



# REPRODUCTIVE SUCCESS AND BREEDING POPULATION SIZE OF SNOWY PLOVERS IN THE MONTEREY BAY REGION, CALIFORNIA, IN 2018



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## SUMMARY

The primary results of the 2018 breeding season are the following:

- An estimated 357 snowy plovers (187 males, 170 females) nested in the Monterey Bay region in 2018. Our estimate exceeded the USFWS Recovery Plan target of 338 adults for the region for the 13<sup>th</sup> time in the 15 years since the target was first attained in 2003.
- We documented a total of 462 nesting attempts (n=431 nests and 31 broods).
- Plovers nested at Laguna Creek Beach and Manresa State Beach for the first time since 2004, and at Seabright Beach for the first time ever recorded.
- The clutch hatch rate of 37% was well below the average of 61% from 1999-2014.
- Approximately 60% of all nest loss was caused by predators.
- Corvids were responsible for 43% of all nests lost to predators and corvid predation of nests was widespread throughout the study area. Common ravens accounted for the majority of corvid-caused losses.
- Mammals were responsible for 20% of all nests lost to predators. Small mammals (skunks, raccoons, and opossums) were responsible for most nest losses caused by mammals in the North Bay whereas coyotes were the only identified mammalian nest predator in the South Bay.
- A minimum of 390 chicks hatched from 462 documented nesting attempts.
- 246 chicks were banded and 34% (n=83) of those survived to fledging. This was slightly below the average fledge rate of 40% from 1999-2014.
- An additional 70 unbanded chicks were confirmed to have fledged for a minimum number of 153 fledglings. The 70 unbanded fledglings should be considered a minimum because more unbanded chicks likely fledged than we were able to verify.
- The minimum estimate of chicks fledged per male was 0.82.

## INTRODUCTION and BACKGROUND

The Pacific Coast population of the western snowy plover (*Charadrius nivosus nivosus*) was listed as threatened by the U.S. Fish and Wildlife Service (USFWS) in 1993. Point Blue Conservation Science (Point Blue), USFWS, and the California Department of Parks and Recreation (California State Parks) have worked together to monitor nesting western snowy plovers (hereafter snowy plover, or plover) in the Monterey Bay region since 1984. Since 1993, this multi-agency working group has worked collaboratively to plan, implement, and assess the effects of management actions taken to protect nesting plovers and meet the population target of 338 breeding plovers and the productivity target of 1.0 chicks fledged per breeding male identified in the federal Recovery Plan (USFWS 2007). Here we report on reproductive success and breeding population size of snowy plovers in the Monterey Bay region in 2018 so that the effect of management efforts intended to support population recovery can be assessed.

## **STUDY AREA**

The study area includes the beaches of Monterey Bay, former salt ponds adjacent to Elkhorn Slough (hereafter Salt Ponds), and beaches in northern Santa Cruz County (Appendices 1-16). For reporting purposes we divide the study area from north to south, and describe approximate area boundaries, land ownership and management, and refer to corresponding area maps and nest identification codes (in parentheses) as follows:

### ***Northern Santa Cruz County***

In northern Santa Cruz County nesting was documented at **Laguna Creek Beach**, north of the City of Santa Cruz, and at **Seabright Beach**, which is adjacent to the City of Santa Cruz. Both beaches are owned and managed by California State Parks; Laguna Creek is part of Wilder Ranch State Park and Seabright is part of Twin Lakes State Beach (see Apps. 2-3 – LC and BB).

### ***North Bay Region***

**Sunset-Manresa:** From the northern boundary of Manresa State Beach south to Beach Road. The southern end is backed by residential development. This beach is owned by California State Parks and private owners and managed by State Parks (see Apps. 4-5 – ME, MO, NO, NM, NT, and PN) and includes all of Manresa State Beach and the northern portion of Sunset State Beach.

**Pajaro Spit:** From Beach Road south to the Pajaro River mouth and includes the beach north of the river and west of the Pajaro Dunes residential development and the sand spit on the north side of the Pajaro River mouth. This beach is owned and managed by California State Parks and includes portions of Sunset State Beach and Zmudowski State Beach (see Apps. 5-6 – PH and PS).

**Zmudowski:** From the Pajaro River mouth south toward Moss Landing. This beach is owned and managed by California State Parks and is part of Zmudowski State Beach (see App. 7– ZS and ZB).

**Moss Landing:** Approximately the southern third of Zmudowski State Beach and all of the shoreline of Moss Landing State Beach, with the southern boundary located at the mouth of Elkhorn Slough at Moss Landing Harbor. This beach is owned and managed by California State Parks (see App. 8 – JR).

### ***Salt Pond Region***

This area includes approximately half of the former salt ponds adjacent to the western terminus of Elkhorn Slough that have been converted to managed, diked wetlands and are now encompassed within the California Department of Fish and Wildlife's (CDFW) Moss Landing Wildlife Area (see App. 9 - SP).

## ***South Bay Region***

**Molera-Potrero:** From the Potrero Rd. parking lot in Moss Landing south to the northern boundary of the Monterey Dunes Colony. This beach includes the northern portion of Salinas River State Beach and is owned and managed by California State Parks (see App. 10).

**Monterey Dunes:** From the northern to the southern end of the Monterey Dunes Colony, a beachfront residential development. This beach includes the middle and southern portion of Salinas River State Beach and is owned and managed by California State Parks (see App. 11 – MD).

**North Salinas River:** From the southern boundary of the Monterey Dunes Colony south to the Salinas River mouth. This beach includes the southernmost portion of Salinas River State Beach and is owned and managed by California State Parks (see App. 11 – SN).

**Salinas River National Wildlife Refuge:** From the Salinas River mouth south to the northern boundary of the Martin Dunes, including the sand spit on the southern side of the Salinas River mouth, and the extensive open dunes of the refuge. This beach is owned and managed by USFWS (see App. 12 – SX).

**Martin Dunes:** From the southern boundary of Salinas River NWR south to the northern boundary of the Cemex property. This beach is owned and managed by Big Sur Land Trust and private owners with assistance from USFWS (see App 12 - SG).

**Marina North:** From the southern boundary of the Martin Dunes south to the northern boundary of Marina Middle, which is located about 300m north of the coastal dredge pond. This beach is owned and managed by private owners with assistance from California State Parks and USFWS (see App. 13 – MN).

**Marina Middle:** From approximately 300m north of the northern end of the coastal dredge pond south to the southern end of the pond, which is actively mined for littoral sand. This beach is owned and managed by private owners with assistance from California State Parks and USFWS (see App. 13 – MA).

**Marina South:** From the southern end of the coastal dredge pond south to Reservation Road. This beach is owned and managed by the Monterey Peninsula Regional Parks District and private owners with assistance from California State Parks (see App. 13 - MX).

**Reservation Road:** From Reservation Road south to the Lake Court beach access for Marina State Beach. This beach is owned and managed by California State Parks and is part of Marina State Beach (see App. 14 - RR).

**Fort Ord:** From the southern boundary of Marina State Beach south to the southern boundary of Fort Ord Dunes State Park. This beach is owned and managed by California State Parks and is part of Fort Ord Dunes State Park (see Apps. 14-15 – RO, FO).

**Sand City:** From the south boundary of Fort Ord south to West Bay Street in Sand City. This beach is owned by California State Parks, the City of Sand City, the Monterey Peninsula Regional Parks District, and private owners (see App. 15 - NC).

**Monterey:** From West Bay Street in Sand City south to the City of Monterey north to. This beach (referred to in previous reports as Del Monte) is owned and managed by California State Parks and is part of Monterey State Beach (see App. 16 - HI).

## **MONITORING and DATA SUMMARY METHODS**

### ***Monitoring***

In 2018, our overall monitoring objective was to locate and document the fate of as many plover nests as we could within the study area, and to band 50% of chicks that hatched in the study area, with banding efforts distributed spatially across sites and temporally across the nesting season. However, because of the large breeding population size, the large study area, and high rates of clutch loss in recent years, some areas were prioritized for monitoring and therefore received more frequent survey effort and more intensive banding effort. We used the following three-tiered implementation strategy to achieve the overall monitoring objective: at Tier 1 sites, the goal was to find and monitor every nest, and to band 85-95% of chicks (Pajaro Spit and Zmudowski); at Tier 2 sites, the goal was to find and monitor every nest, and to band 50% of chicks (Monterey, Fort Ord, Reservation Road, Marina South, Middle and North, Martin, North Salinas River, Monterey Dunes, Molera-Potrero, Moss Landing); at Tier 3 sites, the goal was to find and monitor as many nests as possible and to band a minimum of 30% of chicks (Salinas River NWR, Salt Ponds, Sunset-Manresa). In 2018, plover breeding activity at the northern Santa Cruz beaches and at Sand City was monitored opportunistically so these sites were not included in the three-tier strategy.

We recorded the latitude and longitude of each nest with Global Positioning System (GPS) units. We also used GPS units to create proxy nest locations for all nesting attempts that were found as broods of chicks (i.e. after hatching) by creating a waypoint at the first location a brood was observed. These locations were plotted on nest maps for each area (see Apps. 1-16).

We estimated clutch hatching dates from egg laying dates, when known, or from egg flotation (Hays and Lecroy 1971). Projected hatching dates were refined by examination of eggs for cracked shells, tapping chicks, or peeping chicks in the 4-6 days leading up to the projected hatching date. In order for an egg to be categorized as hatched, the chick had to be observed at the nest or with the attending parent during the chick-rearing period. When eggs disappeared or were destroyed prior to the projected hatch date, causes of nest loss were determined by examining evidence at nests (e.g. damaged eggshells, predator tracks, evidence of tide wash). When cause of loss was unknown because evidence at the nest was lacking, we categorized cause of loss as unknown. In certain cases with no visible cause of loss, we assigned the nest loss to an avian predator “event” when it met both of the following criteria: the nest was within or adjacent to an area where nest(s) were lost to an identified avian predator, and, the nest

was lost during a similar time interval (+/- 3 days). Nests where the fate of at least one egg was known were considered “known fate” nests.

We used unique color band combinations consisting of four individual bands to mark a sample of chicks and adults (App. 17). We trapped adults at or near the nest using noose mat carpets. We captured chicks at or near the nest by hand at the time of hatching. We monitored brood survival throughout the chick-rearing period by directly observing chicks with attending males (or females) and also by observing parental behavior that indicated the presence of chicks (e.g. lure displaying). We considered chicks to have reached fledging age if they survived 28 days or more after hatching. Banded chicks were determined to have fledged by observing their unique color bands at or after the fledge date. Because unbanded chicks within and among similar-age broods were indistinguishable from one another, they were determined to have fledged only when they were directly observed with the attending parent at or within a few days after the fledge date.

To estimate the Monterey Bay breeding population size we used two methods: a monitoring estimate and a window survey estimate. For the first method we derived the estimate from our monitoring across the duration of the breeding season (March-August) that was based on the number of plovers confirmed nesting or attending broods and the probable number of additional breeders based on their observed or extrapolated presence within the study area (see Data Summary for explanation of calculations). For the second method, we conducted a single, coordinated survey of all breeding sites within the study area during the third week of May as part of the rangewide window survey following methods outlined in Elliot-Smith and Haig (2006). The annual window survey is the primary method used by USFWS to estimate the size of the Pacific Coast population of snowy plovers and to monitor population status over time.

In addition to monitoring plovers, beginning in 2008 we also collected information on the number of human activities observed within the study area during regular nest monitoring. The majority of nest monitoring was conducted between 0600 and 1400 on weekdays so data on human activities are from these same hours of the day and days of the week.

### ***Data Summary***

We calculated clutch hatch rates by dividing the number of known fate nests that hatched by the total number of known fate nests for each site and for the study area. Nests found as broods were excluded from clutch hatch rate calculations. To calculate fledge rates we divided the number of banded chicks that were confirmed to have fledged by the total number of chicks that were banded. Site-specific fledging success was based on the broods that originated from the nests located at each site, even in cases where broods moved to adjacent areas before fledging. Beginning in 2016 and continuing through this year, we report minimum and maximum numbers of unbanded chicks that fledged, but we do not report fledge rates for unbanded chicks. Throughout this document, hatch rates, fledge rates and return rates will be compared to a running average from 1999-2014, a period of intensive monitoring where almost

all hatched chicks were banded. Beginning in 2015, we modified our study design, including not attempting to band every chick that hatched, so comparisons with and trends in reproductive rates from 2015 and onward should be viewed with this in mind.

Beginning in 2016, we used a combination of banded and unbanded plovers confirmed on nests and banded birds that were present during May and June with evidence of likely nesting (probable banded breeders) to estimate the total breeding population size. The probable banded breeder category was added because by 2016 the rate of nest loss had become so high that nests increasingly were being lost before nest ownership could be determined, and nesting banded plovers that could not be confirmed on nests would otherwise not be included in our estimate. In 2018, we further refined this methodology to estimate the number of probable unbanded breeders, by applying the ratio of confirmed to probable banded breeders to the estimated number of confirmed unbanded breeders. This produces a breeding number for each sex that is the sum of *confirmed banded breeders + confirmed unbanded breeders + probable banded breeders + probable unbanded breeders*. For each sex, we estimated the minimum number of confirmed unbanded breeding adults by determining the maximum number of simultaneously extant nests with unbanded parents and subtracting the number of unbanded breeding adults that were subsequently banded on nests during the nesting season (see App. 17 for adult banding dates). We identified probable banded breeders by assessing the evidence for nesting for each candidate; evidence was based on the number of sightings in May and June, the duration of presence in the study area, breeding behaviors exhibited (e.g. paired, broody, copulating, scraping, lure display), past history of confirmed nesting, and natal origin. We used the population estimate derived from monitoring to calculate a correction factor for the window survey estimate (monitoring estimate/window survey estimate).

We calculated encounter rates per survey hour of humans for the period 2010-2018, with all types of human activities summed into one encounter rate. We also pooled the summarized data by region and present overall rates for North and South Bay beaches (see area descriptions for beaches in each region).

### ***Permit Activities***

All snowy plover monitoring by Point Blue Conservation Science staff and associates was conducted under **USFWS permit number TE-807078-17**. There were no incidental mortalities of snowy plovers resulting from activities conducted under this permit. In the course of the 2018 nesting season, the Arcata Fish and Wildlife Office of USFWS granted permission to: 1) remove 2 clutches of infertile eggs from nests that were well past normal incubation length, 2) protect 1 nest from tide by moving it slightly inland, and 3) salvage 4 eggs from 2 nests to be reared at the Monterey Bay Aquarium. Please see the Results and Discussion sections of this report for pertinent observations on the ecology and status of this species in the Monterey Bay region. Planned monitoring activities in 2019 are expected to be very similar to 2018.

## **MANAGEMENT**

Management activities to improve snowy plover reproductive success were coordinated and implemented by a multi-agency working group that includes Point Blue, California State Parks, USFWS, and other coastal land managers and owners. Activities in 2018 included habitat protection, education and outreach to beach users by plover researchers, predator control by the Wildlife Services Division of the U.S. Department of Agriculture (USDA), water management to provide nesting and foraging habitat in the managed salt ponds of the CDFW's Moss Landing Wildlife Area and ongoing restoration of beach and dune habitats by land owners, managers and partner organizations. Habitat was protected using cable or rope fencing and regulatory and informational signs to temporarily (March 1 - Sept. 30) close off nesting areas on upper beaches and dunes to recreational access. Fencing and signage were used along most linear beaches, at the sand spits on both sides of the Salinas and Pajaro river mouths, along the upper beach and dunes at Salinas River NWR, and at the public portions of the salt ponds at Moss Landing Wildlife Area. In 2018, the majority of nests were protected by cable fences (n = 428 of 431 nests found at the egg stage) or were within closure areas at the aforementioned sites. Wildlife Services biologists conducted selective removal of avian and mammalian predators in 2018 as guided by the multi-agency working group. Water levels at the Salt Ponds were managed to create dry nesting substrate and associated wet foraging areas for plovers. The type of recreational uses allowed, the level of recreation, and enforcement of regulations on recreational use vary by nesting site and by land owner or manager.

## **RESULTS OF 2018 NESTING SEASON**

### ***Estimated Number of Breeders***

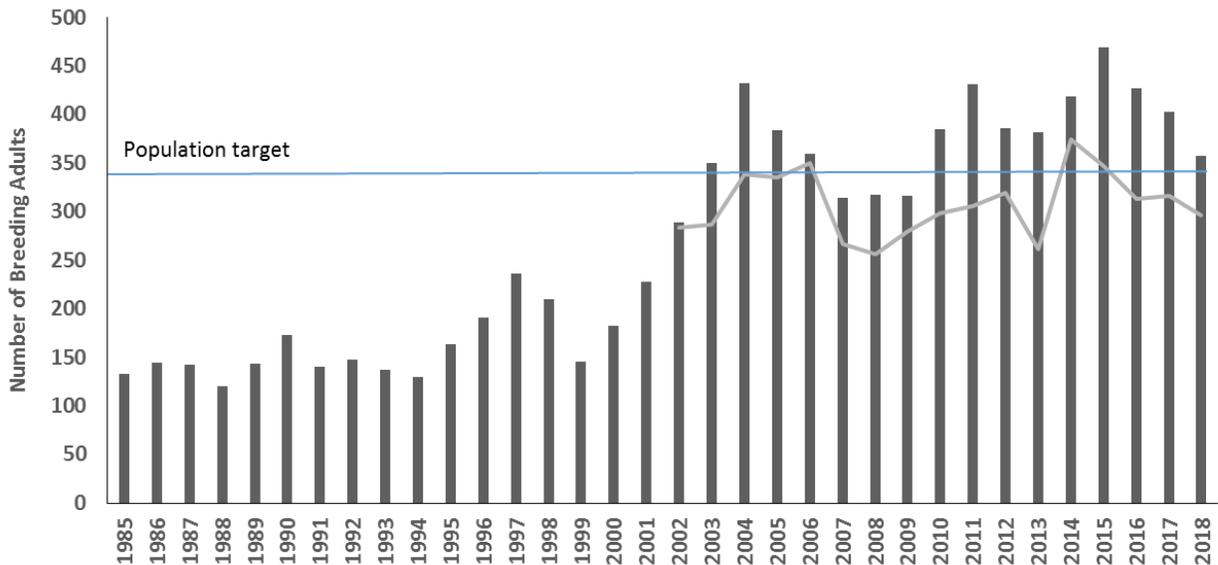
In 2018, the Monterey Bay breeding population estimate derived from monitoring consisted of an estimated 187 males and 170 females for a total of 357 snowy plovers. The 187 males consisted of 143 banded birds (130 confirmed on nests and 13 probable breeders) and 44 unbanded birds (40 confirmed on nests and 4 probable breeders). The 170 females in 2018 consisted of 140 banded birds (134 confirmed on nests and 6 probable breeders) and 30 unbanded birds (29 confirmed on nests and 1 probable breeders). We detected 291 adults on the window survey, making the correction factor for the window survey estimate 1.22 (357 breeding adults from monitoring/291 breeding adults from window survey).

### ***Return Rates***

Of color banded adults that nested (or probably nested) in the Monterey Bay region in 2017, 71% of males and 79% of females returned and bred or were suspected of breeding in 2018. The return rates for both sexes, especially for females, were higher than the average rates of 69% for males and 64% for females from 1999-2014.

Of the banded juveniles that fledged in 2017, 28% recruited into the Monterey Bay population in 2018, including 13 females and 13 males confirmed on nests, and 1 female and 1 male that likely nested on Monterey Bay but could not be confirmed on a nest (i.e. were probable

nesters). An additional 8 juveniles from 2017 were sighted two or more times from March-July but there was no evidence that these plovers nested in the study area.



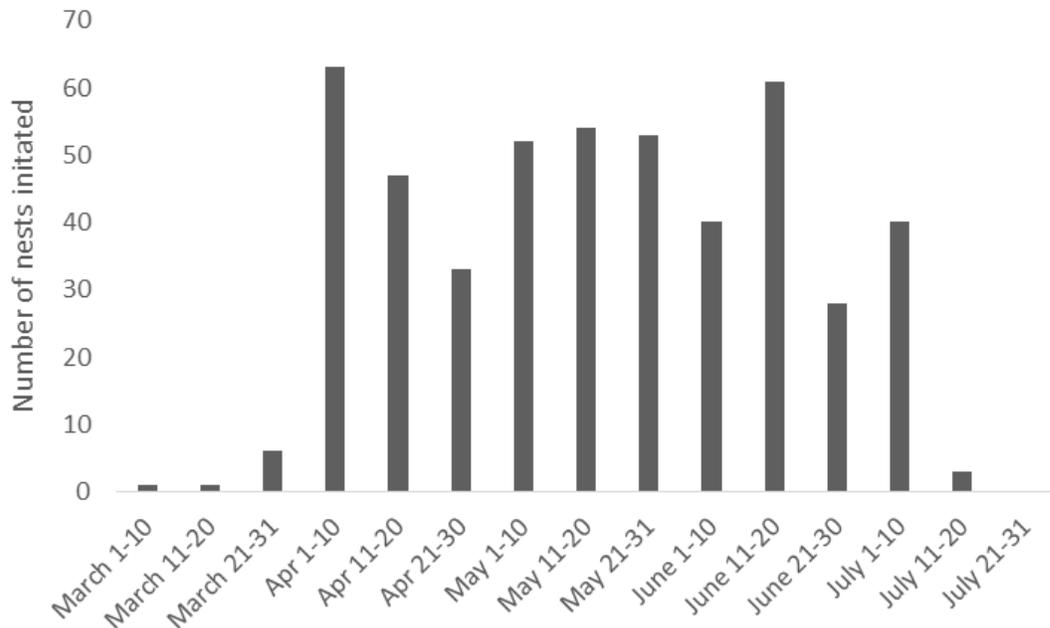
**Figure 1. Estimated number of breeding snowy plovers from monitoring (bars) and window surveys (grey line) in the Monterey Bay region, 1985-2018. See methods for description of changes in method of population estimation beginning in 2016.**

### ***Nesting Attempts***

We found 431 nests and 31 broods of chicks from undetected nests, for a total of 462 documented nesting attempts in the Monterey Bay region in 2018 (Table 1, Apps. 1-16); this total should be considered a minimum number. Of the 431 nesting attempts found at the egg stage, we were able to determine the fate of 407. These totals include a small number of nesting attempts that occurred in areas not regularly monitored in 2018, including at the northern Santa Cruz county beaches (n=3) and at Sand City (n=2; Table 1). This is the first time plovers have been detected nesting at Laguna Creek Beach and Manresa State Beach since 2004 and the first time that nesting has ever been documented at Seabright Beach.

### ***Clutch Initiation***

The first nest was initiated on March 6<sup>th</sup> and the last nest on July 17<sup>th</sup>, with a median clutch initiation date of May 16<sup>th</sup> (Fig. 2). Nesting commenced slightly earlier in the South Bay than in the North Bay; of the first 20 nests initiated only 3 were in the North Bay. Peaks in nest initiation occurred in early April and mid-June.



**Figure 2. Number of nests initiated during 10 day intervals in 2018.**

***Clutch Hatching Rates***

Of the 388 known-fate nests on beaches, 148 hatched, for a 38% hatching rate (Table 1). This rate was well below the long-term average of 60% from 1999-2014. At the Salt Ponds the 21% hatch rate in 2018 was well below the 65% average from 1999-2014. The 37% rate for beaches and ponds combined in 2018 was well below the long-term average of 61% from 1999-2014 and also was lower than the 43% recorded in 2017. Median clutch initiation date for failed nests was May 8th compared to May 31st for hatched nests.



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**Table 1. Reproductive success of snowy plovers in the Monterey Bay region in 2018.**

Location	Nesting Attempts and Clutch Hatching Success							Chicks Hatching			Fledging Success			
	Total Nesting Attempts <sup>1</sup> (n)	Found as Broods (n)	Found as Nests (n)	Unknown Fate Nests (n)	Known Fate Nests (n)	Hatched Nests (n)	Clutch Hatch Rate <sup>2</sup> (%)	Min. Chicks (n)	Max. Chicks <sup>3</sup> (n)	Chicks Banded <sup>4</sup> (n)	Min. Chicks (n)	Max Chicks (n)	Banded Chicks (n)	Banded Chicks (%)
Northern Santa Cruz <sup>5</sup>	3		3	1	2	0	0%	0	2	0	0	0	0	
Sunset-Manresa	48	4	44	1	43	9	21%	25	38	12	14	16	4	33%
Pajaro Spit	76	3	73		73	21	29%	55	63	43	19	25	13	30%
Zmudowski	12	1	11		11	4	36%	8	12	6	1	3	1	17%
Moss Landing	52	1	51	3	48	11	23%	24	37	21	3	5	2	10%
Molera-Potrero	32		32		32	14	44%	32	37	18	15	19	5	28%
Monterey Dunes	25	1	24		24	8	33%	21	24	12	12	17	8	67%
North Salinas River	20	2	18	1	17	7	41%	24	29	14	13	19	9	64%
Salinas NWR	52	11	41	6	35	7	20%	36	66	13	18	27	4	31%
Martin Dunes	8		8		8	1	13%	3	3	3	0	0	0	0%
Marina North	6		6		6	3	50%	6	6	6	2	2	2	33%
Marina Middle	13	1	12		10	4	40%	13	19	9	4	4	1	11%
Marina South	11		11	2	11	4	36%	8	10	4	1	2	1	25%
Reservation Road	20		20	2	18	15	83%	29	44	19	8	15	5	26%
Fort Ord	48		48	5	43	36	84%	75	111	54	32	45	25	46%
Sand City <sup>6</sup>	2	2						2	6	0	2	2	0	
Monterey	7		7		7	4	57%	10	10	8	2	4	2	25%
<b>TOTAL BEACHES</b>	<b>435</b>	<b>26</b>	<b>409</b>	<b>21</b>	<b>388</b>	<b>148</b>	<b>38.1%</b>	<b>371</b>	<b>517</b>	<b>242</b>	<b>146</b>	<b>205</b>	<b>82</b>	<b>34%</b>
<b>SALT PONDS</b>	<b>27</b>	<b>5</b>	<b>22</b>	<b>3</b>	<b>19</b>	<b>4</b>	<b>21.1%</b>	<b>19</b>	<b>34</b>	<b>4</b>	<b>7</b>	<b>15</b>	<b>0</b>	<b>0%</b>
<b>GRAND TOTAL</b>	<b>462</b>	<b>31</b>	<b>431</b>	<b>24</b>	<b>407</b>	<b>152</b>	<b>37.3%</b>	<b>390</b>	<b>551</b>	<b>246</b>	<b>153</b>	<b>220</b>	<b>82</b>	<b>33%</b>

<sup>1</sup> Nesting attempts is the sum of nests found at the egg stage and the brood stage

<sup>2</sup> Nests found as broods and unknown fate nests are not included. Clutch hatch rate is the number of hatched nests divided by number of known fate nests.

<sup>3</sup> Maximum number includes all possible hatching eggs from both known and unknown fate nests.

<sup>4</sup> Banded chicks are a subset of hatched chicks (i.e. not all chicks at each location were banded)

<sup>5</sup> Includes Seabright Beach and Laguna Creek Beach. Seabright and Laguna Creek Beaches were monitored infrequently.

<sup>6</sup> Sand City was monitored infrequently.

## Nest Failure

Of the 255 nests that failed, at least 60% of the losses were caused by predators (Table 2). Of the 152 losses attributed to predators, 62% were attributed to avian predators, 20% to mammalian predators, and 18% to unknown predators.

Corvids were the primary nest predator in 2018 (Table 2). Sixty-six nest losses at a total of 13 sites were attributed to common ravens (*Corvus corax*), raven events, unknown corvid species or American crows (*Corvus brachyrhynchos*). Overall, ravens were responsible for 21% of all nest losses, 36% of all losses to predators, and 57% of all losses to avian predators. Nest loss to ravens was concentrated in the central part of the bay at the Salinas and Pajaro river areas and along adjacent beaches. We suspect that losses attributed to unknown corvid species and unknown avian predators that spanned this same geography also were caused by ravens (Table 2). Gulls were responsible for trampling or depredating 11 nests at the Pajaro Spit and 2 nests were trampled by gull and pelican flocks at other locations.

Mammalian predators were responsible for more nest loss in 2018 (20%) compared to 2017 (7%), with the majority of nest loss to mammals in 2018 occurring in the North Bay. Striped skunks (*Mephitis mephitis*), raccoons (*Procyon lotor*), and Virginia opossums (*Didelphis virginiana*) were the primary species responsible for the North Bay losses. In contrast, in the South Bay coyotes (*Canis latrans*) were the only identified mammalian nest predator and were responsible for 8 losses at 6 sites across more than 7km of coastline extending from Marina South all the way north through Molera-Potrero. From 1984 to 2013, no nest losses were attributed to coyotes on Monterey Bay beaches. After 2013 coyote predation of plover nests

has become increasingly common on beaches, with some losses to coyotes occurring in all subsequent years except 2017.

Humans and their dogs were responsible for trampling a total of 8 nests at 4 sites: Marina South, Sunset-Manresa, Molera-Potrero and Monterey Dunes (Table 2; n=4 human and n=4 dog). Human activities also were implicated in the loss of 3 additional nests (Table 2; n=2 deserted at Monterey Dunes and n=1 trampled after being washed by tide at Fort Ord).

Environmental factors such as tide and wind caused 21 nest losses, with losses to tide occurring across the study area (Table 2). Nest loss caused by desertion was widespread across the study area, occurring at 8 sites. Two nests contained infertile eggs that were incubated well past the projected hatch date (Table 2); with permission from USFWS these clutches were removed to minimize the physiologic costs to the incubating plovers. We were unable to determine the fate of 24 of the 431 nests found at the egg stage (Table 1), but it is unlikely that all of these unknown fate nests hatched.

**Table 2. Causes of loss for 255 snowy plover nests lost out of 407 known fate nests monitored in the Monterey Bay region in 2018.**

Locations	Avian Predators							Mammalian Predators						Unk. Pred. Sp. <sup>7</sup>	Other Causes					Total	
	CORA <sup>1</sup>	CORA event <sup>2</sup>	AMCR <sup>3</sup>	Corvid <sup>4</sup>	Gull	Unk. Av. <sup>5</sup>	Trampled by Avian	Dog	Coyote	Unk. Canine	Skunk	Racc.	Oppos. <sup>6</sup>		Hum. <sup>8</sup>	Tide	Wind	Non-Viable	Des. <sup>9</sup>		Cause Unk.
Northern Santa Cruz														1						1	2
Sunset-Manresa				1				1		3	5	3		4		1				16	34
Pajaro Spit	4	12			9	2					1		3		6			2		13	52
Zmudowski	1													1		3		1	1	1	7
Moss Landing	5	3			1	4			1		2			4	1	2	1	2	2	11	37
Molera-Potrero				4		1			1						1	2			2	7	18
Monterey Dunes	1	3		3										1	3			1	4	16	
North Salinas River	1				1	5	1		1						1						10
Salinas NWR	8	11							2	1					1	1				4	28
Martin Dunes		3							2					1						1	7
Marina North						1											1			1	3
Marina Middle	1			1		1			1					1					1		6
Marina South				1		1		3	1											1	7
Reservation Road															1				1	1	3
Fort Ord	1														2				4		7
Sand City																					0
Monterey				2																1	3
Salt Ponds							1							14							15
<b>Total</b>	<b>22</b>	<b>32</b>	<b>2</b>	<b>10</b>	<b>11</b>	<b>15</b>	<b>2</b>	<b>4</b>	<b>9</b>	<b>4</b>	<b>8</b>	<b>3</b>	<b>3</b>	<b>27</b>	<b>4</b>	<b>15</b>	<b>6</b>	<b>2</b>	<b>14</b>	<b>62</b>	<b>255</b>

<sup>1</sup> common raven; <sup>2</sup> common raven event; <sup>3</sup> American crow; <sup>4</sup> unidentified corvid (raven or crow); <sup>5</sup> unknown avian predator; <sup>6</sup> Virginia opossum; <sup>7</sup> unknown predator species; <sup>8</sup> human; <sup>9</sup> deserted (includes nests deserted after partial loss of clutch)

### **Chicks Hatched and Fledged**

We confirmed that a minimum of 390 chicks hatched from 462 nesting attempts (Table 1). Of the 390 chicks that were confirmed hatching, we banded a sample of 246 (Table 1; see App. 17 for band combinations). An additional 161 chicks may have hatched from nests where fate was unknown (n=23 nests) and from nesting attempts where part of the clutch was confirmed to have hatched (n=152 hatched nests and 31 nests found at the brood stage; Table 1).

In 2018, 83 of 246 banded chicks fledged for a fledging rate of 34%. This is slightly below the average of 40% from 1999-2014. A minimum of 70 unbanded chicks also fledged in 2018 (Table 1) for a minimum total number of 153 fledglings.

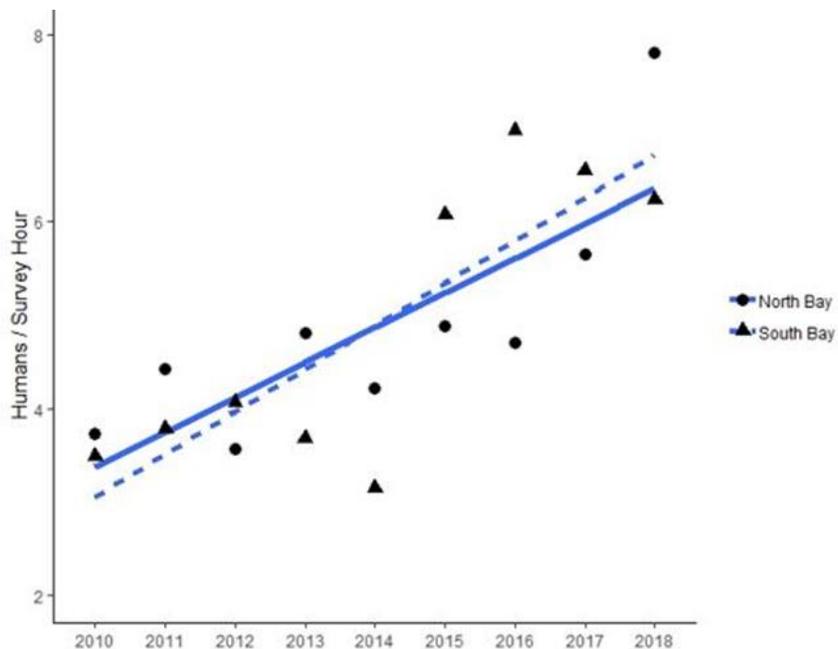
The minimum estimate of chicks fledged per male is 0.82 as calculated by the minimum number of fledglings (n=153) divided by the estimated number of males (n=187) in the population. This estimate of chicks fledged per male is lower than the 1.0 target needed for population stability and well below the average of 1.3 from 1999-2014.

### ***Captive Rearing***

One 3-egg clutch was salvaged from a nest at Fort Ord where 2 clutches of eggs were laid asynchronously in a single nest and the female was having difficulty incubating 6 eggs (the remaining 3-egg clutch was subsequently depredated). An additional single egg from a nest at Salinas River NWR also was salvaged and taken to the Monterey Bay Aquarium to be hatched and reared in captivity. Of these 4 eggs, 1 hatched and was released into the wild at Monterey State Beach, where it was observed being depredated by a group of American Crows shortly after release. The captive-reared chick was not counted in calculations of fledging success.

### ***Human Activity***

The rate of human activity observed in the North Bay and South Bay has increased during the past ten years and the rate is increasing faster in the South Bay (Fig. 2).



**Figure 2. Trends in human activity (encounter rates per survey hour) on North and South Bay beaches, 2010-2018 (see Study Area for description of North and South Bay beaches).**

## DISCUSSION

Our estimate of 357 breeding snowy plovers in the Monterey Bay region in 2018 exceeded the USFWS Recovery Plan target of 338 adults for the region for the 13<sup>th</sup> time in the 15 years since the target was first attained in 2003. The estimate of the breeding population size derived from monitoring was 1.22 times the size of the population estimate derived from the annual window survey. This matches the average of 1.22 from 2005-2014, meaning that detection rates on the 2018 window survey were very similar to recent years. The estimated population size of 357 is 11% lower than in 2017 and represents the third consecutive year of population decline. Continued declines in population size of this magnitude in subsequent years would be of concern because this would result in the population falling below the Recovery Plan target of 338.

The 153 confirmed fledglings in 2018 was well below the long-term average of 229 from 1999-2014 and also slightly below the benchmark of 169 fledglings needed to maintain the population at the recovery target of 338. The number of chicks fledged per male (0.82) also was below the recovery target of 1.0 chicks per male for population stability. However, due to uncertainty around how many additional unbanded chicks may have fledged, it is possible that both the benchmark number of fledglings and the recovery target of 1.0 chicks per male may have been met in 2018.

Now that we are no longer banding every chick, our ability to accurately determine the total number of fledglings in Monterey Bay has declined compared to the period of intensive monitoring that took place from 1999-2014. Thus we are increasingly relying on hatch and fledge rates, rather than the number of chicks fledged per male, as indicators of annual productivity. Comparisons with historic hatch and fledge rates from the intensive monitoring period are relevant because these rates occurred in a period of population growth or maintenance at or above the recovery target. In 2018, plovers experienced subpar productivity with hatch rates substantially lower and fledge rates somewhat lower than average rates from 1999-2014. As in most recent years, clutch hatching was heavily impacted by corvid predation with ravens affecting a majority of sites, and similar to last year, the heaviest predation was concentrated at the Pajaro and Salinas River mouths and adjacent beaches. Successful nests were initiated slightly later in the season, though it is unknown whether this was the result of predator management, seasonal movements of egg predators away from plover nest areas or other factors. Fledge rates were lowest at Moss Landing and Zmudowski in the North Bay, and at Marina Middle and Martin Dunes in the South Bay. Fledge rates were higher than the bay-wide average of 33% at only three sites, all located in the South Bay (Fort Ord, North Salinas River and Monterey Dunes). As in most years, overall factors influencing chick survival in 2018 are poorly understood because chick loss is rarely directly observed.

Human use of beaches in the Monterey Bay region has increased over the past eight years (Fig. 2) and in 2018, we documented several instances of confirmed or suspected human-caused mortality to plovers. At Molera-Potrero we observed an unleashed dog trampling a recently hatched brood of chicks, resulting in their death. At Marina South, an adult male was found

dead while attending a recently hatched brood in an area where beach users frequently cross through closed nesting habitat from the back dunes to access the beach and where unleashed dogs are frequently observed. We suspect that the identified cause of death, blunt force trauma, occurred when the male displayed in response to human disturbance and collided with a habitat fence. In addition to these mortalities, 8 nests were directly lost to trampling from humans and their dogs (Table 2), an additional 2 nests (at Monterey Dunes) were abandoned likely due to sustained human presence near the nest, and 1 nest (at Fort Ord) was trampled by humans after being washed by tide. Impacts to plovers from recreational use of beaches may be more likely to occur in the future as sea level rises and beach habitat is reduced, putting plovers in more direct competition for space with beach users. Given that the trend of increasing human use of Monterey Bay beaches is likely to continue, it is vital that efforts are made now to protect and restore coastal beaches and dunes to promote habitat resiliency while also providing high quality nesting areas for plovers.

## **MANAGEMENT RECOMMENDATIONS**

Here we provide recommendations to management agencies, landowners, and other coastal stakeholders responsible for managing plover habitat in the Monterey Bay region.

### ***Managing Predators***

In 2018, predators had significant negative effects on plover nesting success despite considerable management efforts.

- Ravens have been the most common avian predator of plover nests in recent years and we expect this to continue. We recommend initiating raven management efforts early in the nesting season and a continued investment of effort in developing alternative methods of control or implementation strategies that are adaptable to different sites and circumstances.
- In the past several years, small mammals have been a common predator of plover nests in the North Bay. We recommend initiating management of small mammals early in the season at sites that have been historically impacted and were impacted again this year (e.g. Sunset-Manresa, Pajaro Spit). Cooperative predator management efforts are needed between local stakeholders to control the number of subsidized mammal predators around coastal residential developments.

### ***Human Disturbance***

In 2018, human-caused disturbance resulted in trampling of nests and direct mortality of chicks.

- We recommend increased enforcement to increase compliance with regulations (e.g. dog prohibitions on state and federal beaches) and nesting area closures.
- We recommend that regulatory signs at access points, parking lots, and along symbolic fencing be monitored for problems during the breeding season and replaced or augmented, if necessary, to increase compliance with regulations and area closures.

- We recommend that the impact of high-intensity recreational uses (e.g. equestrians, dogs) on nesting success be assessed for areas where these activities are allowed or are occurring despite restrictions or prohibitions.
- We recommend that seasonal or permanent habitat fencing be installed along the back of the upper dunes at Marina South where beach users cross into closed nesting areas from the rear of the dunes.
- We recommend development of an education and outreach program to provide beach users with information on snowy plover conservation, particularly at sites with high levels of human use.

### ***Coastal Adaptation***

Adapting to the effects of climate change will require directed planning to identify and prioritize resilient areas and to improve the overall resilience of beach and dune habitats through habitat restoration and management.

- We recommend identifying which beaches are vulnerable and which are likely to be resilient to sea level rise, erosion, and narrowing and that adaptive strategies be developed to ensure that these habitats persist into the future.
- We recommend protecting the structural integrity of beach and dune landforms by reducing or eliminating human activities that cause high levels of mechanical disturbance (e.g. vehicle use, equestrian use).
- We recommend continued restoration and enhancement of beach and dune habitats as a means of improving resiliency while also providing high quality plover nesting areas.

### ***Monitoring***

In 2018, nesting was detected at sites in Northern Santa Cruz County (Laguna Creek) and the North Bay (Seabright Beach, Manresa Beach) that were infrequently monitored. Additional funding for monitoring, development of new monitoring partnerships (e.g. with citizen scientists or universities), or additional survey work by land managers would provide additional information to develop management strategies.

- We recommend continued periodic monitoring of plover activity at the following sites: the northern Santa Cruz County beaches (Seabright, Wilder, Laguna, Scott Creek, and Waddell), Manresa Beach, and the beaches from the north end of Manresa to Rio Del Mar.

### ***Site-specific***

In addition to the above recommendations, we provide the following recommendations for management at the Salt Ponds, particularly because nesting density has declined there in recent years, likely for multiple reasons related to reductions in habitat quality.

- Sedimentation throughout the ponds and water conveyance infrastructure has become an impediment to controlling water levels in the ponds, which is an essential management tool to provide dry nesting areas and wet areas for chick foraging. We recommend excavation of water conveyance channels and maintenance of water control structures to reduce pond salinity levels and encourage growth of sparse vegetative cover (e.g. *Salicornia* patches) on pond floors.

- We also recommend reducing non-native vegetation growth on levees and removal of the non-native tree species Monterey Cypress (*Cupressus macrocarpa*) and Eucalyptus (*Eucalyptus* spp.) at the perimeter of the ponds to discourage raptor use of this area.

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Hays, H. and M LeCroy. 1971. Field criteria for determining incubation stage of the Common tern. *Wilson Bulletin* 83:425-429.

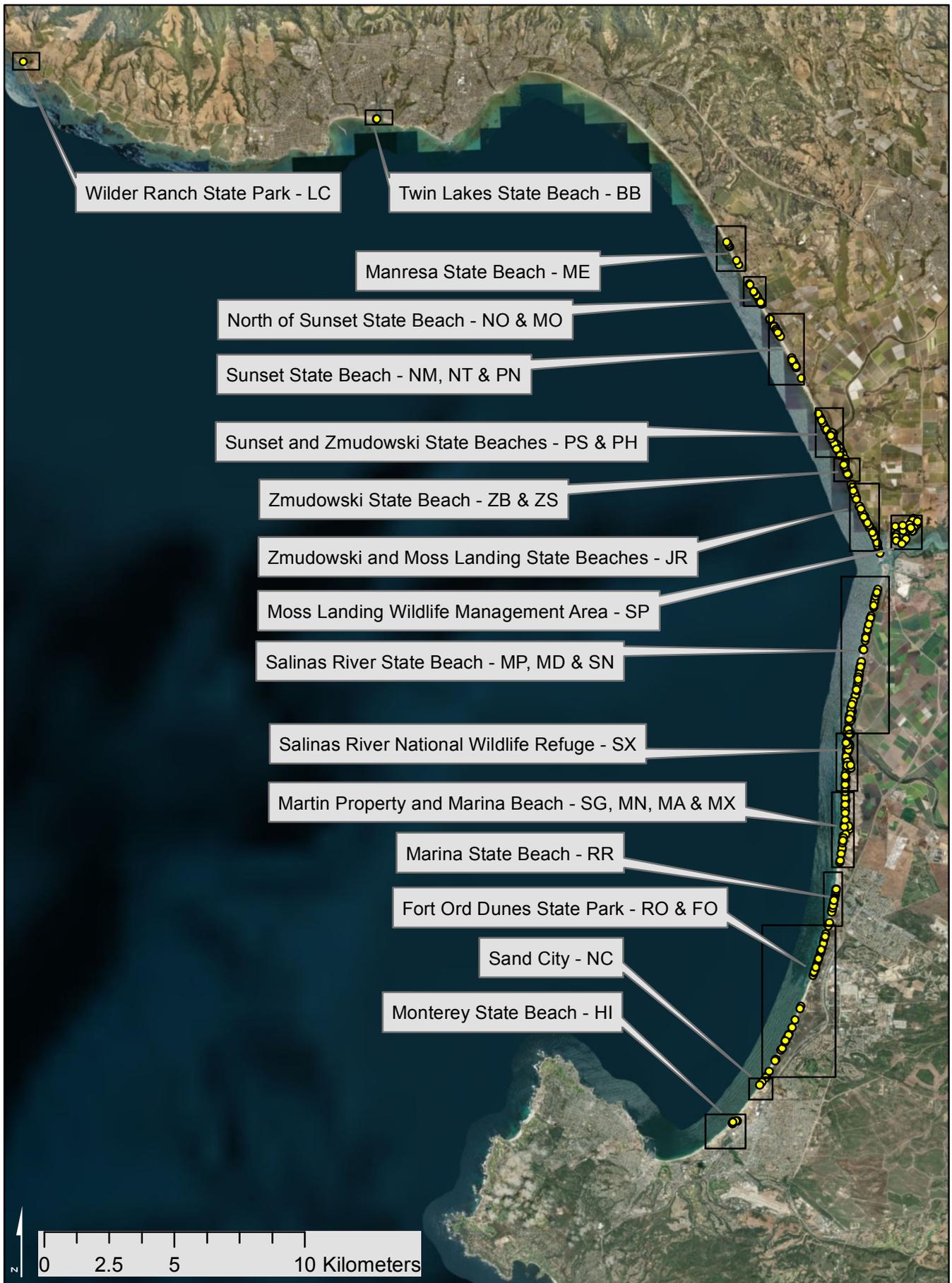
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## ACKNOWLEDGEMENTS

Jacob Martin and Gary Page greatly assisted with the fieldwork at Sunset-Manresa and the Pajaro Spit area, respectively. Chris Caris contributed significantly to the field work at Salinas River NWR. We thank Juan Villarino of California State Parks for conducting the field work at Laguna Creek Beach and for surveying other Northern Santa Cruz county beaches. We also thank Tim Atkins of Wildlife Services, USDA. This project was conducted collaboratively by the following groups: Point Blue Conservation Science, the Salinas River National Wildlife Refuge Unit of the Don Edwards San Francisco Bay National Wildlife Refuge (USFWS), the California Department of Parks and Recreation, the California Department of Fish and Wildlife, the Wildlife Services Unit of the USDA, and the Monterey Bay Aquarium.



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Appendix 1. Overview of Snowy Plover nest locations in the Monterey Bay area in 2018.



Appendix 2. Snowy Plover nest locations at Laguna Creek Beach at Wilder Ranch State Park in 2018.



Appendix 3. Snowy Plover nest locations at Seabright Beach at Twin Lakes State Beach in 2018.



Appendix 4. Snowy Plover nest locations at Manresa State Beach and the northern portion of Sunset State Beach in 2018.



Appendix 5. Snowy Plover nest locations at the central and southern portion of Sunset State Beach in 2018.



Appendix 6. Snowy Plover nest locations at the Pajaro spit at Zmudowski State Beach in 2018.



Appendix 7. Snowy Plover nest locations at the central portion of Zmudowski State Beach in 2018.



Appendix 8. Snowy Plover nest locations at Jetty Road in the southern 1/3 of Zmudowski State Beach and Moss Landing State Beach in 2018.



Appendix 9. Snowy Plover nest locations at the former salt ponds at the Moss Landing Wildlife Area in 2018.



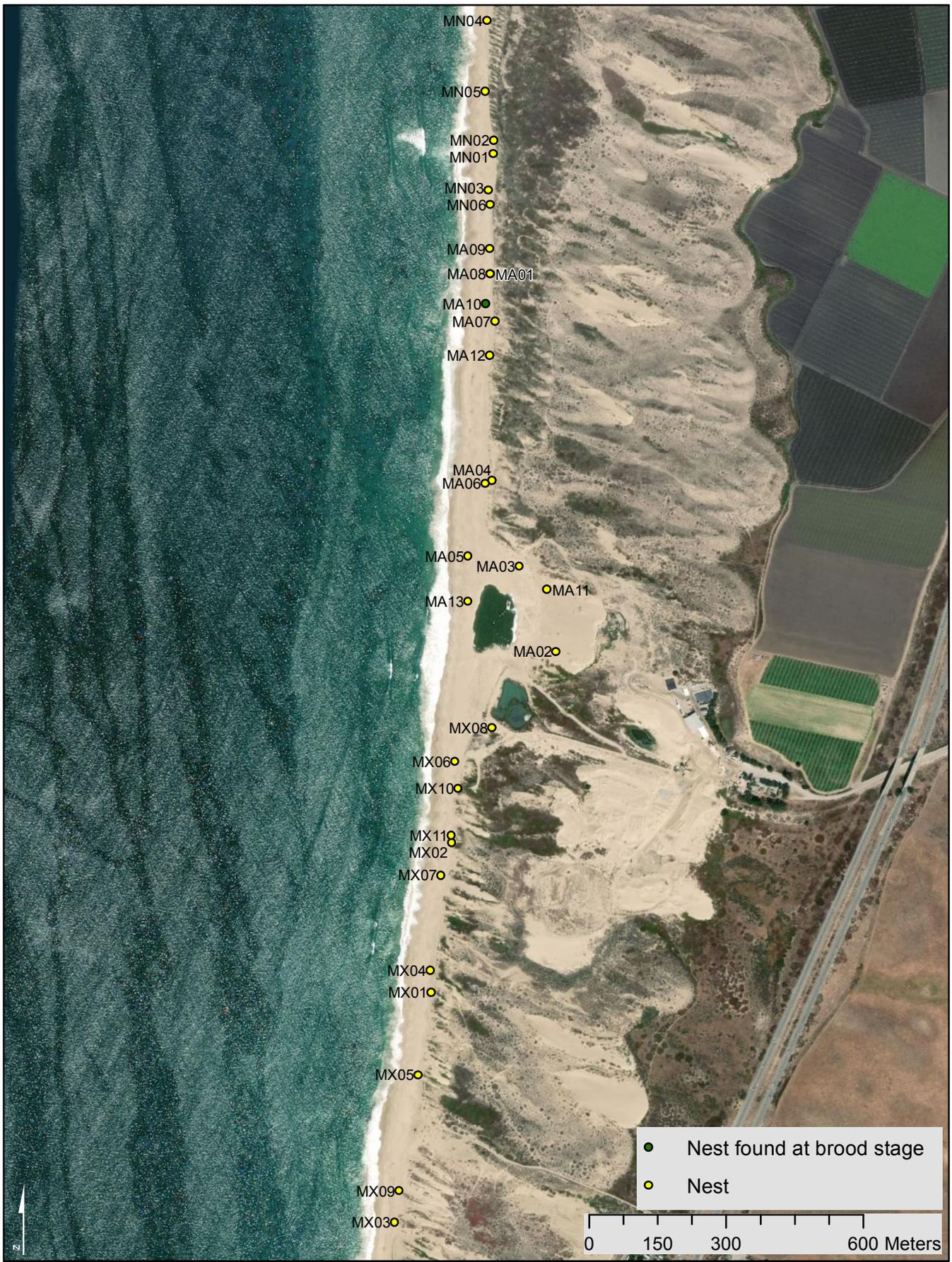
Appendix 10. Snowy Plover nest locations at the Molera-Potrero portion of Salinas River State Beach in 2018.



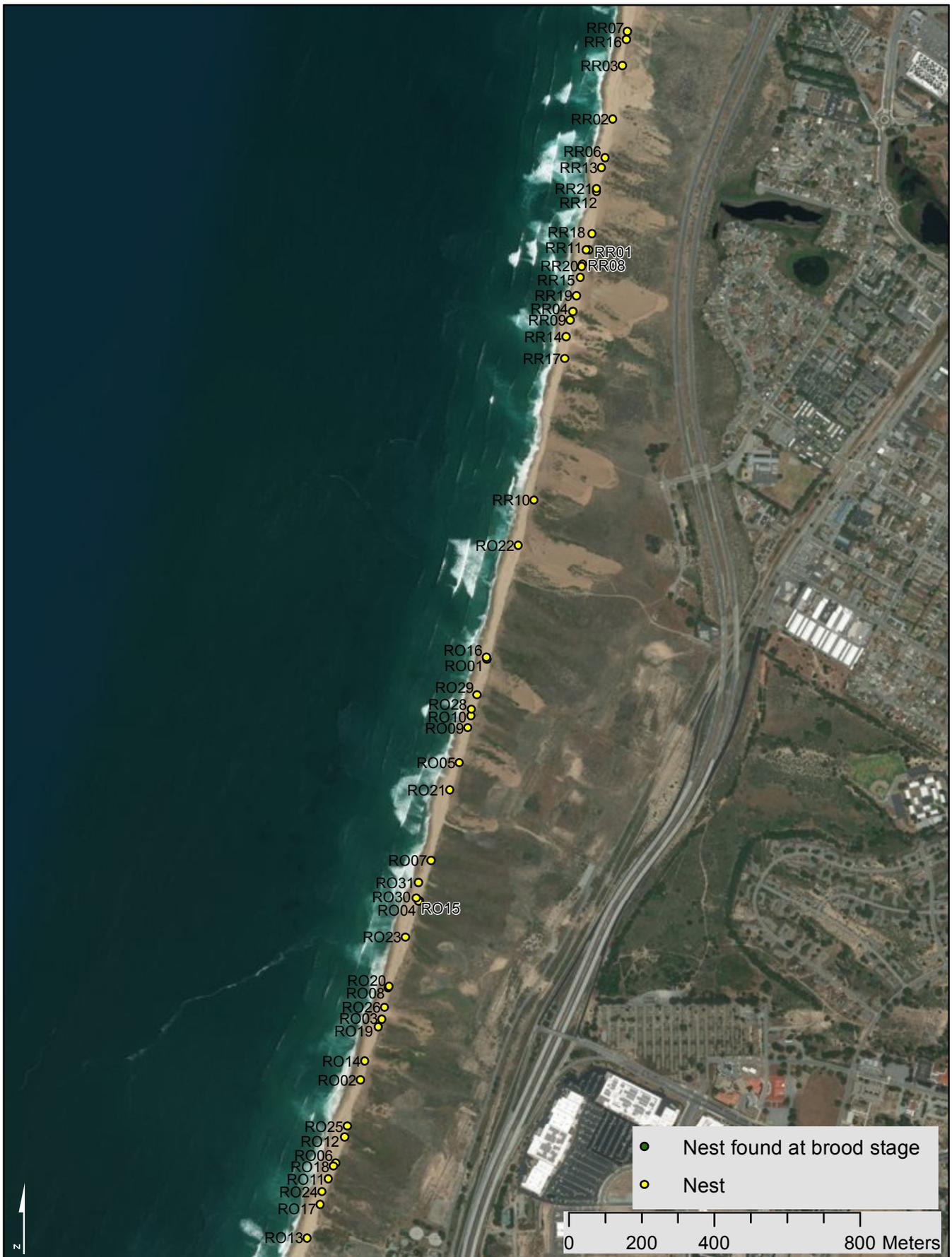
Appendix 11. Snowy Plover nest locations at the Monterey Dunes Colony and North Salinas River portions of Salinas River State Beach in 2018.



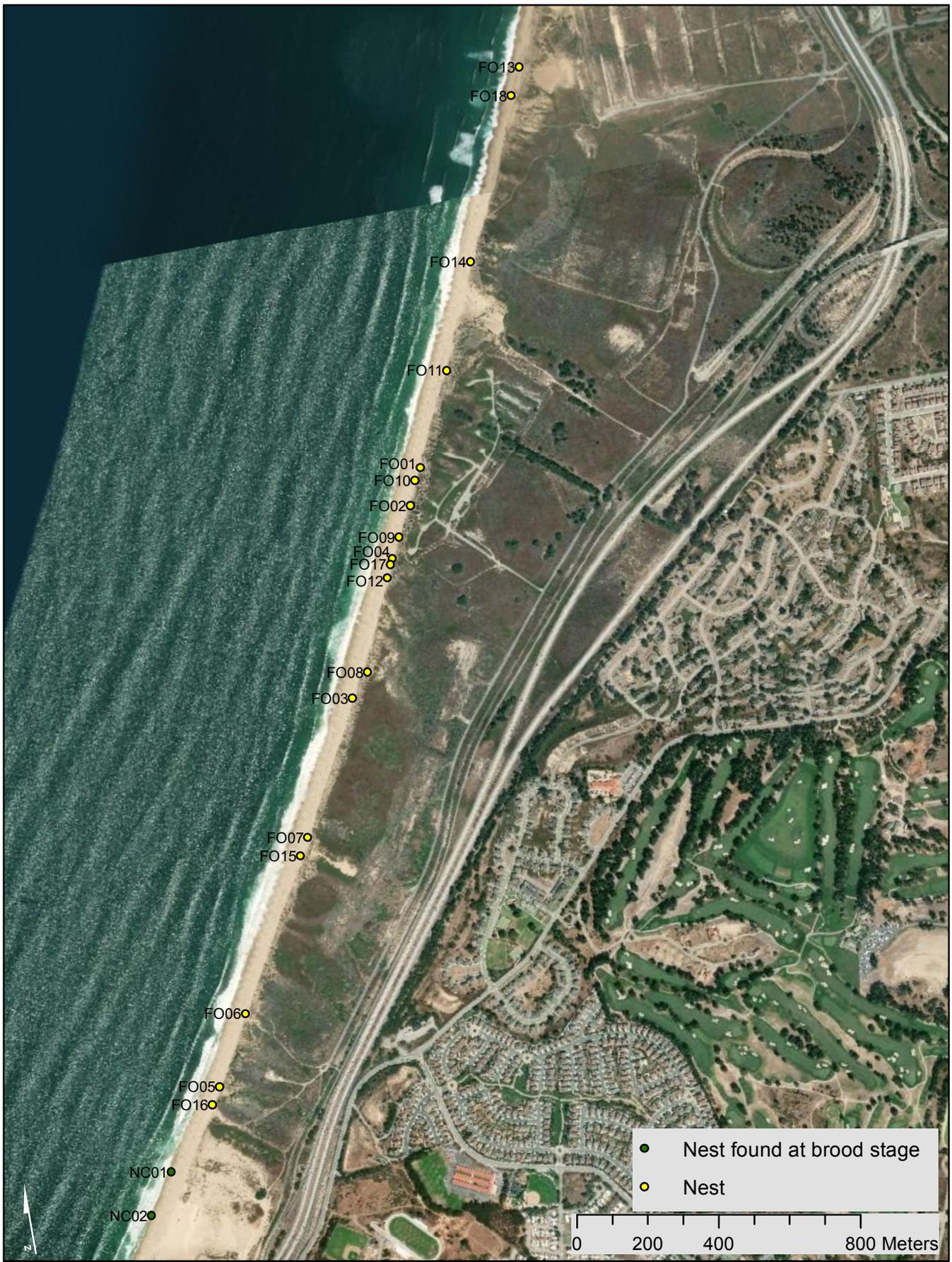
Appendix 12. Snowy Plover nest locations at the Salinas River National Wildlife Refuge and the Martin Dunes in 2018.



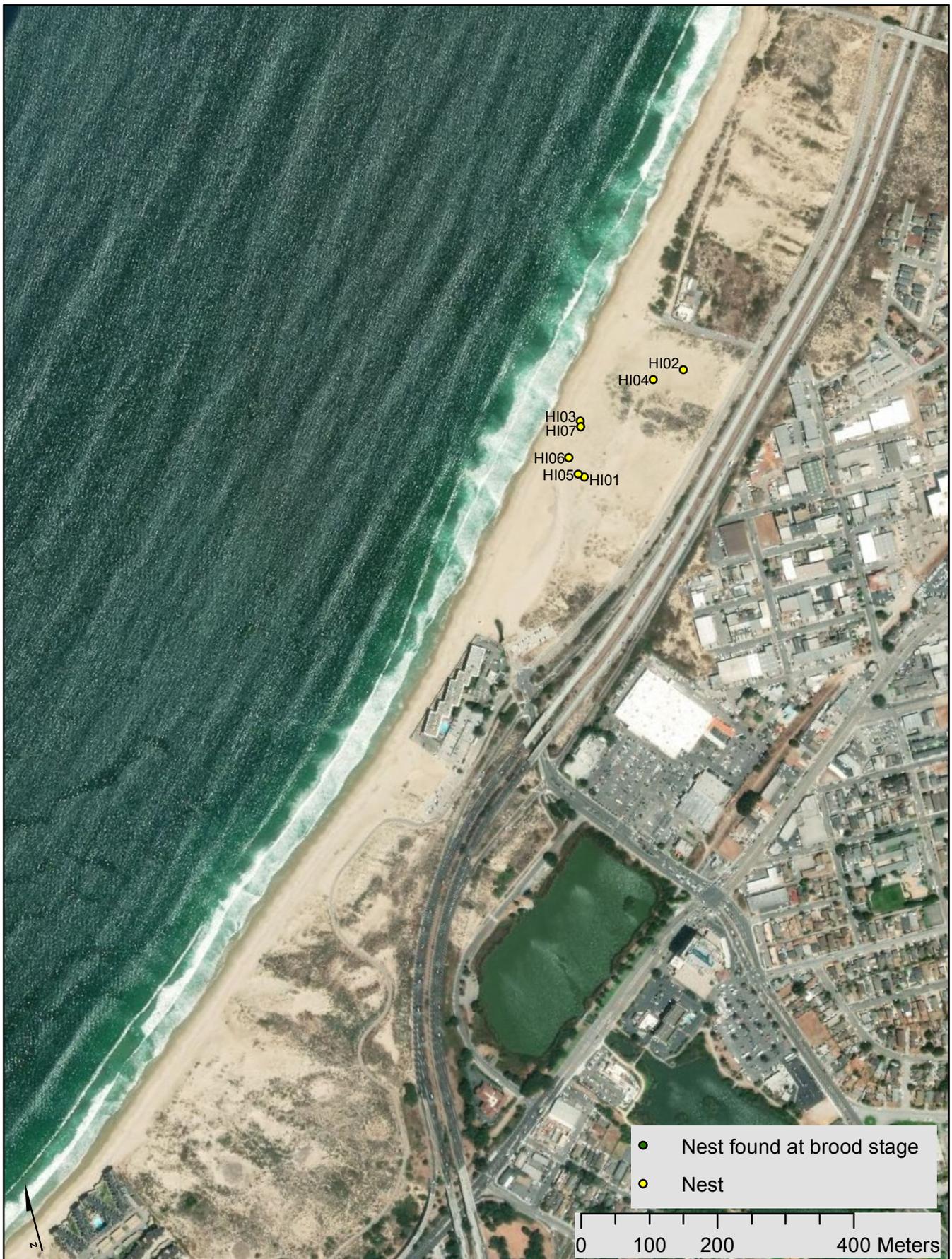
Appendix 13. Snowy Plover nest locations at the north, middle, and south sections of Marina beach in 2018.



Appendix 14. Snowy Plover nest locations at Reservation Road at Marina State Beach and the northern portion of Fort Ord Dunes State Park in 2018.



Appendix 15. Snowy Plover nest locations at the southern portion of Fort Ord Dunes State Park and Sand City in 2018. Sand City was monitored infrequently in 2018.



Appendix 16. Snowy Plover nest locations at Monterey State Beach in 2018.

**Appendix 17. Adults and chicks banded in 2018, Monterey Bay region.**

BAND COMBINATION	BANDING DATE	BANDING LOCATION <sup>1</sup>	BAND TYPE <sup>2</sup>	AGE <sup>3</sup>	SEX <sup>4</sup>
ab ga	25-May	MOSS LANDING	ss-ss	c	u
ab oa	21-Jun	SUNSET-MANRESA	ss-ss	c	u
ab ra	11-Jul	MONTEREY DUNES	ss-ss	c	u
ab va	20-May	RESERVATION RD	ss-ss	c	u
ab wa	25-Jul	PAJARO SPIT	ss-ss	c	u
ab ya	8-May	MONTEREY	ss-ss	c	u
ag aa	12-Jul	PAJARO SPIT	ss-ss	c	u
ag ba	26-Jun	MARTIN DUNES	ss-ss	c	u
ag oa	11-Jul	NORTH FORT ORD	ss-ss	c	u
ag ra	19-Jul	SUNSET-MANRESA	ss-ss	c	u
ag va	9-May	RESERVATION RD	ss-ss	c	u
ag ya	16-Jul	MOSS LANDING	ss-ss	c	u
ap ba	7-Aug	MONTEREY BAY AQUARIUM	ss-ss	c	u
ar aa	10-Jul	MONTEREY DUNES	ss-ss	c	u
ar oa	18-Jul	MARINA	ss-ss	c	u
ar va	20-Jul	MONTEREY	ss-ss	c	u
ar ya	25-Jul	SALT PONDS	ss-ss	c	u
aw aa	8-May	MONTEREY	ss-ss	c	u
aw ga	12-Apr	FORT ORD	ss-ss	c	u
aw va	10-Jul	NORTH SALINAS	ss-ss	c	u
aw ya	3-Aug	RESERVATION RD	ss-ss	c	u
ay oa	19-Jul	PAJARO SPIT	ss-ss	c	u
ay wa	16-Jul	MOSS LANDING	ss-ss	c	u
ay ya	2-Jul	FORT ORD	ss-ss	c	u
ba aa	17-Jul	MONTEREY DUNES	ss-ss	c	u
ba ga	27-Jul	SUNSET-MANRESA	ss-ss	c	u
ba ga	1-Aug	PAJARO SPIT	ss-ss	c	u
ba va	15-Jun	PAJARO SPIT	ss-ss	c	u
ba wa	30-Jun	MOLERA POTRERO	ss-ss	c	u
ba ya	17-May	MOLERA POTRERO	ss-ss	c	u
Bg ab	10-Jul	MOSS LANDING	Ms-ss	a	m
bg ba	26-Jul	MARINA	ss-ss	c	u
Bg by	2-Jul	PAJARO SPIT	Ms-ss	a	f
bg ga	10-May	SOUTH MARINA	ss-ss	c	u
Bg og	11-Jul	PAJARO SPIT	Ms-ss	a	f
bg ra	18-Jun	NORTH FORT ORD	ss-ss	c	u
Bg rr	19-Jul	PAJARO SPIT	Ms-ss	a	f
Bg ry	16-Jul	PAJARO SPIT	Ms-ss	a	m
bg va	2-Jul	NORTH SALINAS	ss-ss	c	u
bg wa	23-May	MOLERA POTRERO	ss-ss	c	u
Bg wb	19-Jul	MONTEREY	Ms-ss	a	m
bo ba	25-Jul	SALT PONDS	ss-ss	c	u
bo oa	28-Jun	SALINAS RIVER NWR	ss-ss	c	u
bo ra	3-Jul	NORTH FORT ORD	ss-ss	c	u

<sup>1</sup> See site descriptions for more detail.

<sup>2</sup> Ms-ss = upper tarsus metal band on Left leg; ss-ss = all lower bands

<sup>3</sup> c = chick; a = adult

<sup>4</sup> u = unknown; m = male; f = female

**Appendix 17. Adults and chicks banded in 2018, Monterey Bay region.**

BAND COMBINATION	BANDING DATE	BANDING LOCATION <sup>1</sup>	BAND TYPE <sup>2</sup>	AGE <sup>3</sup>	SEX <sup>4</sup>
bo ya	2-Aug	MOLERA POTRERO	SS-SS	C	U
bw ba	31-May	SALINAS RIVER NWR	SS-SS	C	U
bw ga	5-Jul	RESERVATION RD	SS-SS	C	U
bw oa	16-Jul	PAJARO SPIT	SS-SS	C	U
bw ra	27-Jul	MOSS LANDING	SS-SS	C	U
bw va	18-May	RESERVATION RD	SS-SS	C	U
by aa	13-Jun	MONTEREY DUNES	SS-SS	C	U
by ba	7-Jul	NORTH FORT ORD	SS-SS	C	U
by va	4-May	RESERVATION RD	SS-SS	C	U
by ya	24-Jul	ZMUDOWSKI	SS-SS	C	U
gb aa	11-Jul	NORTH FORT ORD	SS-SS	C	U
gb ya	9-May	MOSS LANDING	SS-SS	C	U
gl aa	1-Aug	PAJARO SPIT	SS-SS	C	U
gl ba	5-Jul	PAJARO SPIT	SS-SS	C	U
gl ga	4-May	NORTH FORT ORD	SS-SS	C	U
gl oa	6-May	FORT ORD	SS-SS	C	U
gl ra	9-Aug	SALINAS RIVER NWR	SS-SS	C	U
gl va	23-May	MOSS LANDING	SS-SS	C	U
gl wa	16-Jul	MOSS LANDING	SS-SS	C	U
gl ya	7-Jul	NORTH FORT ORD	SS-SS	C	U
go aa	7-May	NORTH FORT ORD	SS-SS	C	U
go ba	20-Jul	PAJARO SPIT	SS-SS	C	U
go oa	7-Aug	PAJARO SPIT	SS-SS	C	U
go va	18-May	NORTH FORT ORD	SS-SS	C	U
go wa	1-May	NORTH FORT ORD	SS-SS	C	U
go ya	12-Jul	NORTH FORT ORD	SS-SS	C	U
oa ba	24-Jul	MONTEREY DUNES	SS-SS	C	U
oa oa	20-Jul	PAJARO SPIT	SS-SS	C	U
oa va	9-Aug	MOLERA POTRERO	SS-SS	C	U
ob ga	7-Jun	FORT ORD	SS-SS	C	U
ob oa	19-Jun	NORTH MARINA	SS-SS	C	U
ob ra	17-Jul	MARINA	SS-SS	C	U
ob va	9-Aug	SALINAS RIVER NWR	SS-SS	C	U
ob wa	23-May	MOSS LANDING	SS-SS	C	U
ob ya	16-Jul	PAJARO SPIT	SS-SS	C	U
ob ya	16-Jul	PAJARO SPIT	SS-SS	C	U
og aa	6-May	FORT ORD	SS-SS	C	U
og ba	25-Jul	PAJARO SPIT	SS-SS	C	U
og oa	23-Jul	PAJARO SPIT	SS-SS	C	U
og ya	19-Jul	SUNSET-MANRESA	SS-SS	C	U
oo aa	9-May	RESERVATION RD	SS-SS	C	U
oo ga	16-Jul	MOSS LANDING	SS-SS	C	U
oo o-	19-Jun	NORTH MARINA	SS-SS	C	U
oo ra	13-Jul	MOLERA POTRERO	SS-SS	C	U

<sup>1</sup> See site descriptions for more detail.

<sup>2</sup> Ms-ss = upper tarsus metal band on Left leg; ss-ss = all lower bands

<sup>3</sup> c = chick; a = adult

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**Appendix 17. Adults and chicks banded in 2018, Monterey Bay region.**

BAND COMBINATION	BANDING DATE	BANDING LOCATION <sup>1</sup>	BAND TYPE <sup>2</sup>	AGE <sup>3</sup>	SEX <sup>4</sup>
oo va	10-May	SUNSET-MANRESA	ss-ss	c	u
oo wa	18-Jul	MARINA	ss-ss	c	u
ow ga	25-Jul	SALT PONDS	ss-ss	c	u
ow va	23-Apr	FORT ORD	ss-ss	c	u
ow ya	21-Jul	PAJARO SPIT	ss-ss	c	u
oy aa	10-Jul	NORTH SALINAS	ss-ss	c	u
oy ba	14-Aug	PAJARO SPIT	ss-ss	c	u
oy ga	18-Jun	RESERVATION RD	ss-ss	c	u
oy oa	3-Aug	RESERVATION RD	ss-ss	c	u
oy ra	18-Jun	NORTH SALINAS	ss-ss	c	u
oy va	1-May	NORTH FORT ORD	ss-ss	c	u
oy wa	19-Jul	PAJARO SPIT	ss-ss	c	u
ra aa	20-Jul	PAJARO SPIT	ss-ss	c	u
ra ga	6-May	FORT ORD	ss-ss	c	u
ra va	15-Jun	PAJARO SPIT	ss-ss	c	u
Rb ab	31-Jul	PAJARO SPIT	Ms-ss	a	u
Rb ay	22-May	MOSS LANDING	Ms-ss	a	f
rb ba	9-Jul	FORT ORD	ss-ss	c	u
Rb by	25-Jul	PAJARO SPIT	Ms-ss	a	m
rb ga	20-Jul	PAJARO SPIT	ss-ss	c	u
rb oa	18-Jun	NORTH SALINAS	ss-ss	c	u
Rb og	18-Jun	NORTH SALINAS	Ms-ss	a	m
rb va	10-May	SOUTH MARINA	ss-ss	c	u
rb ya	13-Jun	MONTEREY DUNES	ss-ss	c	u
ro aa	2-Jul	NORTH SALINAS	ss-ss	c	u
ro ba	18-Jul	ZMUDOWSKI	ss-ss	c	u
ro va	11-May	MOLERA POTRERO	ss-ss	c	u
ro ya	20-Jul	MOSS LANDING	ss-ss	c	u
rw ba	21-Jul	PAJARO SPIT	ss-ss	c	u
rw ga	2-Aug	MOLERA POTRERO	ss-ss	c	u
rw ra	5-Jun	NORTH SALINAS	ss-ss	c	u
rw va	1-Aug	PAJARO SPIT	ss-ss	c	u
rw wa	16-Jul	PAJARO SPIT	ss-ss	c	u
wa aa	18-Jun	NORTH FORT ORD	ss-ss	c	u
wa ab	18-Jun	NORTH SALINAS	ss-ss	c	u
wa ag	20-Jul	PAJARO SPIT	ss-ss	c	u
wa ar	7-Jun	FORT ORD	ss-ss	c	u
wa bb	14-Jun	NORTH FORT ORD	ss-ss	c	u
wa br	4-May	FORT ORD	ss-ss	c	u
wa gb	8-May	MONTEREY	ss-ss	c	u
wa gr	21-Jun	SUNSET-MANRESA	ss-ss	c	u
wa gw	3-Jul	NORTH MARINA	ss-ss	c	u
wa lg	27-Jul	SUNSET-MANRESA	ss-ss	c	u
wa ly	5-Jul	RESERVATION RD	ss-ss	c	u

<sup>1</sup> See site descriptions for more detail.

<sup>2</sup> Ms-ss = upper tarsus metal band on Left leg; ss-ss = all lower bands

<sup>3</sup> c = chick; a = adult

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**Appendix 17. Adults and chicks banded in 2018, Monterey Bay region.**

BAND COMBINATION	BANDING DATE	BANDING LOCATION <sup>1</sup>	BAND TYPE <sup>2</sup>	AGE <sup>3</sup>	SEX <sup>4</sup>
wa oy	18-Jul	MARINA	SS-SS	C	U
wa ra	11-Jul	NORTH FORT ORD	SS-SS	C	U
wa rb	9-Aug	MOLERA POTRERO	SS-SS	C	U
wa rr	11-Jul	NORTH FORT ORD	SS-SS	C	U
wa va	9-May	MOSS LANDING	SS-SS	C	U
wa vg	16-Jul	PAJARO SPIT	SS-SS	C	U
wa wa	2-Aug	MOLERA POTRERO	SS-SS	C	U
wb aa	4-May	RESERVATION RD	SS-SS	C	U
wb ab	19-Jul	PAJARO SPIT	SS-SS	C	U
wb bb	16-Jul	MOSS LANDING	SS-SS	C	U
wb bg	8-Aug	PAJARO SPIT	SS-SS	C	U
wb lg	25-Jul	PAJARO SPIT	SS-SS	C	U
wb or	24-Jul	ZMUDOWSKI	SS-SS	C	U
wb oy	17-May	MOLERA POTRERO	SS-SS	C	U
wb ra	5-Jul	PAJARO SPIT	SS-SS	C	U
wb va	7-May	NORTH FORT ORD	SS-SS	C	U
wb vg	29-Jun	RESERVATION RD	SS-SS	C	U
wb wb	23-May	MOLERA POTRERO	SS-SS	C	U
wb wg	21-Jul	PAJARO SPIT	SS-SS	C	U
wb ww	2-Aug	MOLERA POTRERO	SS-SS	C	U
wb yr	28-Jun	SALINAS RIVER NWR	SS-SS	C	U
wb yw	7-Jul	NORTH FORT ORD	SS-SS	C	U
wg ag	19-Jul	SUNSET-MANRESA	SS-SS	C	U
wg ba	17-Jul	MOSS LANDING	SS-SS	C	U
wg bb	17-Jul	MARINA	SS-SS	C	U
wg br	6-May	FORT ORD	SS-SS	C	U
wg ga	7-Jul	NORTH FORT ORD	SS-SS	C	U
wg gw	18-May	NORTH FORT ORD	SS-SS	C	U
wg lw	1-Aug	PAJARO SPIT	SS-SS	C	U
wg ob	12-Jul	NORTH FORT ORD	SS-SS	C	U
wg or	9-Aug	SALINAS RIVER NWR	SS-SS	C	U
wg ow	23-May	MOSS LANDING	SS-SS	C	U
wg vr	24-Jul	SALINAS RIVER NWR	SS-SS	C	U
wg vw	16-Jul	MOSS LANDING	SS-SS	C	U
wg wa	8-Aug	PAJARO SPIT	SS-SS	C	U
wg yb	7-May	NORTH FORT ORD	SS-SS	C	U
wg yr	9-May	NORTH FORT ORD	SS-SS	C	U
wg yy	6-May	FORT ORD	SS-SS	C	U
wl ba	29-Jun	RESERVATION RD	SS-SS	C	U
wl ra	24-Jul	SALINAS RIVER NWR	SS-SS	C	U
wl va	1-May	NORTH FORT ORD	SS-SS	C	U
wo aa	18-May	NORTH FORT ORD	SS-SS	C	U
wo ag	5-Jul	PAJARO SPIT	SS-SS	C	U
wo ar	23-Jul	SALINAS RIVER NWR	SS-SS	C	U

<sup>1</sup> See site descriptions for more detail.

<sup>2</sup> Ms-ss = upper tarsus metal band on Left leg; ss-ss = all lower bands

<sup>3</sup> c = chick; a = adult

<sup>4</sup> u = unknown; m = male; f = female

**Appendix 17. Adults and chicks banded in 2018, Monterey Bay region.**

BAND COMBINATION	BANDING DATE	BANDING LOCATION <sup>1</sup>	BAND TYPE <sup>2</sup>	AGE <sup>3</sup>	SEX <sup>4</sup>
wo bb	4-May	RESERVATION RD	SS-SS	C	U
wo bg	6-May	FORT ORD	SS-SS	C	U
wo by	18-May	RESERVATION RD	SS-SS	C	U
wo lw	19-Jul	MOSS LANDING	SS-SS	C	U
wo oa	3-Jul	SOUTH MARINA	SS-SS	C	U
wo og	31-May	SALINAS RIVER NWR	SS-SS	C	U
wo or	27-Jul	SUNSET-MANRESA	SS-SS	C	U
wo ra	24-Jul	MONTEREY DUNES	SS-SS	C	U
wo va	5-Jul	RESERVATION RD	SS-SS	C	U
wo ww	20-Jul	MOSS LANDING	SS-SS	C	U
wo wy	10-Jul	MONTEREY DUNES	SS-SS	C	U
wo yr	17-Jul	PAJARO SPIT	SS-SS	C	U
wo yy	14-May	ZMUDOWSKI	SS-SS	C	U
wr aa	9-Aug	MOLERA POTRERO	SS-SS	C	U
wr ab	24-Jul	MONTEREY DUNES	SS-SS	C	U
wr aw	7-Jun	SUNSET-MANRESA	SS-SS	C	U
wr ay	3-Jul	SOUTH MARINA	SS-SS	C	U
wr ba	11-Jul	NORTH SALINAS	SS-SS	C	U
wr bb	2-Aug	MOLERA POTRERO	SS-SS	C	U
wr br	17-May	MOLERA POTRERO	SS-SS	C	U
wr bw	1-May	NORTH FORT ORD	SS-SS	C	U
wr oa	16-Jul	MOSS LANDING	SS-SS	C	U
wr ra	27-Jul	SUNSET-MANRESA	SS-SS	C	U
wr ra	1-Aug	PAJARO SPIT	SS-SS	C	U
wr va	14-Jun	NORTH FORT ORD	SS-SS	C	U
wr vr	25-Jul	SALT PONDS	SS-SS	C	U
wr vw	17-Aug	MOSS LANDING	SS-SS	C	U
wr wa	19-Jun	NORTH MARINA	SS-SS	C	U
wr wb	9-May	RESERVATION RD	SS-SS	C	U
wr ww	18-Jun	NORTH FORT ORD	SS-SS	C	U
wr ya	17-Jul	MARINA	SS-SS	C	U
wr yb	26-Jun	MARTIN DUNES	SS-SS	C	U
wr yg	10-Jul	NORTH SALINAS	SS-SS	C	U
wr yr	23-Jul	PAJARO SPIT	SS-SS	C	U
wy ab	18-Jul	ZMUDOWSKI	SS-SS	C	U
wy ar	11-Jul	NORTH SALINAS	SS-SS	C	U
wy bb	9-Jul	FORT ORD	SS-SS	C	U
wy bg	7-Jul	NORTH FORT ORD	SS-SS	C	U
wy br	26-Jul	MARINA	SS-SS	C	U
wy gy	9-May	MONTEREY	SS-SS	C	U
wy lg	3-Jul	NORTH FORT ORD	SS-SS	C	U
wy ow	6-May	FORT ORD	SS-SS	C	U
wy vw	21-Jul	PAJARO SPIT	SS-SS	C	U
wy wb	17-Jul	MONTEREY DUNES	SS-SS	C	U

<sup>1</sup> See site descriptions for more detail.

<sup>2</sup> Ms-ss = upper tarsus metal band on Left leg; ss-ss = all lower bands

<sup>3</sup> c = chick; a = adult

<sup>4</sup> u = unknown; m = male; f = female

**Appendix 17. Adults and chicks banded in 2018, Monterey Bay region.**

BAND COMBINATION	BANDING DATE	BANDING LOCATION <sup>1</sup>	BAND TYPE <sup>2</sup>	AGE <sup>3</sup>	SEX <sup>4</sup>
wy wg	16-Jul	MOSS LANDING	SS-SS	c	u
wy ww	19-Jun	NORTH MARINA	SS-SS	c	u
wy yb	12-Jul	NORTH FORT ORD	SS-SS	c	u
wy yr	1-May	NORTH FORT ORD	SS-SS	c	u
wy yw	20-Jul	PAJARO SPIT	SS-SS	c	u
ya aa	25-May	MOSS LANDING	SS-SS	c	u
ya ba	21-Jun	SUNSET-MANRESA	SS-SS	c	u
ya ga	16-Jul	PAJARO SPIT	SS-SS	c	u
ya oa	6-May	FORT ORD	SS-SS	c	u
ya va	8-May	MONTEREY	SS-SS	c	u
ya wa	24-Jul	SALINAS RIVER NWR	SS-SS	c	u
ya ya	3-Jul	NORTH MARINA	SS-SS	c	u
yb ba	11-Jul	NORTH FORT ORD	SS-SS	c	u
yb ga	6-May	FORT ORD	SS-SS	c	u
yb va	9-May	NORTH FORT ORD	SS-SS	c	u
yb wa	10-Jul	MONTEREY DUNES	SS-SS	c	u
yb ya	23-Jul	SALINAS RIVER NWR	SS-SS	c	u
yg ga	25-Jun	MARTIN DUNES	SS-SS	c	u
yg oa	19-Jul	MONTEREY	SS-SS	c	u
yg va	8-May	MONTEREY	SS-SS	c	u
yl aa	15-May	FORT ORD	SS-SS	c	u
yl ga	28-Jun	SALINAS RIVER NWR	SS-SS	c	u
yl oa	2-Jul	NORTH SALINAS	SS-SS	c	u
yl ra	18-Jul	ZMUDOWSKI	SS-SS	c	u
Yo ab	9-Jul	MOSS LANDING	Ms-ss	a	f
Yo br	30-Jul	MOSS LANDING	Ms-ss	a	f
yo oa	21-Jul	PAJARO SPIT	SS-SS	c	u
Yo ob	22-Jun	FORT ORD	Ms-ss	a	f
Yo oy	16-Jul	MONTEREY	Ms-ss	a	f
yo ra	14-Aug	PAJARO SPIT	SS-SS	c	u
yo va	18-May	RESERVATION RD	SS-SS	c	u
yo ya	18-Jun	NORTH SALINAS	SS-SS	c	u
yr aa	3-May	FORT ORD	SS-SS	c	u
yr ra	7-Jun	FORT ORD	SS-SS	c	u
yr va	11-May	MOLERA POTRERO	SS-SS	c	u
yy aa	20-May	RESERVATION RD	SS-SS	c	u
Yy ar	12-Jul	PAJARO SPIT	Ms-ss	a	f
Yy bb	11-Jul	PAJARO SPIT	Ms-ss	a	m
yy oa	15-Jun	PAJARO SPIT	SS-SS	c	u
Yy ob	18-Jul	MOSS LANDING	Ms-ss	a	f
Yy or	18-Jul	PAJARO SPIT	Ms-ss	a	f
yy ra	30-Jun	MOLERA POTRERO	SS-SS	c	u
yy va	13-Jun	MONTEREY DUNES	SS-SS	c	u
yy wa	18-Jun	NORTH SALINAS	SS-SS	c	u

<sup>1</sup> See site descriptions for more detail.

<sup>2</sup> Ms-ss = upper tarsus metal band on Left leg; ss-ss = all lower bands

<sup>3</sup> c = chick; a = adult

<sup>4</sup> u = unknown; m = male; f = female

**Appendix 17. Adults and chicks banded in 2018, Monterey Bay region.**

BAND COMBINATION	BANDING DATE	BANDING LOCATION <sup>1</sup>	BAND TYPE <sup>2</sup>	AGE <sup>3</sup>	SEX <sup>4</sup>
Yy wb	13-Jul	ZMUDOWSKI	Ms-ss	a	f
yy ya	26-Jul	MARINA	ss-ss	c	u

<sup>1</sup> See site descriptions for more detail.

<sup>2</sup> Ms-ss = upper tarsus metal band on Left leg; ss-ss = all lower bands

<sup>3</sup> c = chick; a = adult

<sup>4</sup> u = unknown; m = male; f = female