit, and squirrel. Other observations included skunk, bat, weasel, birds (roadrunner, waterfowl, songbirds, crows, and raptors) and rodents (most often non-native rat).
- Bobcats were observed throughout the city at almost all of the camera and tracking stations.
- It *appears* that that bobcats are using undercrossings throughout the City; however, the monitoring methodology was designed to identify presence, rather than determine if bobcats are successfully traveling all the way through.
- Bobcats were observed mostly at night, but a significant number of photos were captured during the day.
- Bobcats were observed even in locations with a heavy presence of dogs and people during the day (i.e., AHLER1 and AHLER3).
- The other species commonly observed appear to be very well adapted to the urban environment, especially coyotes, raccoons, and rabbits.
- Deer appear to be concentrated on the eastern portion of the city where there are larger blocks of core habitat, although tracks have been identified farther west, most prevalently at The Crossings preserve.
- Deer are much more restricted in their movements, requiring large, open structures such as bridges or culverts with an openness ratio ([height*width]/length) of 0.8 -0.9 (Cavallaro et al. 2005).
- Deer also prefer open vegetation at the mouth and to/from an undercrossing entrance.

Table 1. Camera Monitoring Results

Camera ID	Operator	Date in Service	Species Observed
AHLER1[1]	City	July – December 2017	**Bobcat**, coyote, rabbit, raccoon, dog, human
AHLER3[1]	City	June – December 2017	Bird, **bobcat**, coyote, rabbit, raccoon, dog, human
LC1[1]	City	March – December 2017	Bird, **bobcat**, coyote, rabbit, raccoon, dog, housecat, non-native rodent, human
LC2[1]	City	November 2016 – December 2017	Bird, coyote, rabbit, raccoon, human
Calavera Ck	CNLM	2015-2017	bird, **bobcat**, coyote, **deer**, rabbit, raccoon, skunk (striped and spotted), and squirrel
CC1-3	CNLM/SDTT	Village K; August 2014 – 2016	**Bobcat**, coyote, rabbit, raccoon, roadrunner, skunk
CC3-1a	City	July 2014 – September 2016	Bat, **bobcat**, coyote, rabbit, raccoon, squirrel, weasel, rodent
CC3-1b	City	December 2016 – April 2017	bird, **bobcat**, coyote, raccoon, rodent, squirrel, housecat
CC3-6a	City	January – March 2014 (stolen)	Coyote, rabbit, raccoon
CC3-6b	City	January – April 2014	
CH1[1]	CNLM/SDTT	2016	**Bobcat**, coyote
EW2-3	CNLM	College Ave; October 9 -19, 2012; 2015-2016	**Bobcat**, coyote, opossum, rabbit, roadrunner, skunk, squirrel, rodents
EW2-4a	City	January – October 2014 (stolen)	**Bobcat**, coyote, opossum, raccoon, skunk, squirrel
EW2-4b	City	January – October 2014 (stolen)	
EW2-5a	City	February – May 2014	Bat, **bobcat**, coyote, opossum, rabbit, raccoon, skunk
EW2-5b	City	April 2015 – April 2017	
EW2-5c	City	December 2015- December 2017	Bird**, bobcat**, coyote, opossum, rabbit, raccoon, rodent, skunk, squirrel, human
EW2-5d	City	March 2016 – December 2017	
EW2-6	City	July 2014 – May 2015	Bird, raccoon
EW2-9	CNLM	Seasonally 2010-2015; year round 2015-2017	**Bobcat,** coyote, **deer**, opossum, raccoon, skunk, squirrel
EW2-10	CNLM	Couple of months 2015-2016 (mule deer focus)	**Bobcat**, coyote, **deer**, skunk
EW3-5a	CNLM	Dam (E of RSF Rd); 2006-2016; (yearly since 2010)	**Deer**, **bobcat**, coyote
EW3-5b	CNLM	Within RSF tunnel; several times 2015-2016	**Bobcat**, raccoon, skunk
EW3-5c	CNLM	West of RSF Rd; several times 2015-2016; redeployed December 2017	**Deer,** coyote
EW3-6	CNLM	2007 (one month); 2015-2016	**Deer, bobcat** coyote
EW3-6a	CNLM	November 2012 – April 2013; October 2013 – March 2014	**Bobcat**, raccoon, skunk
EW3-6b	CNLM	Oct 2010 – Apr 2011; Sept 2011 – Jun 2014; Dec 2014 – Jan 2015	**Bobcat**, coyote, **deer**, rabbit, raccoon, skunk, squirrel
EW3-7	City	January – March 2014 (stolen)	Coyote, opossum, raccoon, squirrel, weasel
EW3-10a	City	February – October 2014	**Bobcat**, coyote, opossum, raccoon
EW3-13a	City	May 2014 – March 2015	**Deer** (did not enter culvert), opossum, raccoon.
EW3-13b	City	January – July 2014	
M2-1	City	January – October 2014 (stolen)	
M5-1	City	July 2014 – April 2015	**Bobcat**, opossum, rabbit, raccoon, rodent, skunk, squirrel
M6-1 (N & S)	City	October 2010 – April 2014	**Bobcat**, coyote, opossum, rabbit, raccoon, skunk,
M6-1a	CNLM	2013 - 2017	**Bobcat**, coyote, **deer** (buck and doe), raccoon, opossum
M6-3	City	July 2014 – February 2015	**Bobcat**, coyote, opossum, rabbit, raccoon, skunk
M10-1	CNLM	October 2013 – January 2014	**Bobcat**, coyote, raccoon, squirrel
M11-1a	CNLM	Leucadia; October 2013 - 2017	**Bobcat**, coyote, raccoon
M11-1b	CNLM	Barcelona; October 2013 - 2017	**Bobcat**, coyote, rabbit, raccoon, squirrel, skunk
PF	City	July 2014 – April 2017	**Bobcat**, opossum, rabbit, raccoon, rodent, squirrel

[1] AHLER = Agua Hedionda Ecological Reserve, CH = Calavera Hills; LC = Lake Calavera Preserve; PF = Post-Fire (burn area).

Table 2. Results of Focused Deer Tracking and Camera Monitoring Conducted by CNLM

Preserve	Type	Location	Monitoring Date	Deer Observations	Management Recommendations
Calavera Hills/ Robertson Ranch	Undercrossing camera/tracking	EW2-3; College Ave	October 9 -19, 2012; 2015-2016	No deer observed	Needs regular patrols and vegetation maintenance.
Calavera Hills/ Robertson Ranch	Trail camera/ focused tracking	CC1-3; Village K	August 2014 – 2016	No deer observed	
Calavera Hills/ Robertson Ranch/ CHER	Trail camera/ focused tracking	Calavera Creek	2015-2017	Good movement along creek by deer and other wildlife	Need study to help determine density, movement patterns and familial relationships
Carlsbad Oaks North/Raceway	Undercrossing camera	EW2-9; Faraday	Seasonally 2010-2015; year round 2015-2017	Deer were not using tunnel prior to 2015, but started using again regularly after vegetation clearing	Keep vegetation cleared to accommodate deer movement; frequent patrols; graffiti removal
Carlsbad Oaks North/Raceway	Undercrossing camera/tracking	EW2-10; Melrose	2015-2016	One deer track in tunnel; likely going over road; using many areas of CON preserve, critical water and foraging resources; deer on both sides of Melrose in Raceway Preserve;	Vegetation management, directional fencing; patrols. Need study to help determine density, movement patterns and familial relationships
Rancho La Costa	Trail camera	EW3-5a; Dam east of Rancho Santa Fe Rd	2006-2016; (yearly since 2010)	Deer observed consistently each year; most common animal observed	
Rancho La Costa	Undercrossing camera	EW3-5b; within Rancho Santa Fe tunnel	several times 2015-2016	No deer observed in tunnel; deer not using EW3-5, but instead going across road	Tunnel too long/dark; needs directional fencing, lighting inside tunnel and some vegetation removal; little annual maintenance required; more patrols.
Rancho La Costa	Trail camera	EW3-5c; West of Rancho Santa Fe Rd	Several times 2015-2016; redeployed December 2017	Deer observed	Proves that deer are crossing RSF Road rather than using the tunnel
Rancho La Costa	Trail camera	EW3-6	2007 (one month); 2015-2016	One deer during 1 month camera up in 2007; 2015-2016 many deer.	No immediate management needs; routine patrols recommended.
Rancho La Costa, Southern Preserve	Focused deer tracking	Denk Mtn, corridor W of Southern Psv, Ridgeline and East Ridgeline trails, Southern Psv	2015-2016	Deer are moving along San Marcos Creek under bridges; using corridor through Southern Preserve/RLC wildlife corridor parcel; crossing Denk Mountain; found on Ridgeline area west of San Marcos Creek.	Need study to help determine density, movement patterns and familial relationships
City right-of-way near HOA open space	Undercrossing camera	EW3-13; Rancho Santa Fe Road south of Olivenhain	2014-2015	Deer observed at culvert entrance but did not enter the tunnel	
Encinas Creek	Trail Camera	M6-1a; west of Hidden Canyon Rd	2013 - 2017	Deer (buck and doe) observed for first time in 2017	
La Costa Glen	Camera/tracking	M11-1a; Leucadia	2015-2017	No sign of deer 2015-2017; one scat observed in 2017	Needs frequent patrols and homeless camp cleanup. Need study to help determine density, movement patterns and familial relationships
La Costa Glen	Undercrossing Camera	M11-1b; Barcelona	2013-2017	Many animals used undercrossing until 2017, but no deer	Needs frequent patrols and homeless camp cleanup.

4.0 Pinchpoint Adaptive Management

As discussed above, the city-wide pinchpoint inventory and wildlife movement evaluation included information about potential constraints to movement at each location, including traffic, vegetation, human presence, undercrossing structure, and fencing. After the final report was completed, the City worked with CNLM and the Preserve Steward (ESA) to evaluate and prioritize the pinchpoints for adaptive management actions that could improve wildlife movement. In addition to the type and severity of threats at each location, feasibility of task implementation was also evaluated. Locations or management actions that were thought to have significant constraints to management implementation were eliminated from further consideration. Examples of significant constraints include areas with major hydrological issues that might require remedial engineering or dredging, actions that might trigger the need for jurisdictional permitting, remedial work requiring structural changes to an undercrossing, areas with complex landownership issues (e.g., installing fencing on land owned by multiple jurisdictions), or actions considered to be cost prohibitive. After this initial pass was made, a number of pinchpoint locations were re-evaluated in the field to document current conditions. Finally, six pinchpoints were prioritized (Table 3) for possible adaptive management.

Funding to implement these management actions was requested by the City in partnership with CNLM and ESA through a Local Assistance Grant proposal submitted to the California Department of Fish and Wildlife on August 17, 2017. The proposal was not funded; therefore, these tasks are not funded at this time.

Table 3. Priority Pinchpoints for Adaptive Management

Task	Site-Specific Threats	Solution[1]
1 (EW3-6)	Previous camera studies show that deer, coyotes and other species of mammals cross on the busy roadway instead of using the undercrossing; openness ratio = 0.2; western entrance obstructed by dense vegetation.	(1) Install approx. 250 LF of 5-foot chain link fence to guide animals to the tunnel; (2) install solar two powered lights within the tunnel; (3) thin vegetation at the western entrance to make the tunnel opening more apparent; and (4) install 4 wildlife cameras to document movement.
2 (M1-2)	Undercrossing is gated to deter human use; animals may cross on the busy roadway instead of using the undercrossing; eastern entrance obstructed by dense vegetation and debris.	(1) Install approx. 1,000 LF of fence along both sides of Tamarack Ave to guide animals through the tunnel and dissuade human trespass; (2) create small opening in gates at tunnel entrance; (3) clear debris and thin vegetation; (4) increase routine patrols; and (5) deploy cameras to monitor movement.
3 (EW2-10)	Dense vegetation blocks the undercrossing entrances and tunnel visibility from a distance is compromised. Previous monitoring studies show that deer are mostly going over the busy roadway rather than using the undercrossing.	(1) Remove vegetation from the tunnel openings and thin to create a "path" to the eastern tunnel opening; and (2) deploy wildlife cameras (3) increase routine patrols.
4 (CC-3-6)	Northern entrance obstructed by dense vegetation and debris.	(1) Remove vegetation that blocks the northern entrance (2) remove debris from the tunnel; (3) increase routine patrols; and (4) conduct tracking to monitor movement.
5 (M10-1)	Animals may cross on the busy roadway instead of using the undercrossing. Homeless people are commonly observed using the undercrossing. Previous monitoring studies documented only a few animals using this undercrossing.	(1) Install approx. 500 LF of fence to guide animals through the tunnel and dissuade human trespass; (2) conduct tracking or camera monitoring; and (3) increase routine patrols
6 (EW3-1)	Animals may cross on the busy roadway instead of using the undercrossing.	(1) Install approx. 100 LF of fence to encourage wildlife movement under bridge; and (2) conduct tracking or camera monitoring

[1] LF = linear feet

Although the Local Assistance Grant project was not funded, CNLM was able to conduct adaptive management at one of the pinchpoints on the Carlsbad Oaks North Preserve. Quantitative data from camera monitoring clearly shows the improvement of deer movement as a result. Prior to 2015, deer had stopped traveling under Faraday through the EW2-9 undercrossing, but were instead traveling over the road. In 2015 vegetation was cleared from the entrance and vegetation was thinned along a path so that deer could clearly see to the other side of the tunnel. The number of deer captured on camera increased from 0 in 2014 to 221 in 2016 and 188 in 2017. Bobcats and coyotes also frequented the tunnel; however the vegetation clearing did not have as profound an effect, as these species regularly used the tunnel before 2015 (Table 4, Figure 6).

Table 4. Wildlife Observed at EW2-9
Before and After Vegetation Management

Year	Deer	Bobcat	Coyote
2010	0	0	7
2011	1	1	24
2012	0	31	83
2013	0	105	55
2014	0	18	7
2015	11	21	12
2016	221	74	65
2017	188	40	60

* Note: cameras deployed intermittently between 2010-2015

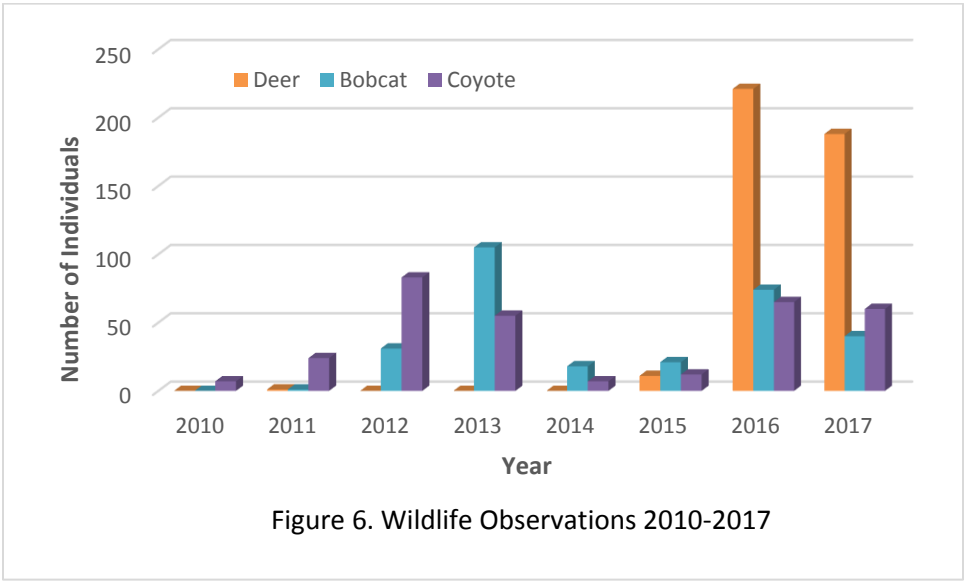


Figure 6. Wildlife Observations 2010-2017

5.0 Discussion

5.1 Summary

Overall, there appears to be a substantial number of small to medium-sized mammals using the undercrossings throughout the city. Many of these mammals, including bobcat, appear to be fairly well-adapted to the urban environment and travel around the city even in areas with daytime presence of humans. This is consistent with a study conducted by Tigas et al. (2002) in which the behavior of bobcats and coyotes in a fragmented urban area northwest of Los Angeles was compared the species' behavior in an unfragmented reference area. This study found that home range sizes were not significantly different in fragmented areas, and that both species adjusted behaviorally by changing their movement patterns temporally and spatially. Although corridors and culverts were used, both species were willing to travel through developed areas between habitat patches, often traveling across well-travelled roads rather than using culverts.

Deer are more restricted than smaller mammals because of their large size and preference for open crossings with a high openness ratio. Restricted movement may lead to insufficient genetic exchange to maintain a healthy population. Southern mule deer, the subspecies that occurs in our region, has been found to have less overall genetic diversity than subspecies elsewhere in the state (Pease et al 2009). Genetic sampling from scat samples in southwest SD County found evidence of limited dispersal, population structure that corresponds to major freeways, and population bottlenecks within the past 60 years (Bohonak and Mitelberg 2014). Because southern mule deer does not migrate, it does not have the opportunity to move to less developed areas during part of the year, and therefore, urbanization can have a greater effect on the southern mule deer than migratory deer elsewhere in the state (Sommer et al, 2007). It is expected that the southern mule deer will experience greater inbreeding effects as population decreases as a result of continued development in the southern California region (Bohonak and Mitelberg).

Overall, the greatest threats to functional wildlife movement throughout the HMP preserve system are: extensive network of roads and heavy traffic, habitat fragmentation from development, and homeless people who are often active at night under bridges when many native mammals are most active. Other threats include sedimentation and hydrological issues that discourage use of undercrossings, and structurally insufficient culverts or undercrossings, as these were not designed with wildlife movement in mind. Adaptive management actions that can improve functional movement include vegetation clearing or thinning at covered entrances, but encouraging adequate native vegetation cover for prey animals to feel safe; sufficient and properly placed directional fencing to direct wildlife into culverts and away from roadways; better access control and patrolling to discourage use of undercrossings or habitat by unauthorized people; and dredging out excess sediment clogging culverts. Constraints to implementing some of the adaptive management strategies includes high cost, insufficient resources, extensive wetland permitting process, obtaining access permission and/or encroachment permits, and complex social issues leading to long-term homelessness or itinerant encampments.

5.2 Potential Future Studies

It is important to note that our study design does not enable us to fully understand the functionality of wildlife movement in Carlsbad. The following questions have not yet been answered:

- Are animals actually traveling through culverts to move from one habitat fragment to another?

- Are they successfully using undercrossings *instead* of roadways, or are they also traveling over roadways?
- How high is the roadkill mortality rate for each species? Are some species more vulnerable than others?
- Are wide-ranging species, such as bobcats and deer, able to move around such that they have a *functional* home range in this urbanized preserve system (e.g., able to find sufficient food and successfully raise young, and the young are able to disperse and establish their own successful home ranges)?
- What effect does authorized (recreational) and unauthorized (homeless, encampments, unleashed dogs, off-trail hiking or mountain biking) have on wildlife movement?
- Are some types of human activities more detrimental to wildlife movement functionality than others?
- Are different functional groups of animals (e.g., songbirds, raptors, roadrunners, large mammals, medium sized predators, small mammals and other vertebrates) differentially affected by human activity, corridor habitat condition, or undercrossing structure?

Potential future studies to help answer some of these questions could include more intensive, targeted camera monitoring, roadkill studies to evaluate roadway mortality, or genetic studies to determine the level genetic exchange in local populations. Much can also be learned from regional studies that are have been conducted or are currently underway, as described below.

5.3 Regional Studies

The SDMMP and collaborators are conducting numerous studies that will help us better understand wildlife movement and genetic connectivity on a regional scale. Examples of these studies are included below.

1. **North County Connectivity Study.** The U.S. Geological Survey (USGS) will perform a preliminary assessment of the potential linkages between the core conserved wildlife areas within northern San Diego County and evaluate connectivity within core areas. GIS and imagery tools will be used to identify points within each linkage where wildlife potentially may move between the core conserved lands. Images of each point, a brief description, and the potential for wildlife to use each will be complied into a report.
2. **Southern Mule Deer.** Amy Vandergast (USGS) will be conducting genetic studies of southern mule deer in North San Diego County and across I-5 to better understand travel routes, population density, territory size, and movement barriers. The study is expected to begin in Spring of 2018.
3. **Bobcat – Connectivity for Large Animals Using Bobcats as a Model Species.** From 2009 – 2012 Megan Jennings and Rebecca Lewison (SDSU and USGS) used remote cameras, GPS telemetry, road kill collection, genetic analysis, habitat/connectivity modeling, and occupancy modeling to better understand connectivity in inland and coastal areas of southern San Diego County (Jennings and Lewison 2013).
4. **Mountain Lion Connectivity Study North San Diego County.** The purpose of this study was to understand which lands in north San Diego County are likely used by mountain lions, and to

assess connectivity within and between current and proposed future conserved lands in North San Diego County and adjacent Riverside, and Orange Counties (Vickers et al. 2017). The results from this study of mountain lion movement, habitat use, gene flow, and highway crossings will be available to inform critical decisions regarding the prioritization of lands for conservation and the potential need and location of highway modifications to enhance connectivity for mountain lions and other wildlife. For this study, Winston Vickers (U.C. Davis) will be conducting genetic analyses, resource selection and movement modeling, and an analysis of potential crossing points of highways.

5. **Coastal California Gnatcatchers.** USGS examined individual relatedness patterns and population genetic structure among gnatcatcher aggregations throughout coastal southern California from Ventura to San Diego Counties to better understand the number of genetically distinguishable populations across the species range, genetic relatedness, dispersal distances of parents and offspring, patterns of genetic diversity, and how these results affect management and monitoring (Vandergast et al. 2014). These results enhance our understanding of the connectedness of gnatcatcher metapopulations across its fragmented habitat.

6. **Small Vertebrates.** In 2012, a small vertebrate underpass study was conducted by USGS (Tracey et al. 2014). The three main objectives in this study were (i) to determine which groups of small vertebrates are currently using or avoiding selected underpasses and understand how these behaviors may be predicted by life history characteristics, (ii) to investigate the effectiveness of adding cover structures to underpasses to enhance small vertebrate use, and (iii) to evaluate the extent to which larger vertebrates often used as focus species in connectivity studies in the region act as indicators of use by small vertebrate species.

7. **Human Impacts.** Sarah Reed, Kevin Crooks and others (Colorado State University) conducted a study on the wildlife response to human recreation on NCCP reserves in San Diego County (Reed et al. 2014). Specific objectives were to develop research recommendations and test methods for monitoring recreation by completing a pilot field study. Phase II of this study will Implement a well-designed study that integrates species monitoring with recreation monitoring to systematically assess recreation's direct and indirect effects on sensitive wildlife species, to improve the understanding of the trade-offs inherent in multiple-use management of reserves, and to ensure that NCCP reserves are providing the required levels of protection and achieving the goals of the NCCP program.

8. **Climate Resilient Connectivity** for the South Coast Ecoregion of California. Megan Jennings and Erin Conlisk (SDSU) are leading an effort to support regional-scale climate-smart connectivity planning by using species distribution and dynamic metapopulation modeling to develop connectivity modeling and planning approaches accounting for climate change, land-use shifts, and uncertainty. Connectivity linkage maps will be prepared for the South Coast Ecoregion, which will be used to develop an implementation guide and decision support framework to aid agencies in the identification and prioritization of land acquisition targets, land management goals, and habitat enhancement projects to protect and improve landscape linkages that will be resilient to climate change

6.0 References

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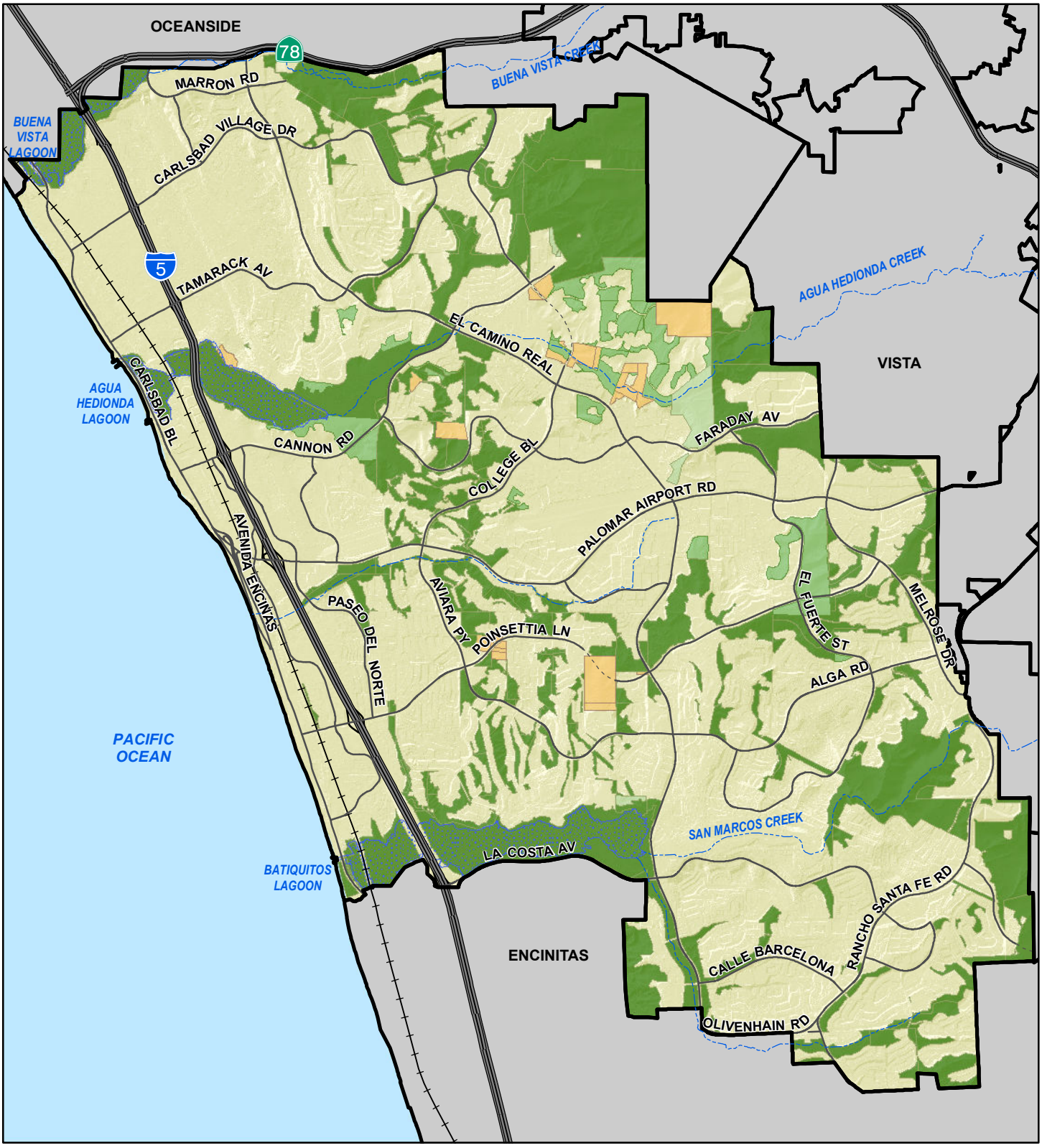
Attachments

Figures
Photo Pages



HMP Preserve Types:

- Existing Hardline
- Outside-Conserved
- Proposed Hardline
- Standards Area

N

0 Feet 6,400

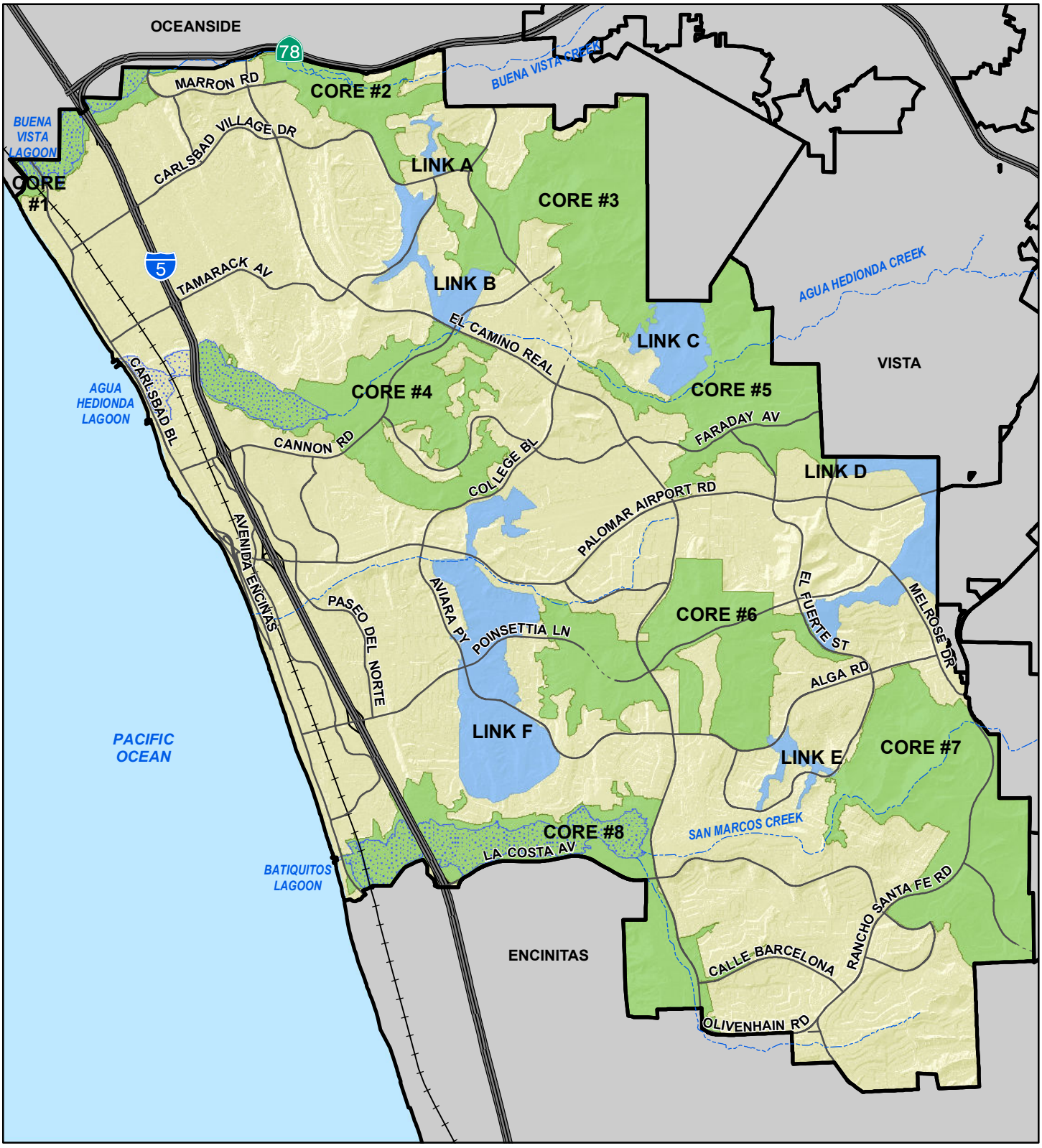
City of Carlsbad

City of Carlsbad
Habitat Management Plan (HMP) Preserve System

Figure 1

Document Path: J:\RequestsMarch2015\PublicWorks\PEM\Stormwater\RITM0011337_18\Figure1_HMPPreserveTypes.mxd

Date: 02/13/2018



HMP Focus Planning Area:

- HMP Core Area
- Linkage

N

0 — Feet — 6,400

City of Carlsbad

City of Carlsbad
HMP Focus Planning Area (FPA) Showing Core Areas and Linkages

Figure 2

Document Path: J:\RequestsMarch2015\PublicWorks\PEM\Stormwater\RITM0011337_18\Figure2_FPACoresLinkages.mxd

Date: 02/13/2018

HMP Preserve Types:

- Existing Hardline
- Outside-Conserved
- Proposed Hardline
- Standards Area

- Potential Pinchpoint

HMP Linkages:

- East-West
- Core to Core
- Minor

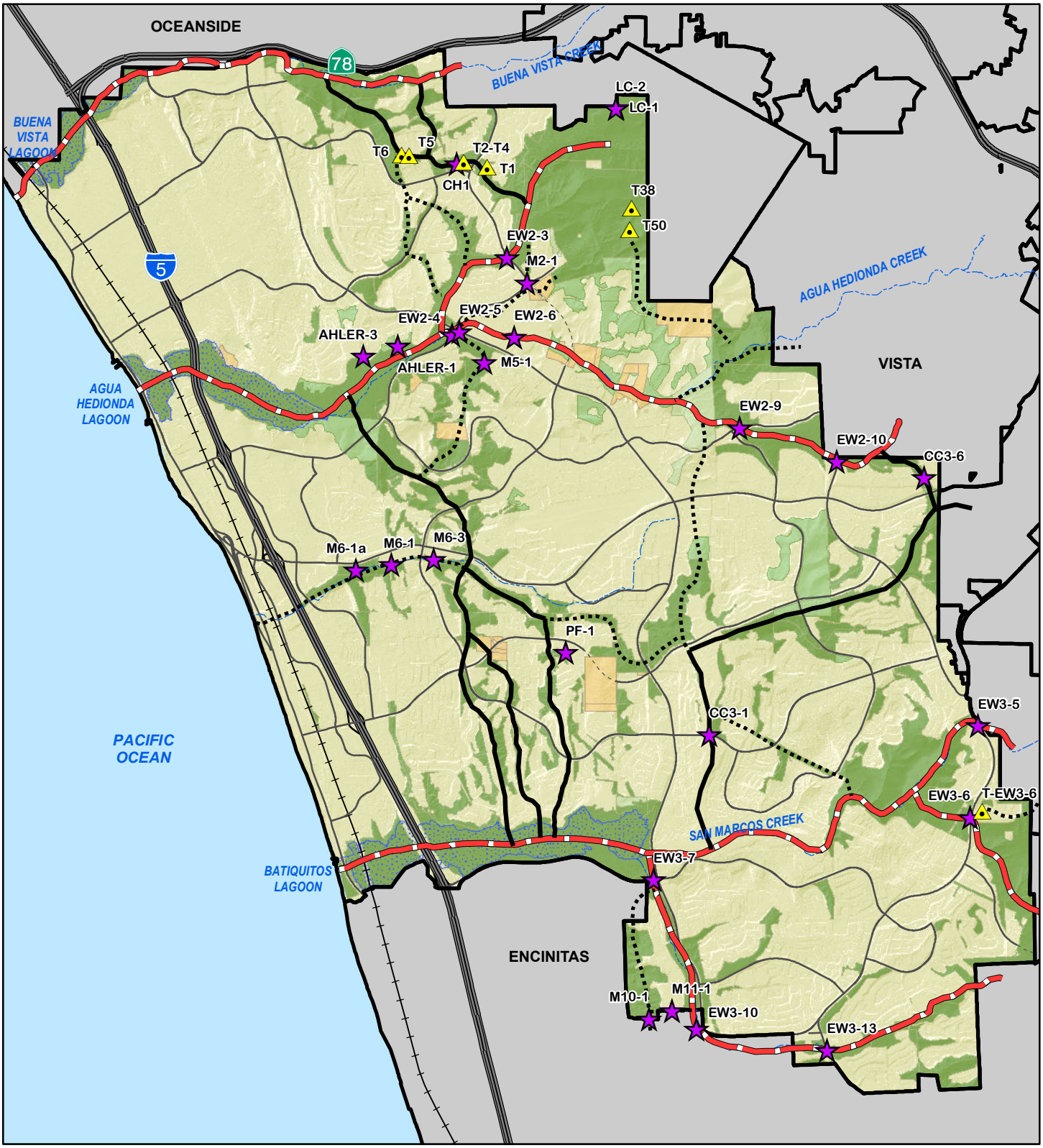
0 Feet 6,400

City of Carlsbad
Potential HMP Wildlife Movement Corridors and Pinchpoints

Figure 3

Document Path: J:\RequestsMarch2015\PublicWorks\PEM\Stormwater\RITM0011337_18\Figure3_Linkages2015.mxd

Date: 02/14/2018



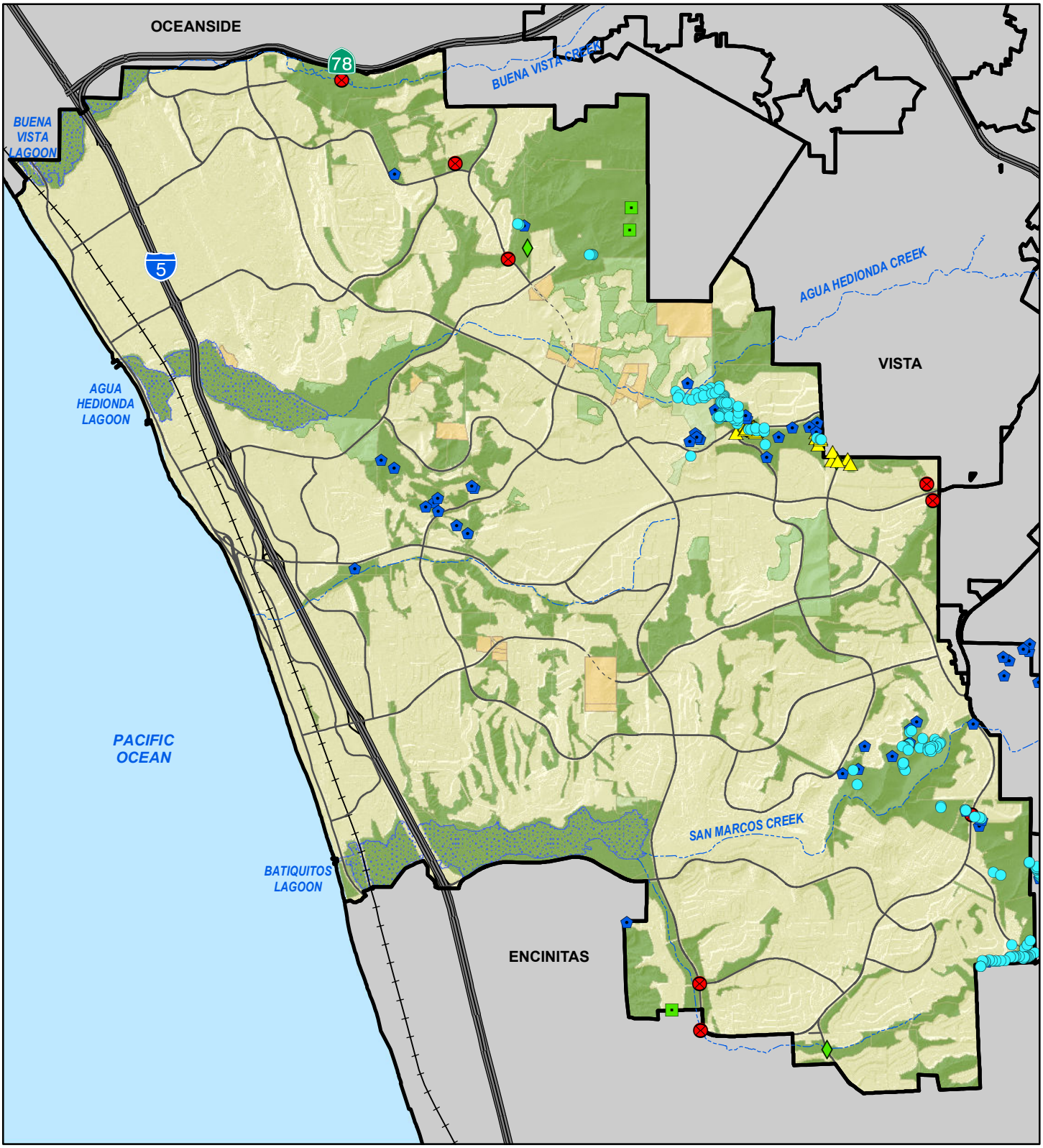
City of Carlsbad

City of Carlsbad
HMP Wildlife Camera and General Tracking Locations 2006-2007

Figure 4

Document Path: J:\RequestsMarch2015\PublicWorks\PEM\Stormwater\RITM0011337_18\Figure4_CamerasTracking2017.mxd

Date: 02/14/2018



HMP Preserve Types:

- Existing Hardline
- Outside-Conserved
- Proposed Hardline
- Standards Area

Deer Sign and Observations:

- CNLM 2016 Tracking Sign
- CNLM 2017 Tracking Sign
- SD Tracking Team Sign
- Sign (Incidental Obs.)
- Not Observed
- Wildlife Camera

N

0 Feet 6,400

City of Carlsbad

City of Carlsbad
2015-2017 Deer Sign and Direct Observations

Figure 5

Document Path: J:\RequestsMarch2015\PublicWorks\PEM\Stormwater\RITM0011337_18\Figure5_Deer.mxd

Date: 02/14/2018

Sample Wildlife Movement Photos

Southern Mule Deer at Carlsbad Oaks North (CNLM)

Southern Mule Deer at Carlsbad Oaks North (CNLM)

Bobcats at Various Preserves (CNLM and City)

Sample Wildlife Movement Photos

Coyote, rabbit, pocket mouse, spotted skunk, striped skunk, dog, cat, raccoon, and roadrunner