SAN FRANCISCO BAY
BIRD OBSERVATORY

# Western Snowy Plover Monitoring in the San Francisco Bay Annual Report 2021

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**EXECUTIVE SUMMARY**

The San Francisco Bay Bird Observatory (SFBBO), USFWS Don Edwards San Francisco Bay National Wildlife Refuge (Refuge), California Department of Fish and Wildlife (CDFW), Hayward Area Recreation and Park District (HARD), East Bay Regional Park District (EBRPD), USFWS Bay Delta Fish and Wildlife Office, USDA-Wildlife Services, and Vollmar Natural Lands Consulting form the Western Snowy Plover (*Charadrius nivosus nivosus*; Snowy Plover) Recovery Unit 3 working group. The goal of this collaboration is to survey managed ponds and other habitats for Snowy Plovers, track breeding success, and contribute to the management and recovery of this species in the San Francisco Bay. During the 2022 breeding season, SFBBO monitored Snowy Plover population size, nesting and fledging success, the use of experimental habitat enhancement sites, and potential predators.

As part of the Pacific Coast breeding season window survey (May 16-22), we counted 263 adult Snowy Plovers in the San Francisco Bay. Over the course of the breeding season (March-September), SFBBO staff determined and documented the fates of 209 Snowy Plover nests in Recovery Unit 3, with 207 located in the South Bay and two located in San Pablo Bay. EBPRD documented the fate of three Snowy Plover nests at Hayward Shoreline. Vollmar Consulting Biologists documented the fate of two nests at Montezuma Wetlands in Suisun Bay near the Sacramento-San Joaquin Delta. Of the total nests, 48% were depredated, 3% abandoned, 2% unknown, 1% flooded, and 1% failed to hatch. Apparent nest success (defined as the percentage of nests that successfully hatched at least one egg out of the total nests monitored) was 45%. A summary of 2021 nesting activity by pond complex or management unit follows:

On Refuge property, we monitored twelve nests in the Alviso Complex, 38 nests in the Ravenswood Complex, and three nests in the Warm Springs Unit. Apparent nest success was 75% at Alviso, 71% at Ravenswood, and 66% at Warm Springs.

On Cargill managed property, Cargill reported one nest at the Newark Production Facility with an unknown fate. We monitored seven nests on Cargill managed ponds in the Dumbarton Complex and two nests on Resource Environmental Solutions owned Newark Slough Mitigation Bank (termed Hickory in this report), documenting 86% and 100% nest success, respectively.

On Midpeninsula Regional Open Space District/NASA property, we monitored 23 nests between Crittenden Marsh West and East, documenting 35% nest success.

On HARD property, EBRPD reported three Snowy Plover nests on Least Tern Island at Hayward Regional Shoreline, with a hatch rate of 100% (D. Riensche, pers. comm.). SFBBO documented 11 nests at the Oliver Brother's North ponds and 13 nests at Franks Dump West, with an apparent nest success of 36% and 15%, respectively.

On CDFW property, we documented 79 nests at Eden Landing Ecological Reserve (Eden Landing), finding that apparent nest success was 23%.

Across Recovery Unit 3, 40 nests were detected at the brood stage, including 39 in the South Bay and 1 in the North Bay.

At Montezuma Wetlands in Solano County, two nests were monitored in Cell 14N, with both determined to have hatched (C. Jasper, pers. comm.).

At Hamilton Wetlands/Bel Marin Keys, SFBBO staff and Hamilton Wetlands Volunteers confirmed the presence of two nests in former Agricultural Ponds, finding that one was depredated and the other hatched.

No nests were found at Napa-Sonoma Marshes Wildlife Area during surveys by SFBBO staff and volunteers or CDFW staff (K. Taylor, pers. comm.)

SFBBO banded 149 Snowy Plover chicks from nests that successfully hatched within Coyote Hills, Dumbarton, Eden Landing, Hayward, Mountain View, Ravenswood, and Warm Springs nesting ponds, representing 43% of all chicks known to have hatched in the South Bay. From band re-sighting surveys, we determined that at least 46 of these 149 chicks survived to fledge (fully flight capable, at least 28 days post-hatching) as of November 11 2021, resulting in an estimated apparent fledging success of 31%. For the second year in a row, we banded Snowy Plover adults, successfully trapping and banding 21 adults. Comparing adult band resighting and fledged juvenile data from 2020, we found return rates of 54% (n=35) for adults banded before 2021 and 35% (n=23) for 2020 fledges.

During avian predator surveys, we counted California Gulls (*Larus californicus*) and unidentified gulls (*Larus* spp.; likely California Gulls due to the time of year and locations) as the most numerous potential avian predators in Snowy Plover nesting areas. Northern Harriers (*Circus cyaneus*), Peregrine Falcons (*Falco peregrines*), and Common Ravens (*Corvus corax*) were among the most commonly observed predators during surveys, and were considered to have the largest impact on Snowy Plover breeding success. American Crows (*Corvus brachyrhynchos*), Red-tailed Hawks (*Buteo jamaicensis*), and White-tailed Kites (*Elanus leucurus*) were among other commonly sighted predatory species. Trail cameras placed at pond access points and strategic locations in E6A, E13, E14, and E16B documented the presence of coyotes, red foxes, and skunks hunting in these ponds. Active red fox dens were located at the E13 saltworks and the levee separating E11 and E16B. Out of concern for attracting mammalian predators, nest cameras were not deployed consistently; as such only three depredation events were documented. Common Ravens were recorded depredating two nests at E14 and one at E8.

We continued to monitor Snowy Plover use of oyster shell plots, which were spread in September 2014 in two areas of Eden Landing pond E14 (Western = 6.47ha; Eastern = 13.76ha)

as a large scale habitat enhancement project. We found at least 35 Snowy Plover nests in E14, with 28 nests found within one of the shell plots. Chi-square analyses indicated that based upon available habitat, breeding Snowy Plovers preferred to nest in shelled plots. Nest survival analyses found the daily nest survival (DSR) to be 93.8% with a 12.8% chance that a nest would survive to hatch (33 days). None of the other models tested were significantly different from the intercept only model.

2021 marked the fifth consecutive year that California Least Terns (*Sternula antillarum browni;* Least Terns) nested at pond E14, as well as the second year of a three year social attraction project conducted by SFBBO. On March 26, 2021, we led a volunteer event to remove predator perches and spread 40 wooden chick shelters, 40 terra cotta chick shelters, and 50 Least Tern decoys within the Western shell plot in a square measuring approximately 2.3 ha. On March 26, 2021, SFBBO staff set up a social attraction sound system among the shelters and decoys. Least Terns were first observed on-site on April 26, when one adult was observed flying over E14. The maximum number of adults recorded on-site was 60 on June 28. A total of 56 nests were monitored at ponds E12-14. In E14, a total of 46 nests were monitored, with five confirmed to have hatched, two presumed to have hatched, and 39 failed. An estimate of one fledgling was produced from E14. At ponds E12/13, a total of ten nests were monitored, with four confirmed to have hatched and six failed. Zero fledglings were produced from these nests. Northern Harriers, Common Ravens, Peregrine Falcons, red fox, and coyotes likely were responsible for the low breeding effort observed. For additional information on Least Tern breeding at Eden Landing in 2021, refer to *California Least Tern and Snowy Plover Recovery at Eden Landing Ecological Reserve, Hayward, CA Progress Report 2021* (Pearl et al. 2022).

During Phase 1 of the South Bay Salt Pond Restoration Project (the Project), restoration and reconfiguration of ponds that formerly supported Snowy Plover breeding habitat resulted in the loss of roughly 19% of available breeding habitat for Snowy Plovers. Since completion of Phase I activities at Eden Landing in early 2015, the Recovery Unit 3 population has averaged 222±25 adults (2015-2019, 2021). E14 has supported 34.8±11.1% of all monitored nests in RU3 during that time frame, yet due to consistently high predation pressure, E14 has had lower overall hatch success (42.4±13.1%) compared to the rest of RU3 (51.0±6.6%). Although we recorded the second largest breeding population size in Recovery Unit 3 in 2021 (n=263) since Breeding Window Surveys began in 2002, this is still well short of the Recovery Unit Goal of 500 adults. Furthermore, with 133 Snowy Plovers observed on Project lands during the window survey, 2021 marked the lowest amount of Snowy Plovers found on Projects lands since 2005, when 132 adults were observed. In order to encourage population growth to meet Project and Recovery Unit 3 goals of 250 and 500 adults, respectively, it is necessary to provide multiple enhanced breeding ponds, both locally and throughout RU3, in conjunction with targeted predator control efforts to reduce predation pressure in any one pond.

Phase 2 restoration on Refuge lands includes planned restoration activities at the Ravenswood Complex (R3, R4, R5/S5), Alviso Complex (A8 Ponds: A8, Mountain View Ponds: A1, A2W and the Island Ponds: A19, A20). Pond R3 will be enhanced for Snowy Plovers by adding water

management capabilities with the addition of a new water control structure. However, overall Phase 2 actions at the Refuge will still result in an additional 8% loss of remaining available breeding habitat due to the breaching of R4. It will be critical to enhance remaining Snowy Plover breeding habitat at R3, R1-2, and RSF2 to account for the higher density of breeding that will likely occur in these areas. Reduced habitat availability could result in increased predation pressure at the Ravenswood Complex, especially by American Crows and Common Ravens, both of which are major nest and chick predators and have been frequently observed in the Complex in recent years. Increased development adjacent to these restoration sites artificially inflates human commensal predator populations such as skunks, feral cats and Common Ravens by supplementing food and complicating predator management opportunities in locations with high visitor use. Without enhancement and informed predator control efforts, population growth at one of the most important breeding sites in Recovery Unit 3 could be impeded.

Currently, most breeding plovers in RU3 are found in the South Bay, and a large proportion of those plovers breed on Project lands. We recommend that the Project plan Phase 2 construction activities to avoid negatively impacting breeding Snowy Plovers, as was done in Phase 1. This includes providing alternative breeding habitats when construction activities impact or eliminate Snowy Plover nesting ponds and scheduling construction activities before or after Snowy Plover breeding season.

The recovery of the RU3 plover population depends on the continued availability of suitable habitats, which are currently owned and managed by multiple landowners. Providing quality habitat at spatially diverse locations throughout RU3 is a critical strategy to prevent population decline caused by overconcentration of breeding in any one area. Our research over the past seven years at E14 highlights that "placing all the eggs in one basket" is not an effective long-term strategy for meeting recovery goals. Adaptive management strategies on Project areas to balance tidal restoration with Snowy Plover needs could serve as a positive example for other landowners. Management actions currently undertaken along these lines by the Project should be continued in future seasons, including management of multiple ponds with a mixture of exposed pond and shallow water depth during the winter and the implementation of large scale shell, gravel, and/or cobble enhancement to attract Snowy Plovers to appropriate nesting ponds.

Thus we recommend that USFWS Snowy Plover Recovery leads at the San Francisco Bay National Wildlife Refuge Complex and Bay Delta Fish and Wildlife Office and landowners continue to identify suitable habitat in all areas of RU3 that can be enhanced or managed for breeding Snowy Plovers and maintain existing Snowy Plover habitat when feasible as outlined in the Recovery Plan (USFWS 2007). In addition, we recommend that all managers communicate and coordinate tidal marsh restoration activities to ensure that adequate Snowy Plover breeding habitat will remain to support recovery throughout RU3.

**INTRODUCTION AND BACKGROUND**

The Pacific Coast population of the Western Snowy Plover (*Charadrius nivosus nivosus*; Snowy Plover) breeds along or near tidal waters and is behaviorally distinct from the interior population (Funk 2006). Coastal-breeding Snowy Plovers have declined as a result of poor reproductive success, likely due to habitat loss, habitat alteration, human disturbance, and increasing predation pressure (Page et al. 1991, USFWS 2007). In response to this decline, the U.S. Fish and Wildlife Service (USFWS) listed the Pacific Coast Western Snowy Plover population as federally threatened in 1993 (USFWS 1993). They are listed as a species of special concern in California (CDFW 1998). The most recent 5-year review (USFWS 2019), which reviewed all available data in all six recovery units, determined that the population remains threatened due to the same threats described above.

Western Snowy Plover Recovery Unit 3 consists of the San Francisco Bay and includes Alameda, Contra Costa, Napa, Santa Clara, and Solano counties, and the eastern portions of Marin, San Mateo, and Sonoma Counties (USFWS 2007). Snowy Plovers in this Recovery Unit nest almost exclusively in dry salt panne habitat provided by former salt evaporation ponds, as well as on pond berms, levees, and dry salt panne in diked marshes. In 1992, the Don Edwards San Francisco Bay National Wildlife Refuge (Refuge) began surveying for Snowy Plovers.

From 2003-2021, SFBBO conducted annual Snowy Plover monitoring and research within the South San Francisco Bay in support of the goals set forth by the RU3. Specifically, we: 1) identified areas used by Snowy Plovers through regular surveys of all potential nesting habitat from March through September, 2) participated in U.S. Fish and Wildlife Service-coordinated Range-wide breeding and winter window counts to estimate Recovery Unit 3 numbers, 3) recorded nest fates, nest densities, and chick fledging rates through nest-monitoring and chick-banding, 4) surveyed for potential avian predators , and 5) identified areas of potential disturbances from predators, trespass, construction activities and other human activities.

When the South Bay Salt Pond Restoration Project (the Project) began active restoration in 2006, project lands supported approximately 62 Snowy Plover breeding pairs. Despite the loss of Snowy Plover breeding habitat (dry panne) expected overall through the Project's actions, the Project set a management target of maintaining 125 breeding pairs of Snowy Plovers within its footprint (USFWS and CDFW 2007). To aid in achieving this goal, SFBBO and the Project initiated a large-scale oyster shell habitat enhancement project, informed by the success of previous pilot studies from 2008-2013, on Eden Landing pond E14. Enhancements were made in September and October 2014, and 2021 marked the seventh year of monitoring the enhancement project.

Plover recovery in RU3 continues to be stymied by predation and the lack of available habitat. As landowners, including those involved with the Project, accelerate tidal marsh restoration in the South Bay, it becomes more critical to identify and manage remaining Snowy Plover ponds and habitats throughout RU3. More baylands will become open for public and recreational use, and some of these areas are adjacent to sensitive Snowy Plover breeding and wintering sites. To encourage public support and awareness of Snowy Plovers as well as to discourage

trespassing and disturbance, SFBBO has been stationing trained volunteer docents at key breeding sites monthly since 2016 to help the public learn about and view Snowy Plovers during the breeding season.

In this report, we summarize results from the 2021 breeding season; this includes Snowy Plover nest distribution and habitat use, RU3 Breeding Window Survey results, nest (hatching) success, fledging success, use and effect of oyster shell plots, and avian predator abundance and distribution. Although we report Snowy Plover numbers in other areas of RU3, this report focuses on our research in the South San Francisco Bay, from just north of the San Mateo Bridge to the southern terminus of the Bay.

## METHODS

### Study Area

From March 1 to September 17, 2021, SFBBO staff and volunteers conducted Snowy Plover and avian predator surveys at all known Snowy Plover breeding sites throughout the South Bay and nearby Hayward Shoreline (Figure 1, Table 2). In the North Bay, SFBBO staff and volunteers surveyed and contributed information for Napa-Sonoma Marsh Wildlife Area (Figure 2, Table 3). SFBBO staff conducted two surveys and nest monitoring at the Hamilton Wetlands and Bel Marin Keys Restoration Site.

The Refuge includes approximately 30,000 acres of former salt ponds, tidal marsh, mudflats, and uplands in the South Bay (Figure 1). Many of the ponds used by Snowy Plovers are currently managed as seasonal ponds, or are dried down for the purpose of creating nesting habitat. For this study, we divided the Refuge into seven geographic complexes: Alviso (Figure 4), Mountain View (Figure 4), Ravenswood (Figure 5), Coyote Hills (Figure 7), Dumbarton (Figure 12), Warm Springs (Figure 11), and Mowry (Figure 12). The Mountain View section includes Alviso ponds A2E and A3N as well as Crittenden Marsh, which is co-owned by Midpeninsula Regional Open Space District (MROSD) and the National Aeronautics and Space Administration, Ames Research Center (NASA-ARC).

CDFW owns and manages Eden Landing (formerly known as Baumberg), which includes approximately 6,400 acres of former salt ponds, marsh, and tidal habitat (Figure 7). In the North Bay, CDFW also owns and manages the Napa-Sonoma Marshes Wildlife Area (NSMWA), including ponds 7 and 7A, the Wingo Unit, and the Green Island Unit/Napa Plant Site (Figure 2).

HARD and EBRPD co-own Hayward Regional Shoreline (Hayward Shoreline), which includes 1,841 acres of former salt production ponds and tidal marsh located directly north of Highway 92 on the east side of the San Francisco Bay (Figures 1, 6). Hayward Shoreline is managed by EBRPD, and includes Snowy Plover foraging and nesting habitat in the Oliver Brothers North ponds (OBN ponds), Frank's Dump West (FDW), and an island constructed for California Least

Terns (Least Tern Island) within treatment ponds that are also used by nesting Snowy Plovers. This island and treatment ponds were monitored by EBRPD.

In the North Bay, the Hamilton Wetlands and Bel Marin Keys Restoration site is located in Novato at the former Hamilton Army Airfield and former agricultural lands, and is owned by the Department of Defense and State Coastal Conservancy (Figure 2). Prior to being opened to tidal action, Snowy Plover breeding activity was observed in the tidal basin. Despite the loss of this area, the site provides potentially suitable Snowy Plover nesting and foraging habitat in the North Seasonal Wetlands, South Seasonal Wetlands, former agricultural ponds, and Bel Marin Keys Seasonal Wetlands (Figure 9).

Snowy Plovers were first observed breeding at Montezuma Wetlands (Figures 3, 8) by Napa-Solano Audubon Society members conducting surveys for the Solano County Breeding Bird Atlas in 2006. This is a privately owned dredge placement site within the Montezuma Wetlands Restoration Project footprint. This year, Snowy Plover weekly surveys and breeding and winter window surveys were performed here by Vollmar Consulting. Both adult numbers for the survey windows and nest fates are included in this report.

Cargill Inc. owns two large tracts of land used for salt production in Redwood City and Newark (Figure 13). Both locations contain potentially suitable Snowy Plover breeding habitat, depending upon pond management and resulting water levels. Although targeted Snowy Plover surveys are not performed at either location, any opportunistic sightings of Snowy Plover adults and broods by Cargill staff are relayed to USFWS and reported here.

**Snowy Plover Surveys**

To document areas used by Snowy Plovers and to estimate the number of Snowy Plovers in the South Bay, we identified ponds with potential nesting habitat and surveyed those ponds weekly from March 1 to September 17. We surveyed other ponds with less suitable (i.e., ponds without dry salt panne) habitat monthly.

SFBBO biologists and volunteers surveyed potential Snowy Plover breeding ponds by driving slowly on the levees or walking levees without vehicle access. We stopped approximately every 0.3 miles to scan for Snowy Plovers with spotting scopes. During each survey, we recorded the number and behavior of all Snowy Plovers present, identified the sex and age class of each individual using plumage characteristics (Page et al. 1991), and marked the approximate location of sightings on a geo-referenced paper map. We also recorded the color-band status and combination, if applicable, of any banded Snowy Plovers. Any observed instances of interspecies aggression between Snowy Plovers and other nesting shorebirds and/or seabirds were recorded.

Volunteers surveyed some Eden Landing ponds monthly (Table 2).

From May 16-22, we participated in the Pacific Coast Snowy Plover breeding window survey. This survey was coordinated by the USFWS as part of an annual, regional effort to census all coastal-breeding Snowy Plovers during the same time period. In Recovery Unit 3, the survey covered all potential breeding habitats at known sites, including Crittenden Marsh, Patterson Pond, Eden Landing, Hayward Regional Shoreline, Napa-Sonoma Marshes Wildlife Area, Hamilton Wetlands, and Montezuma Wetlands. Surveyors at all sites used the same methods for sighting and counting Snowy Plovers as described above.

*Snowy Plover Docent Surveys*

SFBBO Snowy Plover docent volunteers were stationed on public trails at Eden Landing ponds E12-E14 in March, June, July, and August during a 3-day window on the last weekend of the month. During each survey, docents looked for Snowy Plovers using a combination of spotting scopes and binoculars. Docents were equipped with a handout that provided general information about Snowy Plovers, including pictures, physical description, range, conservation status, reasons for decline, and ways to get involved with Snowy Plover conservation. During encounters with the public, docents recorded the type (pedestrian, bicyclist, other) and size of the group, the nature of the contact (positive, negative, neutral), what information was shared (ecology, salt making history, conservation, etc.), and any other relevant information (Table 4).

**Snowy Plover Nest Monitoring**

We located Snowy Plover nests by scanning for incubating females during weekly surveys. We then searched for nests on foot and recorded nest locations with a hand-held tablet (Apple® iPad) or smartphone (Apple® iPhone) equipped with a nest monitoring application (Narwhal Systems).

We monitored nests weekly until we determined the fate of the nest. On each survey, we recorded whether the nest was still active (adults incubating) and if visited up close, the number of eggs or chicks in the nest. During the first visit, we floated the eggs (Hays and LeCroy 1971) to estimate egg age if incubation had been observed (typically 3 egg clutch throughout most of season, sometimes 1-2 eggs later in season). Snowy Plover nests are active for an average of 33 days, from initiation (the date the first egg was laid) to hatching (Warriner et al. 1986), and using the known egg age, we calculated the nest initiation date and predicted hatch date for all nests monitored. When there were no longer eggs in the nest, we assigned each nest a fate based on evidence seen at the nest (Mabee 1997). Nest fates included: hatched, depredated, flooded, abandoned, failed to hatch, unknown, or other. In addition, at Eden Landing pond E14, we recorded whether the nest was located in an oyster shell enhancement or non-shelled plot (see *Oyster Shell Habitat Enhancements* methods below.)

We defined a nest as successful if it hatched at least one egg. We calculated apparent nest success as the percentage of nests that successfully hatched at least one egg out of the total nests monitored.

## Snowy Plover Color Banding

### *Chick Banding*

Since 2008, SFBBO and Refuge biologists have banded Snowy Plover chicks to study their movements and to estimate fledging success rates in the South Bay. To band chicks, biologists checked nests daily, starting four days before the estimated hatch date. Due to the precocial nature of chicks, arrival at nests was timed to allow complete hatching of chicks prior to their movement away from the nest; this is typically a several hour window. We banded each chick with a unique four-color combination by placing two bands on each leg below the tibiotarsal joint. Each combination consisted of three darvic (XCLA Darvic Leg Bands I/D 3.1mm n.d.) or acetal (XCLA Acetal Leg Bands I/D 3.1mm n.d.) color bands and one silver U.S. Geological Survey band. All bands were then wrapped in colored auto pin-striping tape. Both darvic and acetal color bands were used depending on availability.

### *Fledge Rate*

We defined a fledged chick as one that survived to 28 days of age, at which point it is considered to be capable of flight (Warriner et al. 1986). We calculated apparent fledging success as the percentage of fledged, banded chicks out of the total chicks banded. Since re-sighting banded chicks on salt panne habitat is extremely difficult, this method of estimating fledging success has significant limitations and is a conservative estimate.

Chicks fledged per male was determined using the same data for broods in which all chicks were banded, allowing for an estimate of the number of chicks fledged per male.

### *Adult Banding*

In an effort to increase the number of color banded adults at Eden Landing, we resumed banding adults on a limited basis in 2021. After placing the noose mats, biologists hid nearby and waited for the adult to attempt to return to the nest. If adults were trapped within five minutes, biologists would quickly band and process the adult, then release and confirm they came back to the nest. If they were not trapped within five minutes, biologists would remove the noose mats and cease attempts to trap the adult.

### *Return Rates*

In an effort to track survival of color banded adults, we compared our band resighting data from 2020 and 2021 to calculate the proportion of 2020 fledges that were observed in 2021, and the proportion of banded adults observed in 2020 that were observed in 2021.

## Oyster Shell Habitat

### *E14 Large Scale Enhancement*

Our oyster shell pilot study (2008-2013) provided evidence that Snowy Plovers preferentially selected shelled areas for nest locations (Robinson-Nilsen et al. 2013). Based upon these findings, we carried out a large scale habitat enhancement project in September 2014 at Eden

Landing pond E14 by treating 20.23 hectares with oyster shells at the previously tested density. Two distinct plots were created within the pond – a western plot totaling 6.47 hectares (referred to as Western, 9.47 hectares when contiguous three pilot shelled one hectare plots included) and an eastern plot totaling 13.76 hectares (referred to as Eastern). The remaining untreated areas without shells are termed Control in this report.

**Predator Surveys**

To identify avian predators in the area that might affect Snowy Plovers, SFBBO biologists and interns conducted predator surveys concurrently when surveying ponds for Snowy Plovers (Tables 2-3). Volunteers conducted avian predator surveys at ponds surveyed monthly for Snowy Plovers. Observers chose survey points that provided a comprehensive scan of all required ponds for predators. At each survey point, the location, start time, and stop time were recorded. Observers recorded the number, species, behavior, and habitat type at the time of sighting of any predators present. The approximate locations of the predators were marked on a map. In addition, observers documented any predator nests in the area and their fates when possible. We calculated the average number of predators observed per survey at each pond during the season. While most predators likely have a larger territory than a single pond (Strong et al. 2004), we felt it meaningful to present indices of predator abundance at the pond scale since both predator and Snowy Plover surveys were conducted at this level.

We defined avian predators as any species that could potentially prey on a Snowy Plover egg, chick, or adult. This includes most raptors, gulls, corvids, herons, and egrets (Table 5) found within Snowy Plover breeding habitat in Recovery Unit 3. While a number of potential mammalian predators (Table 6) and their signs (e.g., tracks) were noted, these surveys were not designed to detect mammals, particularly since many are nocturnal. Among all predators, we considered corvids, raptors, gulls, and mammals (especially coyote, red fox and striped skunk), to be the most critical potential predators of Snowy Plover adults, eggs, and chicks due to previous predation captured on camera and consistent with previous documentation of predation.

Due to past concerns over predators identifying nest cameras, especially mammals, SFBBO was cautious in deploying Snowy Plover nest cameras in 2021. Coyotes and red foxes appeared to be present at Eden Landing for much of the season; therefore only two Snowy Plover nests at E14 had a camera on them. The camera on this nest was placed directly on the ground between 2-3 meters from the nest; this method was used after testing other further but unsuccessful placements in the past. Cameras were housed in a camouflage case and made even less conspicuous by using oyster shells, wood and other debris from the surrounding area. Three rapid-fire still images were taken whenever motion was detected, in color by day and monochrome infrared by night. Cameras were checked and serviced each time we visited a nest, typically once per week.

In order to provide an index of mammalian predator activity at ponds E12-14, trail cameras were placed on the narrow E12/13 levee, at pond E14 access points, and at random locations throughout the pond to opportunistically capture evidence of mammals in these areas.

**Habitat Availability**

Habitats within the South San Francisco Bay ponds change based on precipitation, management, and other factors. In order to better measure the available potential nesting habitat over the course of the season, we conducted weekly habitat availability surveys during the 2021 breeding season.

Maps for each pond were overlaid with a grid composed of 50m x 50m squares. During each survey, the approximate location of available habitat within each pond was marked on the corresponding map. Available habitat included dry pond bottom, dry levees, and sparse vegetation cover; unavailable habitat included standing water, saturated pond bottom or mud, and full vegetation cover. Each square was considered available or unavailable for breeding based on which type constituted >50% of its space. Habitat availability surveys were conducted on the same day as each breeding survey in order to maintain comparability with nesting behavior. Though the habitat availability maps are an estimate with some measure of error, they provide a much more accurate measure of potentially available nesting habitat over time compared to previous methods used from 2003-2014.

**Analytical Methods at the E14 Large Scale Enhancement**

Due to small sample sizes and analytical complications, we chose to lump all observations in all western shelled treatment plots (three old 1ha plots and New 6.47ha plot) and termed this area Western (Figure 14). The 13.76ha eastern shell treatment plot is termed Eastern, and all remaining untreated areas are termed Control.

*Nest Densities*

Nest densities were calculated for each pond by dividing the number of nests found within each area by the available habitat in hectares.

*Nest Site Selection*

In order to test for significance of nest site selection by treatment type, we calculated the proportion of all nests in each treatment area (Western, Eastern, Control; Figure 14). We then calculated the proportion of available habitat in each treatment type. We used a chi-square analysis to compare the percent area available and percent nest use of each treatment area (Schwarz 2015).

*Nest Survival*

We conducted a nest survival analysis for all nests in E14 during the 2021 breeding season in program R (version 3.5.3, 64 Bit; R Studio 1.1) using Package RMark (Laake & Rexstad 2008). We built encounter histories with information including date nest found, last date nest known to be

present, last date nest checked, and fate date. Each encounter history also included year, treatment type (Western, Eastern, and Control), distance to nearest levee (m), and number of Least Tern nest neighbors as additional covariates in order to determine their effect on nest survival rates.

## RESULTS

### Snowy Plover Surveys

*Recovery Unit 3*
During the 2021 Pacific Coast breeding season window survey (May 16-22), a total of 263 adult Snowy Plovers were counted in the South Bay, North Bay, and Delta (Table 1, Figure 15).

*Overall*
With the exception of the week of May 17, we consistently observed the greatest numbers of Snowy Plovers at Eden Landing (Figure 16). We documented Snowy Plover nesting activity at 31 South Bay ponds, one North Bay pond, and one Delta pond (Figure 18, Table 7).

*Alviso*
We observed a mean of 24.3±23.3 Snowy Plovers per week in the Ravenswood complex (Figure 17).

*Ravenswood*
We observed a mean of 40.7±14.0 Snowy Plovers per week in the Ravenswood complex (Figure 17).

*Mountain View*
We observed a mean of 16.9±10.5 Snowy Plovers per week at Crittenden Marsh West (CMW) and East (CME) (Figure 17).

*Eden Landing*
We observed a mean of 122.7±59.0 birds per week at Eden Landing (Figure 16). Pond E14 supported the largest amount of Snowy Plovers overall and during the first half of the breeding season (March 1-June 13), while ponds E6B and E8 supported the largest amount of Snowy Plovers during the latter half of the breeding season (June 14-September 15).

*Hayward*
We observed a mean of 36.5±34.5 Snowy Plovers per week at FDW and OBN ponds (Figure 17).

*Early and Late Season Trends*
In March, we observed large flocks at E16B and E14, averaging 35.4±32.1 and 116.4.3±45.8 Snowy Plovers per week during this period, respectively. From August 1 - September 15, we observed large flocks at numerous ponds, including A15 (32±45.5), A23 (40.4±23.6), FDW

(52.3±49.7), E6A (36.9±50.9), E6B (54.9±51.8), and E8 (73.7±53.3) (Figure 20). In both cases, many of these birds may have been staging (for migration), arriving for the breeding season (in March), or early arriving wintering birds (in August and September).

*Interspecies and Intraspecies Aggression*

In recent breeding seasons, high density breeding resulted in numerous incidences of interspecies (Pearl & Chen 2018) and intraspecies aggression (Pearl et al 2016). In some instances, this was due to lack of available breeding habitat during the early months of the breeding season. Due to drought conditions, there was an abundance of suitable nesting habitat available throughout the South Bay (Figure 28), and as a result zero incidences of interspecies or intraspecies aggression were observed during the 2021 breeding season.

*Snowy Plover Docent Surveys*

SFBBO volunteers conducted five surveys at ponds E12-14 (Table 4). A total of five contacts were made during these contacts with a total of eleven people. Docents shared information on Least Tern and Snowy Plover ecology and conservation status, salt pond history and site information, South Bay Salt Pond Restoration Project information, and general information about the San Francisco Bay Bird Observatory.

*Deceased Snowy Plover collected at Hayward Shoreline*

On the morning of May 14, we went to check on the status of a nest in process of hatching at pond OBN1. Upon scanning the area near the nest with a scope, we found that there was a deceased male Snowy Plover located approximately 3m away from the nest. The specimen was collected, properly bagged and placed in a freezer at SFBBO's office until it was transferred in October to the California Department of Fish and Wildlife's Marine Wildlife Veterinary Care and Research Center in Santa Cruz for necropsy. The necropsy found dermal abrasion, hemorrhage and bruising of the lower left and right abdomen, diffuse vascular congestion, and acute subcutaneous and fascial hemorrhage and bruising of the neck, skull, and behind the eyes. The presumptive cause of death is acute trauma of an unknown cause.

**2021 Snowy Plover Nest Abundance and Success**

*South Bay Overall*

SFBBO determined the fates of 211 Snowy Plover nests and EBRPD determined the fates of three nests. Of these, 95 nests hatched (45.0%, 102 nests were depredated (48.3%), six were abandoned (2.8%), two were flooded (0.9%), one nest failed to hatch (0.5%), and the fates of five nests were unknown (2.4%; Table 7, Figure 21). Across all surveyed areas, we documented 40 broods from undetected nests, indicating that despite our best efforts, some breeding went undetected (Table 7). We documented the greatest amount of breeding activity at Eden Landing, followed by Ravenswood, Alviso/Mountain View, Coyote Hills/Dumbarton, and Hayward (Figure 22).

*North Bay/Delta Overall*

SFBBO determined the fates of two Snowy Plover nests at Hamilton Wetlands and Bel Marin Keys Restoration Site and Vollmar Consulting determined the fates of two nests at Montezuma Wetlands. Of these, three nests hatched (apparent nest success = 75%), and one nest was depredated (25%; Table 7, Figure 19). At Montezuma Wetlands, Vollmar Consulting documented one brood from an undetected nest (Table 8).

*Refuge*

SFBBO determined the fate of 60 Snowy Plover nests on Refuge lands (Table 7).

At the Ravenswood Complex (R1, R3, R4, and RSF2), 27 nests hatched (71%), six were depredated (15%), two were abandoned (5%), one was flooded out (3%), one failed to hatch (3%), and one was abandoned (3%). An additional four nests each in R1 and R4 were found as broods in these ponds (Table 7). The Ravenswood Complex contained 18% of all nests found in the South Bay (Figure 22), and we found the most nests in the Ravenswood Complex on pond R4 (20 monitored; Figure 24).

In the Alviso Complex (A15), nine nests hatched (75%), two nests were depredated (17%), the fate of one nest was unknown (8%), and an additional four nests were detected as broods (Table 7-8).

At the Warm Springs Unit, two nests hatched and one nest was depredated, and an additional seven nests were detected as broods (Table 7-8).

*Coyote Hills*

At Patterson Pond within the Coyote Hills Complex, we determined the fates of 19 nests, finding 14 hatched (74%), three were depredated (16%), one was abandoned (5%), and the fate of one nest was unknown (5%; Table 7).

*Mountain View*

Within ponds CME and CMW, we determined the fates of 23 nests, finding that eight hatched (35%), fourteen were depredated (61%), and one nest was abandoned (4%) (Table 7).

*Eden Landing*

We determined the fates of 79 Snowy Plover nests at Eden Landing, comprising 38% of all nests found in the South Bay (Figure 22). Of these, 18 hatched (23%), 57 were depredated (72%), one was flooded (1%), and two were abandoned (3%; Table 7). An additional 14 nests were detected as broods across Eden Landing (Table 7). E14 supported the most nests (35 nests), followed by E6B (19 nests), E16B (7 nests) and E8, E13, and E4C (4 nests; Table 7). E14 alone comprised 45% of the nests found in Eden Landing (Figure 23) and 17% of the nests found in the entire South Bay in 2021 (Table 7).

*Hayward*
EBRPD reported three Snowy Plover nests on the California Least Tern Island at HARD, all of which hatched (D. Riensche, pers. comm.; Table 7). SFBBO monitored 11 nests this season at the Oliver Brothers North Salt ponds, of which 4 hatched (36%) and 7 were depredated (64%; Table 7). We monitored 13 nests at Franks Dump West, of which two hatched (15%) and 11 were depredated (85%).

*Napa-Sonoma Marshes Wildlife Area*
No Snowy Plover adults were observed during the breeding window survey. SFBBO volunteers conducted monthly surveys at ponds 7/7A from March-May, observing a total of three Snowy Plovers, while SFBBO staff conducted a total of 15 surveys from March-June at the Wingo Unit, observing zero Snowy Plovers during this time. CDFW conducted broad monthly surveys at 7/7A and the Green Island Unit, observing zero Snowy Plovers (K. Taylor, pers. comm.).

*Montezuma Wetlands*
Two Snowy Plover nests were monitored at Montezuma Wetlands, both of which hatched. An additional nest was detected as a brood. The 2021 breeding season marked the first year in which targeted Snowy Plover surveys were conducted at this site, increasing the confidence in overall breeding effort reported at this site. However, given the presence of 8-9 adults on site while the three nests were active, as well as the large size of the site, it is possible that additional nesting activity occurred and went undetected (C. Jasper, per. comm.).

*Hamilton Wetlands and Bel Marin Keys Restoration Area*
SFBBO determined the fates of two Snowy Plover nests in the Hamilton Wetlands and Bel Marin Keys Restoration Site, finding one nest hatched (50%) and one nest depredated (50%; Table 7). These nests were located within former agricultural ponds that had not been previously surveyed until an SFBBO staff site visit on April 30. Since the entire site is not surveyed frequently by trained Snowy Plover biologists, it's possible that additional nesting attempts went undetected.

*Dumbarton and Cargill Salt Evaporation Ponds*
At the Dumbarton production ponds, we determined the fates of six nests at N1 and one nest at NPP1, finding that all six monitored nests on N1 successfully hatched and the one nest at NPP1 to have been depredated (Table 7). An additional three nests were detected as broods on N1 (Table 8).

Adjacent to NPP1 at Hickory (Figure 12), we determined the fates of two nests, finding both nests hatched (100%; Table 7).

At Cargill's Newark Plant Site, one nest was reported with an unknown fate. Due to the size of the Newark Plant Site and lack of targeted surveys, it is possible that additional Snowy plover breeding occurred there in 2021. No Snowy Plover breeding activity was reported at the Redwood City Plant Site.

*Breeding Chronology and Density*

Over the course of the season, average apparent nest density in the South Bay (across all ponds with dry panne) was 0.06 nests per hectare (Table 31). The highest apparent nest density was observed at Franks Dump West (0.37 nests per hectare), followed by CMW (0.11 nests per hectare), and CME (0.10 nests per hectare; Table 31). Although E12 had a higher mean nest density than CMW and CME (0.12 nests per hectare), only one nest was monitored throughout the season. Density in this pond was artificially inflated by the small amount of habitat available between islands, dry panne, levees, and berms, and is thus not biologically significant.

We observed an extended period of moderate nest initiation throughout the breeding season. Between the weeks of March 28 and July 4, a mean of a mean of 13.5±3.2 nests were initiated per week. The peak of nest initiation occurred between the weeks of May 2 and May 30, when a mean 17.2±1.8 nests were initiated per week.

For the fifth year in a row, we observed one extended period of active nests across the season rather than two distinct periods. Between the weeks of May 2 and July 4, a mean of 67.8±5.5 nests were active, with a high of 76 nests active during the week of May 30 (Figure 28).

**Snowy Plover Color Banding**

*Chick Fledging Success*

As part of our efforts to document breeding success within the San Francisco Bay, we banded 149 Snowy Plover chicks in 2021 in the field. At least 46 chicks survived to fledge (31%, Table 9-10) from 56 separately banded broods, resulting in a chicks fledged per male rate of 0.82 (Table 10). Considerable effort was put into finding fledglings during band resighting surveys, yet due to the difficulties in finding and reading banded Snowy Plovers in San Francisco Bay, it is possible that additional chicks fledged as well.

In addition SFBBO released six banded juveniles that had been raised in captivity. On July 7, we brought three eggs from an abandoned nest at R4 whose eggs were still alive and in process of hatching to International Bird Rescue (IBR) in Fairfield, who hatched and raised the chicks. When these chicks were ready for release on August 20, there were only a few adult Snowy Plovers remaining in the Ravenswood Complex, therefore we chose to release the chicks at E8 near a large post-breeding flock. On August 23rd, we brought in an additional three chicks to be raised at IBR from E6B that had been abandoned after trapping and color banding the attending male. These chicks were released at E8 on September 30.

*Adult Banding*

We made a concerted effort to band Snowy Plover adults in 2021 to increase our ability to track individuals. We banded a total of 21 adults, including fourteen males and seven females (Table 11).

*Return Rates*

We observed a total of eight out of 23 banded 2020 fledges, resulting in an apparent return rate of 35% (Table 13). Of 35 previously banded adults observed in 2020, 19 were observed in 2021, resulting in a return rate of 54% (Table 13).

**Eggs and Chicks Raised in Rehabilitation**

*Ravenswood*

On July 7, three eggs at pond R4 that were in the process of hatching were collected by SFBBO after it was determined that they had been abandoned. These eggs were first found to be in process of hatching on June 29, when small cracks and tapping were observed in at least one egg. No adult was observed at that time, leading us to suspect that at minimum the female may have abandoned the nest. The nest was visited again on July 2 just after sunrise to check the status of the hatching eggs, at which point it was found that the eggs were cold and not being incubated by either adult. Due to a young brood nearby that was being disturbed, the eggs were not collected at this point. On July 7 the nest was visited again, with no adults observed incubating or nearby. However, when the eggs were examined it was discovered that the chicks were still alive and attempting to hatch. The eggs were collected and brought to the Ohlone Wildlife Rehabilitation Center in Newark to be kept warm overnight, then were transferred by SFBBO to International Bird Rescue (IBR) in Vallejo the following morning. On August 20, SFBBO staff returned to IBR to color band the fully developed juveniles, then drove them down to Eden Landing to be released into a large post-breeding flock of Snowy Plovers at E8.

*Eden Landing*

On August 23, SFBBO biologists trapped and color banded a 1-2 day old three chick brood and attending male. After banding and releasing the male, he was observed within 100m of the trap site, but had not returned to the chicks for 1.5 hours after staff had left the area. The male eventually flew off with a flock of sandpipers, and the decision was made to recapture the chicks and bring them to IBR to be raised. The fully grown juveniles were driven to Eden Landing and released at E8.

**Oyster Shell Habitat Enhancements**

During the seventh season following large scale enhancement at pond E14, we located and monitored a total of 35 nests in pond E14; 10 nests in Western (which includes the three 1-ha pilot plots), 18 nests in Eastern, and 7 nests in the non-shelled areas of the pond (Control) (Figure 14, Table 29).

Examining the treatments individually, apparent nest success declined in all areas: Western was 20% (42% in 2020), Eastern was 33% (41% in 2020), and Control was 14% (40% in 2020) (Table 29). Depredation was the most significant cause of nest failure in all areas of E14 (Western=70%, Eastern=66%, and Control=86%). Only one nest was determined to be abandoned in E14, located in the Western plot.

*Nest Site Selection*

Our chi-squared analysis showed that plovers continued to prefer nesting in oyster shell plots ($p=1.05e^{-05}$) (Table 30). While Western and Eastern shell plots accounted for 41% of available nesting area in E14 during 2021, these areas accounted for 80% (n=35) of all nests found in E14 during that time.

*Nest Survival*

Nest survival models using RMark in program R determined that the constant daily survival rate (DSR) in E14 in 2021 was 93.8%, with a 12.8% probability that a nest would survive for 33 days to hatch (Table 32). None of the other models significantly differed from the intercept-only model.

**Avian Predators**

*Ravenswood*

California Gulls were the most abundant avian predators at Ravenswood (Table 15). Excluding gulls, Common Ravens, American Crows, Snowy Egrets, and Great Egrets were the most abundant predators observed. We frequently observed Common Ravens walking on ponds R3 and R4 and flying over the ponds (Table 15). Peregrine Falcons were the most frequently sighted raptor at Ravenswood, as they nested in a power tower near R4.

*Alviso*

Unidentified gulls, California Gulls, and Western Gulls were the most numerous predators observed at Alviso (Table 16). Excluding gulls, Common Ravens were the most frequently observed predators in the complex. They were frequently observed walking on ponds A15 and A16. Peregrine Falcons were the most frequently observed raptor in the complex, and were most frequently observed perched on posts in A15.

*Warm Springs*

Unidentified gulls and California Gulls were the most numerous predators observed at Warm Springs (Table 17). American Crows and Common Ravens were the next most frequently observed predators, with most found in A22. On April 16, one active Common Raven nest was removed from PG&E towers in A22. Red-tailed Hawks were the most frequently observed raptor in the unit, where they were often observed perched on power towers and poles.

*Dumbarton*

California Gulls and unidentified gulls were the most numerous predators observed at the Dumbarton Complex (Table 18). American Crows were the next most frequently observed predators, with most found foraging in Hickory. Very few predators were observed in N1 and NPP1. Red-tailed Hawks were the most frequently observed raptor at Hickory, where they were sometimes perched in power towers. White-tailed Kites were the most frequently observed raptor at N1, where they were occasionally observed hunting in adjacent tidal marsh and upland.

*Mountain View*

California Gulls were the most numerous predators at Crittenden Marsh (Table 19). Snowy Egrets and Great Egrets were the next most frequently observed predator at Crittenden Marsh. Common Ravens were frequently observed hunting in both CMW and CME, and were often perched on the fence separating the site from Moffett Airfield. Red-tailed hawks and Northern Harriers were the most frequently observed raptors, where they were occasionally observed perched on power towers and other perches.

*Eden Landing*

California Gulls and unidentified gulls were the most numerous predators at Eden Landing (Tables 20-23). Great Egrets and Snowy Egrets were the next most frequently observed predators at Eden Landing. Gulls and egrets were especially numerous at ponds E3C (Table 20), E6A (Table 22), E10 (Table 23), and E12 (Table 21), all of which provide large amounts of open water habitat that these species often hunt in. Northern Harriers and Peregrine Falcons were the most commonly observed raptors at Eden Landing. They were both observed with moderate frequency hunting in ponds E14 (Table 21), E6B, and E8 (Table 22). Common Ravens were observed with moderate frequency hunting in ponds E1C (Table 20) and E14 (Table 21).

In January of 2016, hunting blinds in adjacent ponds E14 and E9 that were within 100m from the pond and used as nesting and perching sites by raptors were demolished or wrapped in landscape cloth. This was done in an attempt to reduce predation risk for adults, chicks, and nests. During the 2021 breeding season, the landscape cloth was still intact, resulting in no observed raptor nesting or perching on these blinds. In pond E10, we suspected that Peregrine Falcons may have nested in a hunting blind based upon their being observed there consistently for a portion of the season (Table 23).

*Hayward Shoreline*

Unidentified gulls and California Gulls were the most frequently observed predators at Hayward Shoreline (Table 24), with most found foraging at FDW during the beginning and end of the breeding season when the pond had a large amount of water. Common Ravens were the next most frequently observed predator. During the middle of the season, they were observed hunting on FDW frequently, as well as flying between the OBN ponds and active Raven nest, co-located with a Double Crested Cormorant colony) located within the first electrical power tower to the west of the Highway 92 toll plaza. Peregrine Falcons were the most frequently observed raptor at Hayward Shoreline, where they were sometimes observed perched in OBN ponds on remnant salt production infrastructure.

*Coyote Hills*

California Gulls and Great Egrets were the most frequently observed predators at Patterson Pond (Table 25). Common Ravens and Northern Harriers were seen with equal frequency, with both often in transit over the pond.

*Napa-Sonoma Marshes Wildlife Area*

Common Ravens were the most frequently observed predator at the Wingo Unit, and were seen with high frequency walking on dry pond (Table 26). American Kestrels and Northern Harriers were the most frequently observed predators in the unit.

**Mammalian Predators**

SFBBO did not conduct targeted surveys for mammalian predators. However, opportunistic data collected during avian predator surveys, other visual observations, camera trap images, and tracks are reported to aid in analyses of predator threats. Feral Cats were observed on one occasion at E15B (Table 23), while red foxes were observed several times at R4 (Table 15), E12 and E13 (Table 21), and E16B (Table 23). Active red fox dens were located at the E13 saltworks and the levee separating E11 and E16B. Striped Skunks were observed once each at A22 and R4. To provide an index of mammal presence on the ponds, trail cameras were placed at pond access points and within ponds at strategic locations. At E6A, a coyote was recorded in transit near the PG&E boardwalk (Table 27). At E13, a juvenile red fox was recorded on camera in the saltworks, and later in the season a red fox ran across a nest camera on the high salinity nesting island. At E14, a skunk and red fox were both recorded accessing the pond from the southwest corner. At E16B, coyote were recorded at a pond access point on two separate occasions, while red fox and raccoon were each recorded once.

At Eden Landing, USDA-Wildlife Services removed 66 mammals at Eden Landing in 2021, including red foxes, coyotes, striped skunks, feral cats, Virginia opossums, and raccoons (E. Covington, pers. comm.).

**Human Disturbance**

Throughout the season, we observed pedestrians trespassing into restricted areas of E12-14 and other parts of Eden Landing.

At Ravenswood, pedestrians and cyclists were frequently observed trespassing into sensitive habitat on restricted levees, including at R3, R4, and the All-American Canal between R3 and R4.

At Crittenden Marsh and Patterson Pond, we observed evidence of both pedestrians and cyclists trespassing onto the pond bottom near active Snowy Plover nests.

**DISCUSSION**

**Population Size**

During the May breeding window survey, we counted 263 breeding adult Snowy Plovers, representing the second largest breeding window survey count in RU3 since surveys began in 2003 (Table 1). While we are encouraged to see the population rebound after observing a slight

decline from 2017-2019 (the 2020 survey was incomplete and thus can't be compared), it is still well short of the RU goal of 500 breeding adults. Additionally, of the observed Snowy Plovers, only 139 were found on the Projects lands, representing the smallest proportion of Snowy Plovers ever recorded on Project lands during the breeding window survey.

In the South Bay, we observed a major decline in the population size recorded at Eden Landing, with 44 adults counted in 2021 compared to 115 in 2020 (Table 1). In the four weeks prior, 102±7 adults had been observed on-site but the numbers suddenly dropped during the week of the survey. We suspect that this may have been due to high nest and chick predation rates throughout Eden Landing, which likely encouraged adults to seek alternative nesting locations. During the window survey week, we observed elevated populations at Hayward Shoreline, Dumbarton, Ravenswood, and Crittenden Marsh that corresponded to the drop at Eden Landing (Figure 16).

At Hayward Shoreline, we observed a major increase in adults counted during the window survey, increasing from 19 in 2020 to 56 in 2021, the highest count ever recorded at Hayward during the breeding window survey. While some of these adults may have been the aforementioned Eden Landing refugees, we had observed similar numbers of adults in the four weeks prior (52±17, Figure 16). Hayward Shoreline, especially FDW, was one of the most successful Snowy Plover breeding sites in RU3, thus we suspect that the successful breeding at FDW in 2020 resulted in a Hayward Shoreline breeding population increase in 2021.

At Crittenden Marsh we observed an even greater increase in population size, from eight adults counted in 2020 to 35 adults in 2021. As with Hayward Shoreline, some of the adults at Crittenden Marsh may have come from Eden Landing, but we again suspect that this area achieved population growth through successful breeding in 2020. Both instances represent the largest populations recorded at these respective sites during an RU3 breeding window survey.

We also observed a record breeding window survey population size at Dumbarton, but for different reasons. The Dumbarton complex is managed by Cargill to produce salt and usually does not provide much suitable nesting habitat (excluding adjacent Hickory), with the exception of when NPP1 occasionally partially dries out in some years. In 2021, N1 dried out a considerable amount due to a number of factors affecting Cargill's management of the pond, and as a result, we observed 16 adults at N1 during the breeding window survey.

In the North Bay, nine adults were observed at Montezuma Wetlands, while zero were observed elsewhere (Table 1). This is the largest population size observed at Montezuma during the breeding window since 2015 (when 14 birds were seen), the first year that Montezuma participated in the survey. 2021 marked the first year that this area was surveyed regularly for Snowy Plovers, which may have aided in the detection of Snowy Plovers. Although zero Snowy Plovers were observed at the Hamilton Wetlands and Bel Marin Keys Restoration site during the breeding window survey, SFBBO staff observed at least three (and potentially up to seven) Snowy Plovers on-site, including a scraping pair and active nest in former agricultural ponds in

Hamilton Wetlands, on an April 30 site visit. Although the nest was confirmed as depredated by SFBBO staff on May 7, we suspect that breeding Snowy Plovers may have still been on-site during the window survey but went undetected by volunteers conducting the survey.

At Napa-Sonoma Marshes, SFBBO volunteers detected one male Snowy Plover at pond 7/7A in late April, while zero Snowy Plovers were observed by SFBBO staff at the Wingo Unit throughout the season. These areas have both supported breeding Snowy Plovers in recent years, although recent changes in pond configuration and water management at 7/7A have resulted in minimal habitat availability, while at Wingo, drought conditions resulted in lack of foraging habitat for breeding Snowy Plovers.

**Nest Abundance, Success, and Timing**

In 2021, we monitored 211 nests in the South Bay and two nests in the North Bay, EBRPD monitored three nests in the South Bay, and Vollmar Consulting visually monitored two nests at Montezuma Wetlands. Nest totals should be viewed as an index rather than a precise total since not all successful nests were detected and unsuccessful nests were even less likely to be detected (Mayfield 1975). This is exemplified by our observation of at least 39 broods in the South Bay and one at Montezuma Wetlands that were not detected as nests.

Apparent nest success varied greatly by pond. Across the South Bay, the ponds with the highest hatch rates (minimum 10 nests) were R1 (77%; n=13), A15 (75%; n=12), Patterson Pond (74%; n=19), and R4 (65%;n=20), while the lowest hatch rates were observed at FDW (15%; n=13), E6B (21%; n=19), CME (23%, n=13), and E14 (26%; n=35). Depredation continues to be a major limiting factor in the recovery of Snowy Plovers in the South Bay and across the Pacific Coast (USFWS 2007, USFWS and CDFW 2007). In 2021, SFBBO began a collaborative predator study at Eden Landing with UC Berkeley and installed a camera array to better understand mammalian predator abundance. As part of the project, we plan to conduct targeted nesting avian predator surveys in 2022. This study will help us to better understand how both avian and mammalian predators are impacting Snowy Plover nesting success at their most important breeding site in the Bay and the impacts of current predator management strategies.

*Refuge*

The Ravenswood ponds appeared to provide some of the best nesting habitat in the South Bay in 2021, with a 71% (n=37) hatch rate observed across R1, R3-4, and SF2 (Table 7). R1 in particular provided the best habitat, with zero depredated nests. Due to drought conditions that persisted through the winter of 2021, R1 began to dry out in mid-April, much earlier than in prior years. As a result, the first three nests found at R1 this year represent the three earliest documented nest initiations in the pond (on April 26, May 3, and May 13). The pond dried out extensively during the breeding season, allowing Snowy Plovers to space out nests across the eastern side of the pond while maintaining distance from the large power towers in the pond that provide perches for raptors and corvids. In addition, the R1 pond bottom dried to a light brown color that provided good crypsis for breeding Snowy Plovers. The only negative aspect of

the pond drying out early was the gradual reduction in foraging habitat, which resulted in Snowy Plover broods frequently being observed foraging on or near the public trail. On July 15, the Refuge briefly opened up the R1 water control intake structure to provide more foraging habitat on the pond.

Both R3 and R4 were also very dry to start the season, with the majority of both ponds available for nesting at the beginning of March (Figure 28). Nesting began in R4 by April 3 and in R3 by April 10. Despite similar conditions in both ponds, R4 supported at least 24 nests compared to only four in R3. While both ponds had the same observed nest depredation rate of 25%, a greater amount of American Crows were consistently observed on R3 (Table 15), and although slightly fewer Common Ravens were observed on R3, all of those observed were hunting on the pond, while many of the observations of Common Ravens on R4 were at a Common Raven nest located near the pond on Bedwell Bayfront Park. Therefore, it is possible that increased corvid presence and proximity to buildings and disturbance in R3 resulted in Snowy Plovers favoring R4.

With the impending tidal restoration of pond R4-S5 in the Ravenswood Complex as part of Phase 2 of the Project, approximately 27% of currently available Snowy Plover breeding habitat in the Complex will be opened to tidal action. Based upon the large amount of breeding activity observed in the Ravenswood Complex in recent years, we expect that post-restoration, R3, RSF2, and R1-2 will consistently host a larger amount of Snowy Plover breeding. At R3, improving nesting habitat will be critical. Predator perches were removed by the South Bay Salt Pond Restoration Project in fall 2020, which appeared to reduce the ability of raptors to hunt in the pond. Spreading oyster shells, gravel, or other materials to increase crypsis in both nesting and foraging areas, as well as attempting to prevent predator perching on structures adjacent to R3, could also result in improved breeding success. At R3, it will be imperative that water levels are managed appropriately (once structures are installed) to prevent extensive vegetative growth and to provide quality foraging habitat throughout the season.

*Crittenden Marsh*

We monitored the largest number of nests ever documented at Crittenden Marsh since surveys began in 2014 (23, previous high of 15 in 2020). This is in large part due to high annual variation in habitat availability on both ponds. Both CMW and CME are hydrologically connected by a gap in the levee separating the two ponds, and collectively serve as a stormwater retention basin for Moffett Airfield. Neither pond has functioning water control structures, so water levels are seasonal and available breeding habitat in both ponds is dictated by winter precipitation. Drought conditions continued throughout the winter of 2020-21, resulting in a greater amount of available breeding habitat in both ponds compared to recent years (Figure 28, Pearl et al. 2015-19). Despite this, water levels restricted breeding activity during March and April to the western area of CMW on MROSD property known as Stevens Creek Shoreline Nature Study Area and edges of CME on NASA property. The first nest was initiated on April 3 in CMW and April 9 in CME. Beginning in late April, Snowy Plovers spread to

other areas as both ponds began to further dry and expose pond bottom. The receding water levels also provided a large amount of foraging habitat for both broods and adults.

While Crittenden Marsh provided good quality Snowy Plover breeding habitat in 2020, in 2021 we observed high rates of nest and chick depredation, especially at CME. One of the main issues with CME is the lack of habitat complexity and relatively small size of the pond. We observed some of the highest nest densities across the South Bay in both CMW and CME, which may increase the likelihood of predators detecting multiple nests. There are several ways that these issues can be addressed, some of which are currently in planning. MROSD's board recently voted to manage their portion of CMW to support breeding Snowy Plovers and other pond dependent species, with anticipated actions in the next five years including vegetation removal to increase the amount of available nesting habitat and spreading of oyster shells, gravel, or other materials to increase the crypsis of Snowy Plovers on the pond. After several years conducting analysis and planning, MROSD also plans to install a low berm to separate their property from the rest of CMW and install new water control structures to allow for management of water levels on their property. All of these actions will result in a greater amount of breeding and foraging habitat being consistently available to breeding Snowy Plovers at CMW. At CME, while installation of water control structures may be difficult to implement, removal of derelict hunting blinds and spreading enhancement materials could help reduce avian predators' ability to detect Snowy Plover eggs and chicks.

*Eden Landing*

For the eighth consecutive season, the majority of Snowy Plover breeding activity at Eden Landing was found at E14 (n=35, Table 7). Despite this, for the second year in a row we observed a significant decline in Snowy Plover breeding activity at E14, with 44% fewer nests found in 2021 compared to 2020 (Pearl et al. 2020). This was likely due to high egg and chick loss on the pond, as 71% of monitored nests were depredated and only 17% of banded chicks (n=23) survived to fledge. Nest initiation during the first half of the season was steady, with 21 nests initiated April 5-May 24 (Figure 28). Zero monitored nests were initiated again until June 14, and only fourteen more nests were initiated through July 12 (Figure 28). The number of adults observed on the pond steadily declined from 69 on April 5 to 9 adults on July 12 (Figure 16). Within the rest of Eden Landing, an additional 23 nests were initiated from May 25-July 20 (Figure 28), indicating that Snowy Plovers did not prefer E14 after May 24. Similarly, we observed a decline in nesting activity at ponds E12, E13, and E16B, with only five nests found in E12-13 and seven in E16B in 2021 compared to nine and nineteen nests in 2020, respectively (Pearl et al. 2021). As with E14, high nest depredation in these ponds likely caused depressed breeding activity, as 75% (n=4) of monitored E12-13 nests were depredated and 100% (n=7) of monitored E16B nests were depredated (Table 7). We suspect that Common Ravens, which nested on a nearby power tower and were confirmed as a nest predator at two E14 nests, Northern Harriers, which were the most frequently observed raptor in E14, and red foxes, which had dens located on the E11/16B levee and E13 saltworks, were the primary predators impacting breeding in these ponds.

The amount of nests monitored in ponds E6A, E6B, and E8 declined by 26% from 2020 (n=42) to 2021 (n=31), and nests in these ponds experienced very poor hatching success in 2021, with only 19% determined to have hatched (Table 7). Ponds E6B and E8 were managed at higher water levels in 2021 compared to 2020, resulting in less available breeding habitat in these ponds. This may have aided predators in detecting nests within a smaller area. Common Ravens were confirmed by camera predating one nest in E8 on May 24, and although the camera malfunctioned, we suspect that they were also responsible for a depredated nest in E6B on June 7. Northern Harriers were the most frequently observed raptor in E8 and second most frequently observed raptor in E6B (Table 22), and as known nest predators, likely also impacted nest initiation and success in these ponds.

*Hayward*

For the second consecutive year, SFBBO staff monitored plover breeding activity at Hayward Shoreline, and again documented a large amount of nesting (n=27) between OBN and FDW. We monitored the same amount of nests (n=11) at OBN in 2020 and 2021, and found that a similar amount of monitored nests hatched in both years (5 in 2020, 4 in 2021). In sharp contrast to last year, when FDW was the most successful Snowy Plover breeding site in RU3, in 2021 it was one of the least successful breeding sites, with only two nests out of 13 hatched. California Gulls were the most frequently observed predator on the pond, and were mostly seen in the early and late part of the breeding season (Table 24). One of the two nests to hatch in FDW may have suffered partial depredation by California Gulls. We visited the nest on the morning of August 12, expecting to find three hatched chicks ready to be color banded, but instead found three eggs still in the process of hatching. At the time, we noticed that there was a large California Gull flock roosting within 50m of the nest. When we returned in the afternoon to band the chicks, we were initially unable to locate the brood and believed that they had all been depredated after visiting the nest. Yet after scanning the pond again, we were able to locate the brood, which only contained two chicks, approximately 100m from the nest. While we can't be certain, depredation of the last egg or chick by the nearby gull flock was a distinct possibility. Aside from gulls, Common Ravens were the most frequently observed species at FDW, and the most frequently observed predator at OBN. A pair nested on a power tower west of the Highway 92 toll plaza, and we suspect that it was this pair that was observed hunting in both ponds and may have depredated many of the nests in these ponds.

*Patterson Pond*

Since the majority of Snowy Plover breeding habitat in RU3 occurs on SBSPRP lands, identifying and improving Snowy Plover habitat outside of the Project footprint will be critical to reaching the RU3 population goal of 500 adults. Patterson Pond, located west of Coyote Hills along the Alameda Flood Control Channel, is one such area that could provide good quality Snowy Plover habitat. This area supported a large amount of Snowy Plover breeding activity in the late 90's and early 2000's, but the last documented breeding activity was in 2003. After not observing Snowy Plovers on-site for several years afterwards, and as other areas became more frequently

used by breeding Snowy Plovers, the pond eventually became a lower priority site and was not surveyed regularly.

SFBBO resumed breeding window surveys at Patterson in 2016, with adults observed in both 2016 and 2019. However, no breeding activity was observed at Patterson during follow up surveys. This was again the case in 2020, and due to the large amount of breeding activity found at Hayward Shoreline, we did not have the time to continue surveys at Patterson after June. However, on August 11, 2020 an SFBBO volunteer observed three adults and two young broods at the pond, indicating that the pond had supported at least two nests. As a result, we conducted weekly surveys at Patterson Pond in 2021, monitoring 19 nests and finding that 14 hatched (Table 7). These nests were spread throughout the pond, indicating that the entire pond can provide good nesting habitat.

*North Bay*

SFBBO staff made a site visit to the Hamilton Wetlands and Bel Marin Keys Restoration Sites on April 30, and opportunistically located an active Snowy Plover nest in former agricultural ponds within Hamilton Wetlands. We were able to check on the status of the nest the following week, finding that it had been depredated. When the nest was first located a coyote was observed 50m away at the edge of the pond, therefore we suspect that the coyote may have eventually found the nest. In addition to the incubating adult, pairs were also observed that day scraping in an adjacent salt panne and foraging in the North Seasonal Wetlands and Bel Marin Keys Wetlands. Due to these sightings being spaced out by several hours, it is unclear if these observations were of the same pairs or different ones, but they indicate that the site contains a number of suitable Snowy Plover nesting and foraging sites. On July 15, Hamilton Wetlands volunteer monitors observed six Snowy Plovers, including a possible second nest, in the same agricultural ponds where the first nest was located. SFBBO staff were able to visit and confirm the nest the following day, finding that it was in the process of hatching. We were next able to visit the site on July 30 and located three chicks brooding with the male in the pond. All of the Snowy Plover breeding activity observed at Bel Marin Keys in 2021 occurred in ponds that had not been surveyed regularly by Hamilton Wetlands volunteers prior, thus it is possible that nesting occurred in these ponds in prior years. As one of only two sites known to support breeding Snowy Plovers in the North Bay in 2021, it is important that this area continue to be monitored for Snowy Plovers in the future, and even more important that the needs of breeding Snowy Plovers are considered when planning for tidal marsh restoration.

At Napa-Sonoma Marshes Wildlife Area, Snowy Plovers were not observed during the breeding window survey, and no sign of breeding activity was observed in 2021 by SFBBO or CDFW (K. Taylor, pers. comm.) We surveyed the Wingo Unit a total of 15 times in 2021, never observing any Snowy Plovers on-site despite potentially suitable habitat. SFBBO volunteers conducted three surveys at ponds 7/7A, finding a pair in March, a single male in April, and zero Snowy Plovers in May. In recent years the Least Tern colony at this site has been wiped out by river otters (K. Taylor, pers. comm.). It is possible that ponds 7/7A no longer provide viable breeding habitat for Snowy Plovers (or Least Terns) due to the consistent presence of the otters.

A small amount of breeding activity was detected at Montezuma Wetlands in 2021 (n=3, Table 7). 2021 marked the first year that targeted Snowy Plover surveys were conducted at this site, increasing confidence that this is an accurate reflection of breeding activity in this area. Nevertheless, considering the presence of nine adults consistently on-site through May and June (C. Jasper, pers. comm.), large size of the site, and mosaic of vegetation that could make detecting incubating birds difficult, it remains possible that additional nesting went undetected. This area represents one of only three locations in the North Bay known to support breeding activity in recent years, therefore it is critical that breeding activity continue to be documented and management action taken to support breeding.

**Chick Fledging Success**

We color banded 149 Snowy Plover chicks in the field in 2021, the most since we began color banding in 2008 (Table 9). This represents 43% of all Snowy Plover chicks known to have hatched in the South Bay from nests monitored and detected as broods in 2021. If only considering the pond groups where banding occurred, it represents 49% of all chicks that hatched. Banded Snowy Plover chicks experienced poor fledging success, with only 31% confirmed to have fledged, resulting in an estimate of 0.82 chicks fledged per male across the South Bay (Table 10). The USFWS goal of 1.0 chicks fledged per male represents what is needed for population growth, therefore our banding data suggests that the South Bay population likely did not have enough successful breeding to achieve population growth. Since we were able to band close to half of all chicks that hatched, we believe that this data represents our most accurate assessment of Snowy Plover fledging success to date. Despite the apparent increase in population size, the combination of poor hatching success (48% across RU3 2015-2019) and fledging success (32% 2015-2019) observed in recent years poses a major problem to both RU3 and rangewide population recovery goals (Table 1). It is critical that habitat enhancement, management, and predator control are all maximized to improve the number of chicks that hatch, and that high quality brood rearing habitat be provided for them to successfully fledge.

*Eden Landing*

We focused our banding efforts at Eden Landing on E14, which hosted 48% of all hatched chicks at Eden Landing despite poor pond hatching success (Table 33). We banded 23 chicks from eight different broods, accounting for 58% of all chicks hatched in E14 (Table 33). Only four chicks from two broods survived to fledge, resulting in a fledge rate of 17% (Table 10). Aside from the four banded chicks that were confirmed to have fledged, we did not observe any unbanded chicks at E14 survive past approximately two weeks old, and thus believe that the true fledging success in the pond may have been as low as 10%. With ample foraging available and no inclement weather events during the 2021 breeding season, we believe that the main cause of the poor fledging success at E14 was predation, likely from a combination of Northern Harriers, Peregrine Falcons, Common Ravens, red foxes, coyotes, and possibly owls. Two of the banded chicks that survived to fledge hatched on June 10, when the Least Tern colony at E14 was at its largest and most effective in warding off predators. These chicks were observed

within the colony area each week until they fledged, indicating that they benefited from protection provided by the Least Terns before the colony itself declined due to predation. The other two chicks that survived to fledge were observed frequently in the northeast corner of the Eastern shell plot, close by to where they were banded. This area provides foraging along the nearby borrow ditch, cover from predators in the shells and nearby pickleweed stands, and is not near the historical Archimedes screws on the pond that avian predators frequently perch on.

Due to reduced breeding activity and poor hatching success, we were only able to band an additional 15 chicks in the rest of Eden Landing, including four at E8 and eleven at E6B (Table 10). These chicks also experienced poor hatching success, with just two chicks from E8 surviving to fledge. We suspect that a similar suite of predators impacted chick survival in these ponds, as Northern Harriers and Peregrine Falcons were the two most frequently observed raptors in these ponds. Common Ravens were documented depredating a nest in E8 and likely impacted chick survival as well, and an inactive mammal den with bones and feathers was located by SFBBO staff in E6A along the levee parallel to Old Alameda Creek.

We continued our efforts to improve chick foraging habitat by removing predator perches in E14 provided by derelict hunting blinds and remnant salt production infrastructure. After several volunteer events in 2021, there are now only a handful of remaining predator perches yet to be removed from the pond. We plan to remove these remaining perches during two events planned for March 2022. In addition, there remain perches provided by active water control structures, pipe gates, and historical structures (Archimedes screws) that can't be removed. These structures all provide a large amount of surface area for perching, making perch prevention difficult. Nevertheless, these structures should be modified as much as possible to further limit the ability of raptors to hunt from perches in Snowy Plover breeding and foraging habitats. SFBBO also spread some oyster shells along foraging areas in E14 that we hope will provide additional cover for foraging chicks and improve survival.

*Ravenswood*

Due to high nest success in the complex, we were able to band 60 chicks that hatched from 22 nests in ponds SF2, R1, R3, and R4 representing 61% of chicks known to hatch in the Ravenswood ponds (Table 33). While zero banded chicks fledged from SF2 or R3, at least ten banded chicks fledged from both R1 and R4. With an estimate of 43% chick fledging rate and 1.25 chicks fledged per male (n=23, Table 10), R1 appeared to provide the best habitat for chicks to fledge in Ravenswood, as well as some of the best in RU3. This pond dried out to its greatest extent since at least 2013, with some small stretches of the borrow ditch drying up completely in June and July. With a greater amount of area to search, this may have reduced the ability of predators to find chicks, which blend in with the large, lightly colored pond bottom.

Snowy Plover chicks experienced moderate fledging success (32%, 0.82 chicks fledged/male) at R4, but still fell short of the productivity needed to result in population growth. In looking closer

at chick fledging success in June compared to July, we found that Snowy Plover chicks banded in June experienced high rates of fledging success (64%, n=17), while chicks banded in July experienced poor fledging success (7%, n=14). There are two factors that may explain this major discrepancy. Undoubtedly many of these chicks were depredated by predators, including by Common Ravens, which nested in a Eucalyptus tree in Bedwell Bayfront Park within 100m of the pond and were observed hunting on the pond, and Peregrine Falcons, which nested on a power tower north of R4 between R1 and Greco Island and were observed hunting for adult Snowy Plovers on multiple occasions. But another explanation may have been the extreme lack of foraging habitat in R3 and R4 due to drought conditions. Lack of standing water and flies could have exposed chicks to greater predation risk as they searched for prey, and in the most extreme scenario, may not have provided chicks with the nutrients needed to survive and fledge. We observed a chick that hatched and was banded in R3 in early August each week in R4, and noticed that it did not appear to be growing at a normal rate. When we last saw it at 29 days old, an age at which most other chicks have fledged, it had clearly not yet physically developed enough to fly. This further highlights the importance of having water control structures installed that allow for management of ponds to provide quality nesting and foraging habitat throughout the breeding season.

*Mountain View*

We were able to band 72% of all chicks that hatched between CMW and CME, finding stark differences in survival by pond. As with nests in CME, chicks banded in the pond experienced poor fledging success (14%, Table 10). Several Common Ravens were observed hunting in the pond on numerous occasions, while both tracks on the pond and direct observation of a red fox entering a satellite den abutting Moffett Airfield indicate they were also hunting in the pond. Without much habitat complexity on the pond to aid in crypsis, young chicks may have been exposed to increased predation risk foraging in CME. The only chick banded in CME that survived to fledge was observed foraging in CMW before fledging. This occurred in mid-June when most of CMW was exposed, allowing for chicks to spread out and making predation more difficult. At CMW, chicks experienced the highest rate of fledging success (64%) in RU3 among ponds with at least ten chicks banded (Table 10). The first two chicks were banded in May and did not survive to fledge. The same red fox was observed hunting in CMW during this timeframe as well, and Common Ravens were the most frequently observed predator (aside from gulls and egrets early in the season) hunting on the pond (Table 19). Due to a gap in nesting activity on the pond, chicks were not banded in the pond again until July, when there was ample space for broods to spread out on the pond, which may have aided broods in avoiding predators.

Similar to R4, due to lack of water in either pond in September, we observed that at least three chicks that hatched in August from an undetected nest required a greater amount of time to fledge than is usual. These chicks were able to find prey and cover in pickleweed patches located along the Bay Trail in CME, and fledged by approximately 35 days old.

*Patterson*

We banded Snowy Plovers chicks at Patterson Pond for the first time in 2021, banding 13 of 37 chicks that hatched (Table 33). Although nests in the pond experienced high hatch success, chicks experienced poor fledging success (23%). As with other areas, predation was likely the main cause of chick mortality. Common Ravens and Northern Harriers were both observed hunting in the pond, and small flocks of California Gulls were observed roosting on the pond not far from active nests. While we don't believe that Great Egrets, Snowy Egrets, or Great Blue Herons are major predators of Snowy Plover chicks, these species were regularly found on the levee separating the west side of the pond from Cargill's intake pump in N1A. On a number of occasions, we observed them on the west side of the pond where chicks were frequently observed foraging, leading us to believe that they may have depredated some chicks as well.

Aside from direct predation, some chicks (both banded and unbanded) appeared to suffer mobility issues caused by mud sticking to their legs. This only occurred in a narrow strip on the western side of the pond in July, when most of the water in the pond had evaporated. Due to its proximity to N1A, the mud in this area appeared to stay moist, which created foraging habitat but also resulted in mud sticking to chicks legs. We have observed mud sticking to chicks legs at other ponds in the past, but usually there is water nearby that helps to wash off the mud. On two separate occasions we observed chicks with so much mud stuck to their legs that they were easily captured despite attempting to run away. Since these chicks were banded we knew how old they were, and it became apparent that they had been unable to forage and grow at a normal rate. We removed the mud from all three chicks, but none were observed again.

**Oyster Shell Habitat Enhancement**

*Large Scale Enhancement Study*

The implementation of large-scale oyster shell enhancement at pond E14 in Eden Landing allowed us to test the efficacy of oyster shells as camouflage for nesting Snowy Plovers. Overall nest abundance throughout the pond, and nest density in enhancement plots Western and Eastern were lower in 2021 when compared the previous six years (2015-2020) and pre-enhancement conditions (2014). Water levels and management in nearby ponds were comparable to recent years, suggesting that habitat conditions did not impact Snowy Plover nest site selection. Therefore, we believe that predation was the primary cause for the decline in nest abundance and density in 2021.

*Nest Site Selection*

The results of our chi-squared analysis indicated that Snowy Plovers preferentially selected to nest in shelled areas in E14 over non-shelled areas, yet as we have documented since 2016, the shells did not result in high breeding success. High density breeding in E14 may increase predation pressure and reduce Snowy Plover nest success, thus it may be advantageous to spread oyster shells, gravel, or other materials in other Eden Landing ponds with ample breeding and foraging habitat to reduce the amount of breeding concentrated in E14 and

thereby ease density dependent effects. E8 and E6B, which have consistently hosted a large amount of Snowy Plover breeding and low nest and fledging success in recent years, as well as E6A, which has hosted a moderate amount of Snowy Plover Breeding, may benefit from habitat enhancement to increase texture on the pond.

Monitoring and research should continue at the E14 enhancement site. We began a collaborative project with UC Berkeley in 2021 to assess occupancy and abundance of mammalian predators throughout Eden Landing, including at E14. As part of this study, we plan to install fencing at all levee junctions at E14 in an effort to prevent mammals from accessing the pond. We will continue to conduct perch removal at E14, and through our avian predator surveys will document if this results in reduced presence of raptors hunting in the pond. Consistent monitoring will document how Snowy Plover use of the enhancement site changes over time, a critical piece of knowledge to inform future restoration efforts within Recovery Unit 3 and across the Pacific Coast.

*Additional Considerations*

As the amount of available Snowy Plover nesting habitat in RU3 is reduced due to tidal marsh restoration, Snowy Plover nesting density will likely increase in order to sustain or grow breeding numbers within a smaller habitat footprint (Figure 29-31). However, our research has shown that high density breeding may also result in consistently high rates of predation, resulting in poor breeding success and, if sustained, population decline. Therefore, high density breeding habitat should not be considered a preferred management scenario when restoration actions are considered, and attempts should be made to provide multiple, large breeding sites within each region of RU3.

Where high density habitat is necessary, shell plots are one way to achieve the higher nest densities. However, the efficacy of oyster shells can decline over time due to winter management of ponds for ducks and resulting sedimentation. Past research observed a decline in use of shell plots by breeding Snowy Plovers over time (Robinson-Nilsen et al. 2013) , therefore shells may need to be refurbished or supplemented on a consistent basis (approximately every 5-10 years) in order to maintain their benefits for Snowy Plover breeding. While the closing of Drake's Bay Oyster Company in Marin County in 2014 reduced the availability of oyster shells, in late 2021 we established a connection with Hog Island Oyster Company, also headquartered in Marin County. Hog Island Oyster Company has a large pile of oyster shells located in Marshall, CA that they are willing to donate to us. SFBBO recently applied for grant funding for a large-scale habitat enhancement project at ponds E6A, E6B, and E8, and if funded, will transport these oyster shells down to Eden Landing. Despite this, other sources of oyster shell or use of other enhancement materials should be considered. Establishment of an oyster collection program in local restaurants may provide a consistent shell source. Gravel and cobble, which have shown promise as a nesting substrate along the Eel River (Colwell et al. 2011) and at Point Reyes (L. Stenzel, pers. comm.), were tested on a small scale as an enhancement material at cell U3 in RSF2 in 2019. Although no evidence of Snowy Plover breeding was observed among the graveled areas, we believe that gravel and cobble, or

potentially a combination of gravel, cobble, and shell, may provide the right mix of color and texture to provide Snowy Plovers with high quality breeding habitat in RU3. Spreading of egg sized gravel was included in our grant funding application for enhancement at ponds E6A, E6B, and E8. At the Oceano Dunes State Vehicular Recreation Area, California Department of Parks and Recreation staff spread wood chips and pieces of driftwood in foraging areas in an effort to increase cover for chicks (A. Clark, pers. comm.).

**Avian Predators**

*Northern Harriers*

For the second consecutive year, Northern Harriers were the most frequently observed raptor at E14 and E8, and were often flushed by biologists driving during the course of their survey. At E14, they frequently perched on levee sides with mustard and other vegetation that provided cover for them, and were also observed flying low over the pond hunting. On several occasions in June we observed Northern Harriers hunting around the E14 Least Tern colony despite Least Terns dive bombing them repeatedly. Although Northern Harriers were not directly observed depredating Least Tern or Snowy Plover adults, eggs, or chicks during the 2021 breeding season, we found the remains of several Least Tern eggs with talon punctures in them and believe that Northern Harriers were the predator of these eggs. Furthermore, our past observations of Northern Harriers at E8A (Robinson-Nilson and Demers 2009) and E14 (Pearl et al. 2019) and their frequent presence on the ponds lead us to believe that they were a significant predator of Snowy Plovers and Least Terns. Due to their documented history of impacts to both species at E14 and across the Pacific Coast, targeted Northern Harrier control options should be considered...

*Peregrine Falcons*

Although Peregrine Falcons were one of the most frequently observed raptors at Eden Landing (Table 20-23), they were observed less frequently compared to 2020. This may have been due to the greatly reduced amount of Snowy Plover breeding observed at Eden Landing in 2021. It's also possible that our efforts to remove predator perches in ponds E6B, E8, and E14 reduced their ability to hunt in these ponds. Peregrine Falcons were most frequently observed at Eden Landing in pond E10, where we suspect that they may have been nesting in 2021. Despite their reduced presence, we believe that Peregrine Falcons continued to pose a major threat to the recovery of Snowy Plovers and Least Terns at Eden Landing. There remain a large number of perches throughout Eden Landing in need of removal or modification with bird spikes.

At Ravenswood, Peregrine Falcons nested on a power tower within 500m and 700m of R4 and R1, respectively. Although we did not closely track the nest, we observed older chicks in the nest and believe that they likely fledged. While we did not observe them depredating Snowy Plovers, they were observed attempting to take adult Snowy Plovers at R4 on several occasions. It is critical that Peregrine Falcons are prevented from nesting near Snowy Plover breeding ponds when possible, as past research has shown that Peregrine Falcons diet will shift

seasonally based upon the availability of prey (Rejt 2001). During spring and fall migration, Peregrine Falcons have access to an abundance of migratory shorebirds, waterfowl, and gulls, but during the summer there are limited prey options on the Bay, making nearby Snowy Plover adults and chicks more attractive targets.

*Common Ravens*

Common Ravens nested nearby Double Crested Cormorants on the first power tower west of the Highway 92 toll plaza in 2021, and thus the nest could not be removed. Though we used cameras on a limited basis, they were confirmed as the nest predator at two Snowy Plover nests in E14, one in E8, and suspected as the predator at a nest in E6B where the camera malfunctioned (Table 28). They were frequently observed hunting at Hayward Shoreline and we suspect that they were responsible for the high nest loss observed at both OBN and FDW. It is difficult to determine chick predators, but we suspect that Common Ravens contributed to poor chick survival at both Eden Landing and Hayward Shoreline.

Common Ravens also nested at Bedwell Bayfront Park within 100m of R4. They were observed hunting on the pond on several occasions and may have depredated both eggs and chicks, though we did not observe so and did not use nest cameras at this location. Ravens were also frequently observed at CMW and CME, and likely impacted Snowy Plover breeding success in these areas as well.

*Egrets and Heron Spp.*

Aside from gulls, Snowy Egrets and Great Egrets were the two most commonly observed predators throughout the South Bay. Although SFBBO has not confirmed these species as nest or chick predators, they may have an effect on breeding success. It is possible that these species, as well as Great Blue Herons, serve as egg and chick predators at ponds with large amounts of open water and smaller amounts of dry habitat, including E6A, E12, E13, and CMW early in the season. During the early and late part of the breeding season, herons, egrets, and gull species often form large multi-species feeding flocks on small fish in the same areas where chicks forage. In 2021, E8 and E6B were both managed at a higher water level compared to 2020, resulting in more suitable hunting habitat for these species and potentially increasing risk of egg and chick predation by herons and egrets in these ponds.

*Gulls*

SFBBO was able to resume our California Gull walkthrough surveys in 2021, estimating that 45,294 California Gulls bred in the South Bay. At Eden Landing, large mixed gull flocks (mostly California Gulls) were frequently observed at E12-13 during the early (March-April) and late (July-August) part of the breeding season. At FDW, mixed gull flocks were found in the pond in August once water was added to the pond, and we suspect that one egg or recently hatched chicks may have been depredated by them. Especially late in the season, these gull flocks may opportunistically depredate Snowy Plover eggs and chicks along narrow levees, berms, and nesting islands, where there is a high chance of inadvertently finding nests and broods.

**Mammalian Predators**

Although we did not conduct targeted mammalian surveys, mammals were observed opportunistically on several occasions. At Ravenswood, we observed red fox hunting on R4 on numerous occasions, and observed a striped skunk in Bedwell Bayfront Park near R4 on one occasion. SBSPSRP construction activity along the pedestrian trail and R4 has created a gently sloped transition onto the pond bottom to benefit future tidal marsh species, however they also create easy access for these and other mammals to hunt Snowy Plover eggs and chicks in the near term. Knowing the importance of the R3-RS5 Pond Complex for Snowy Plovers, this pond complex has received high priority for predator management. One red fox was observed hunting at Crittenden Marsh, and a satellite den was eventually discovered at the edge of CME next to Moffett Airfield.

At Eden Landing we located two active red fox dens, including one in the E13 saltworks where red foxes have denned in the past, and another along the levee separating E16B and E11. A total of four red fox were removed by USDA-APHIS at Eden Landing in 2021 (E. Covington, pers. comm.), however it is unknown if they were adults or kits associated with these dens. We also found an inactive den in E6A, but could not determine which species may have used it. Trail cameras placed at strategic locations on ponds and levees in Eden Landing indicated that coyotes were present at E6A and E16B. It is unknown what the full impact mammals may have been on breeding Snowy Plovers at Eden Landing; however, our collaborative predator study with UC Berkeley should shed light on their abundance and occupancy at Eden Landing. This will provide a baseline to help us further understand how coyotes and other mammals may impact breeding Snowy Plovers and Least Terns at Eden Landing.

**Restoration and Snowy Plover Nesting**

The majority of RU3's Snowy Plover breeding habitat is located within the South Bay Salt Pond Restoration Project area. The Project aims to restore large areas of former salt ponds to tidal marsh, yet one of the Project's long-term goals is to support 250 breeding Snowy Plover adults within the Project area (USFWS and CDFW 2007). It will be critical that enough suitable breeding habitat is maintained to support the population goal on project lands. During Phase II of the Project at Ravenswood, installation of water control structures and enhancement of R3 breeding habitat prior to breaching R4 will help to ensure that there is high quality nesting habitat available to Snowy Plovers when overall habitat availability decreases. Further enhancement of RSF2 and R1-2 for Snowy Plover breeding, including spreading of a camouflage enhancing substrate (oyster shells, gravel, etc.) and removal of remaining predator perches, could also help to offset the loss of R4. If ponds are to be drained during construction, providing breeding habitat throughout the season in R1 and R2 could reduce breeding in drained ponds and help to prevent overly high nesting density that could negatively affect breeding success in R3 and RSF2 during the first half of the season.

Identifying and managing suitable habitat outside of the Project is crucial to allowing RU3 to meet its goal of supporting 500 adult Snowy Plovers, as well as enabling the Project to reach

tidal marsh restoration acreage goals. In 2021, Patterson Pond supported a large amount of Snowy Plover breeding after minimal breeding had been observed over the past 18 years. This site is owned by the Alameda County Flood Control District and is not actively managed. With installation of a water control structure along the Alameda Flood Control Channel and pond enhancements to improve crypsis, this property could provide consistent Snowy Plover breeding habitat. Crittenden Marsh supported a record amount of breeding activity, and despite poor breeding success early in the season, may have produced more fledglings than all of Eden Landing. MROSD plans to actively manage their portion of Crittenden Marsh, which constitutes ⅓ of the pond, to support breeding Snowy Plovers beginning in July 2022. In order to maximize the value of the remaining ⅔ of the pond, owned by NASA-ARC, it is crucial to continue to engage with NASA-ARC to identify habitat management that will both support their needs and those of breeding Snowy Plovers. FDW and OBN again supported a large amount of Snowy Plover breeding, yet these areas are planned for tidal marsh restoration in the near future. N1, which does not have a history of breeding Snowy Plovers, supported at least nine successful Snowy Plover nests, highlighting that Snowy Plovers will quickly move into suitable habitat if available. At the Hamilton Wetlands and Bel Marin Keys Restoration Site in the North Bay, where nesting had not been previously confirmed, we located two nests and observed additional breeding activity. Since the most suitable areas of this site were not being surveyed, it highlights the need for increased survey effort in this area. Most critically, since the 2021 breeding locations are planned for tidal marsh restoration, other areas of this site should be managed to support breeding Snowy Plovers once the areas have been breached.

## RECOMMENDATIONS

### Management Recommendations

1. USFWS, CDFW, HARD, EBRPD, and MROSD should continue to meet Snowy Plover habitat requirements by providing dry ponds with nearby high salinity foraging habitat and managing ponds in multiple areas around the South Bay for Snowy Plovers to reduce impacts from predation, flooding, disturbance and/or disease.
2. USFWS Snowy Plover recovery leads should engage and coordinate with landowners whose lands currently or have supported breeding Snowy Plovers outside of the Project footprint. These include USFWS at San Pablo Bay NWR, CDFW at the Napa-Sonoma Marshes WA, MROSD and NASA-ARC at Crittenden Marsh, ACFCD at Patterson Pond, HARD and EBRPD at Hayward Shoreline, the Department of Defense and State Coastal Conservancy at the Hamilton Wetlands and Bel Marin Keys Restoration Site, and private owners at Montezuma Wetlands. In order to reach RU3 goals, the aforementioned areas are critical to providing additional habitat.
3. Addition of gravel and oyster shell at E6A, E6B, and E8 may improve overall breeding success at Eden Landing by reducing predation in these ponds and simultaneously reducing breeding density in other ponds by attracting more plovers to these ponds.
4. Addition of oyster shell and gravel at RSF2 cell 3, R3, and R1-2 could partially mitigate against depredation related to potential high-density Snowy Plover breeding following

breaching of R4. Installing new water control structures at R1 to allow for lowering of water levels would greatly improve the ability of this pond to consistently provide high quality Snowy Plover breeding habitat.

5. Relocation of Northern Harriers (and potentially lethal removal) and Peregrine Falcons identified as targeting breeding Snowy Plovers, especially at Eden Landing, must be seriously considered to reduce high rates of predation.
6. Demolition and removal of non-historical or non-functional structures on ponds should be prioritized. Those that are historical or functional should be treated with a perching deterrent such as bird spikes.
7. USFWS should continue to work with PG&E to remove predator nests from towers at the Refuge and Eden Landing, and coordinate with EBRPD and HARD to do the same at Hayward Shoreline. Special focus should be given to locations adjacent to or near Snowy Plover breeding habitat.
8. Invasive and/or overgrown vegetation (such as black mustard and coyote brush) along levee sides should be removed to reduce the ability of predators to hide and prevent perching.
9. The predator management and gull hazing programs should continue in 2022 in the South Bay, with increased focus on removing mammals in the early part of the breeding season and preventing gulls from breeding and roosting near Snowy Plover breeding and foraging habitat throughout the breeding season.
10. At E16B, repair or replacement of the water control structure would allow for better management of the pond, including the prevention of Snowy Plovers nest inundation in low lying areas that are prone to flooding. This action, along with connecting interior channels to the borrow ditch, should be implemented to increase the amount of foraging habitat in the pond.
11. Construction activities on Snowy Plover nesting ponds should occur outside of the breeding season whenever possible, per applicable Biological Opinions and associated BMPs and minimization measures.
    - If construction activities occur on ponds where Snowy Plovers are nesting, or on levees in between breeding and/or foraging ponds, there should be a trained biologist onsite to clear work areas and during working hours as needed to minimize impacts to Snowy Plovers.
    - If construction occurs adjacent to or within a Snowy Plover nesting area, then weekly or greater communication will be necessary to ensure that all parties understand their roles in regards to minimizing impacts to listed species.
12. Expand Snowy Plover outreach, which will become increasingly important as more trails near Snowy Plover breeding habitat are opened to the public.
    - When COVID-19 health orders allow, station trained docents at public areas adjacent to nesting sites, to provide information on Snowy Plover conservation and disturbance issues and viewing opportunities of nesting birds. This would create public awareness and support for Snowy Plovers, thereby reducing the human disturbance.

- Interpretive panels should be placed on trails at Crittenden Marsh and Hayward Shoreline, and additional panels added at Eden Landing and Ravenswood to provide information on Snowy Plover ecology and conservation.
- Law enforcement patrols should be increased at Eden Landing and Ravenswood to reduce high rates of observed trespass.

**Research Recommendations**

Future research involving Snowy Plovers and their nesting areas within the ponds should include projects that address the following topics:

1. Expanded color banding, GPS, or Motus tracking of chicks and adults to provide a more reliable dataset on Snowy Plover survival rates and habitat use. This is vital information needed to inform the recovery goal of 500 birds in Recovery Unit 3.
2. Document changing Northern Harrier population size, territory size and habitat use and impacts on nesting Snowy Plovers as tidal marsh nesting habitat for harriers increases.
3. Examine the recent expansion of coyote populations into Eden Landing and the Refuge; identify their impact on breeding Snowy Plovers.
4. Impacts of corvids, raptors, and gulls on breeding Snowy Plovers.
    a. Efficacy of avian predator management on Snowy Plover breeding success.
    b. Relationship between number of predators observed and breeding success
5. Potential impacts to nesting Snowy Plovers of human disturbance from recreational trail use.
6. Identify benefits and challenges of Snowy Plovers and Least Terns nesting in close proximity within Recovery Unit 3 and how that relates to similar co-nesting within other RUs.
7. Long-term use of E14 large-scale oyster shell enhancement by breeding and wintering Snowy Plovers.

**Monitoring Recommendations**

1. The Recovery Unit 3 Snowy Plover monitoring program should continue. Monitoring numbers of breeding birds and reproductive performance is important to track progress towards recovery goals and the response of Snowy Plovers to management actions, including the effects of tidal marsh restoration.
2. Identify funding sources for regular monitoring at HARD-owned areas of Hayward Shoreline, NASA-ARC owned areas of Crittenden Marsh, and Patterson pond.
3. Monthly surveys should include scouting areas that do not have a recent history of supporting breeding Snowy Plovers, including Crown Beach in Alameda and Bayfront habitat in Foster City and Redwood City. As the amount of managed pond habitat decreases, Snowy Plovers may use historical or new areas for nesting.
4. Surveys in the North Bay should be conducted more frequently to better document Snowy Plover breeding effort.

**ACKNOWLEDGEMENTS**

In 2021, Western Snowy Plover monitoring was supported by California Department of Fish and Wildlife, U.S. Fish and Wildlife Service, Ducks Unlimited, California Wildlife Foundation, State Coastal Conservancy, Alameda County Fish and Game Commission, Santa Clara County Fish and Game Commission, Sonoma County Fish and Wildlife Commission, Cargill Inc., and SFBBO donors. California Least Tern monitoring was supported by California Department of Fish and Wildlife and U.S. Fish and Wildlife Service. We are especially grateful to Rachel Tertes of the Don Edwards San Francisco Bay National Wildlife Refuge, John Krause of CDFW, Mark Taylor and Cliff Rocha of EBRPD, and Garrett Turner of NASA-ARC for logistical support at the Refuge, Eden Landing, Hayward Shoreline, Patterson Pond, and Crittenden Marsh respectively. We thank SFBBO Biologists Jessica Gonzalez, Parker Kaye, Cole Jower, Josh Scullen, and Dan Wenny for their hard work throughout the season. We also thank our many dedicated volunteers for conducting Snowy Plover surveys, Least Tern Surveys, docent surveys, and/or data entry. We also thank Karen Taylor of CDFW, David Riensche of EBRPD, Chris Jasper of Vollmar Consulting, and David Sexton of the Hamilton Wetlands Restoration Volunteer Monitoring Group for contributing information about Snowy Plover nesting activity in Napa Sonoma Marsh Wildlife Area, Hayward Shoreline, Montezuma Wetlands Restoration area and Hamilton Wetland Restoration area, respectively.

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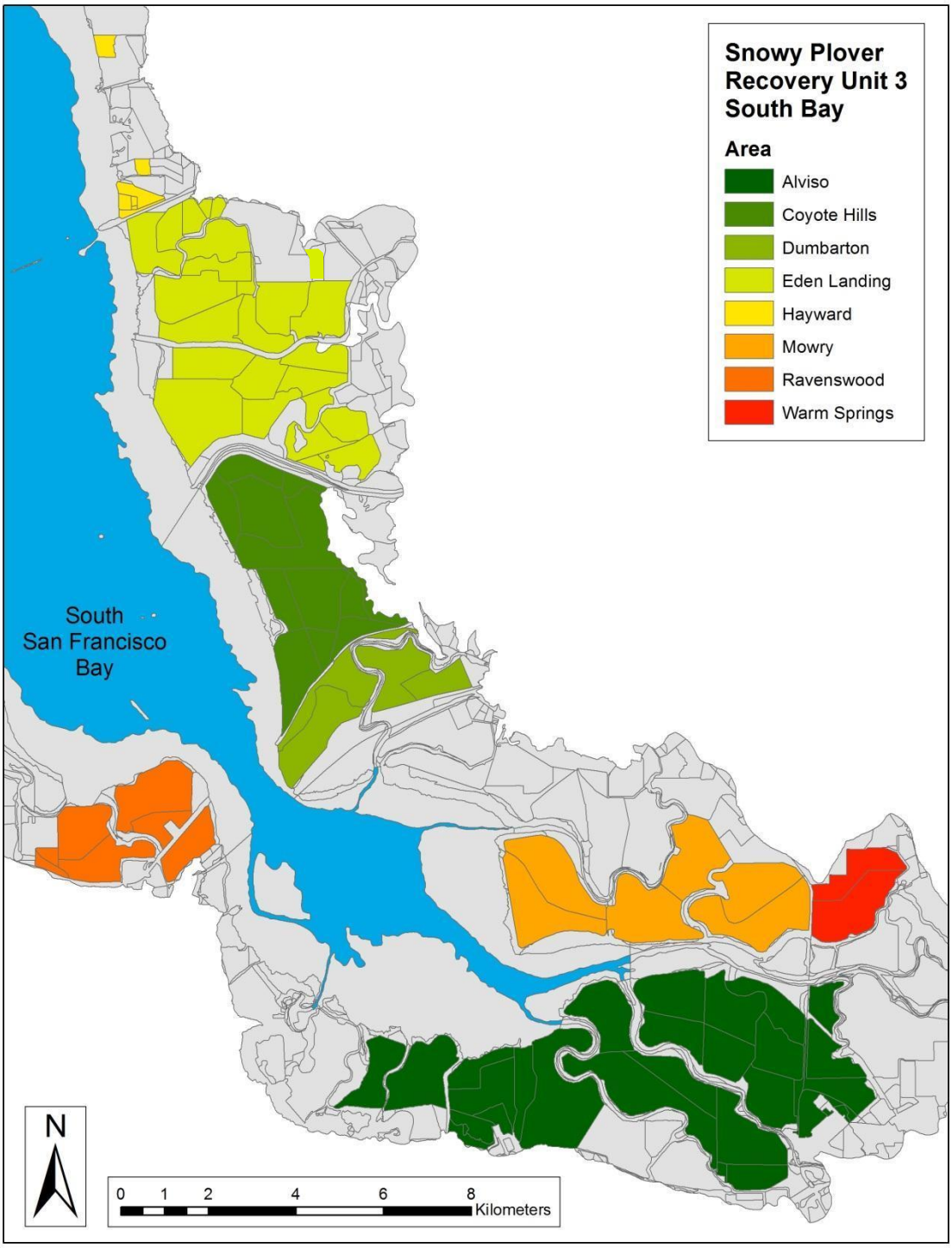


Figure 1. The Don Edwards San Francisco Bay National Wildlife Refuge, CDFW's Eden Landing Ecological Reserve, East Bay Regional Park District and Hayward Area Recreation and Park District lands in the South San Francisco Bay, California.

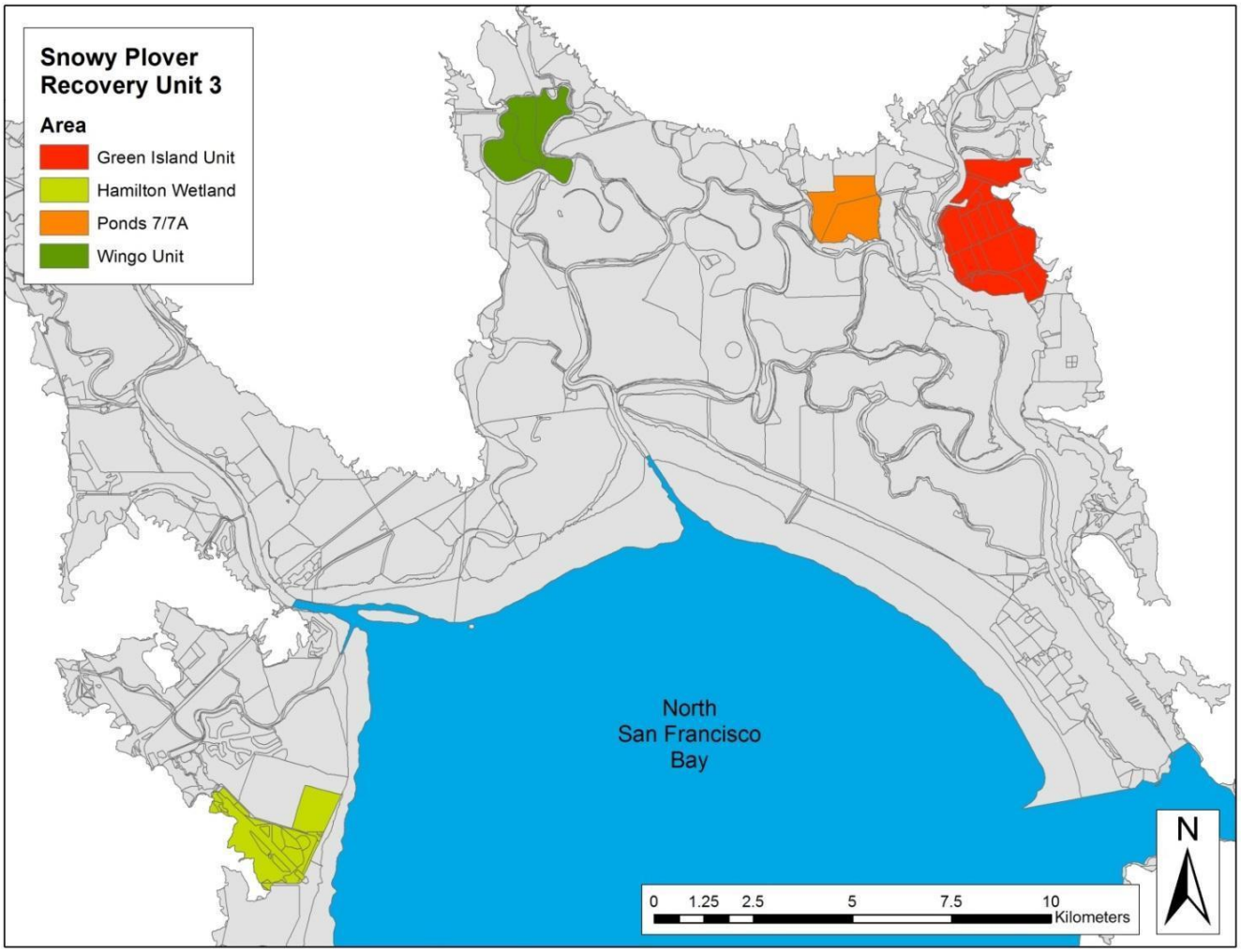


Figure 2. Snowy Plover breeding areas in the CDFW's Napa-Sonoma Marshes Wildlife Area: the Wingo Unit, ponds 7/7a, and the nesting islands at the Green Island Unit (formerly called the Napa Plant Site); Coastal Conservancy's Hamilton Wetlands, North San Francisco Bay, California.

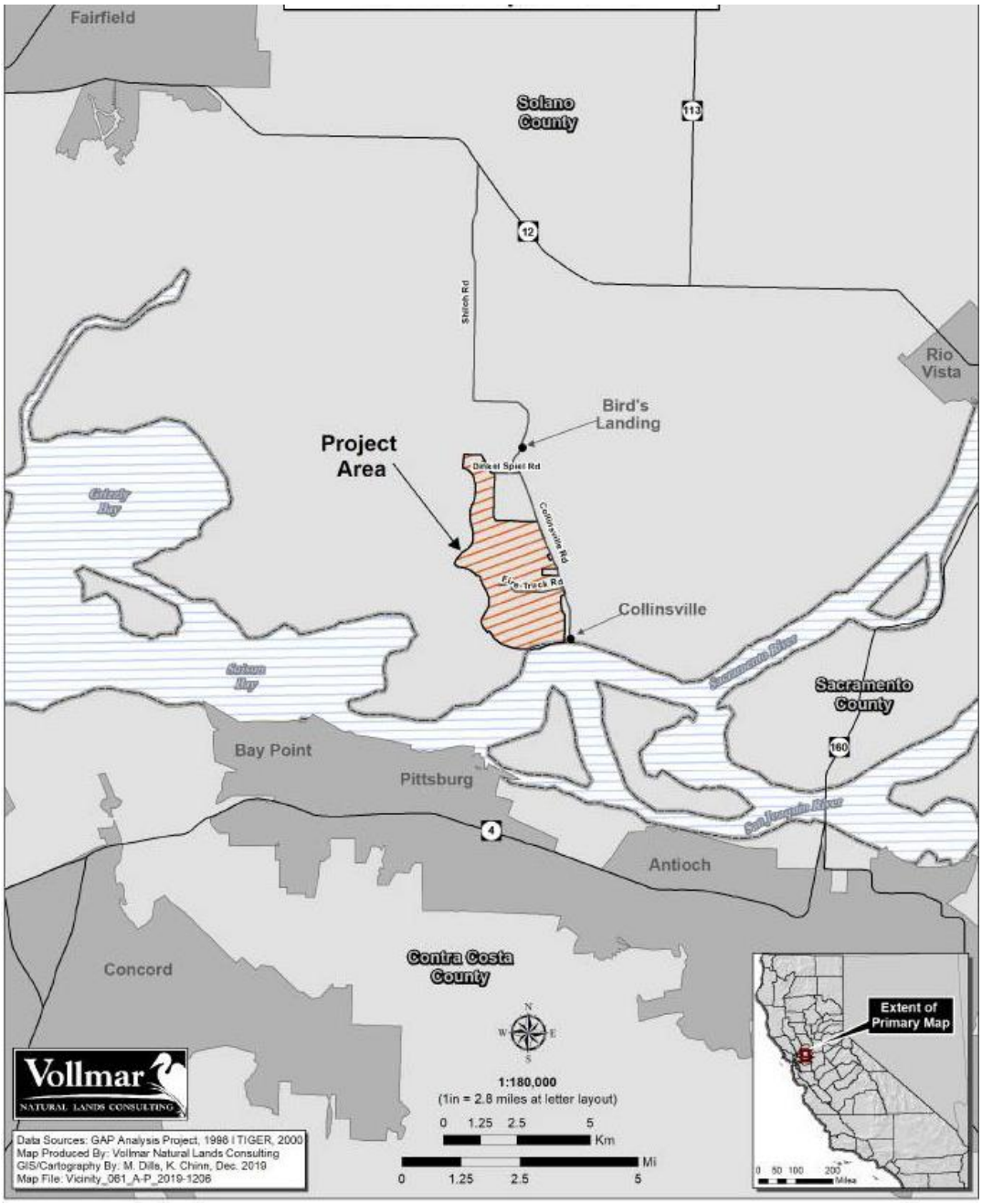


Figure 3. Snowy Plover breeding habitat at Montezuma Wetlands, located in Solano County, CA adjacent to Suisun Bay and the Sacramento/San Juaquin River Delta. Montezuma Wetlands is a private wetland restoration site. Image used courtesy of Vollmar Natural Lands Consulting.


Figure 4. Ponds in the Refuge's Alviso Complex, including Mountain View (A1-A3N) and NASA-ARC/Midpeninsula Regional open Space District property (Crittenden Marsh), at the southern end of the South San Francisco Bay, California. See Figure 1 for location of Alviso within South San Francisco Bay.


Figure 5. Ponds in the Refuge's Ravenswood Complex, at the west end of the Dumbarton Bridge, South San Francisco Bay, California. See Figure 1 for location of Ravenswood within the South San Francisco Bay.


Figure 6. Ponds in Hayward Shoreline north of the San Mateo Bridge in Hayward, CA. See Figure 1 for location of Oliver Brother's North, Least Tern Island, and Franks Dump West within South San Francisco Bay.


Figure 7. Ponds in the CDFW's Eden Landing Ecological Reserve and ACFCD's Patterson Pond in the Coyote Hills complex. See Figure 1 for the location of Eden Landing and Coyote Hills within South San Francisco Bay.

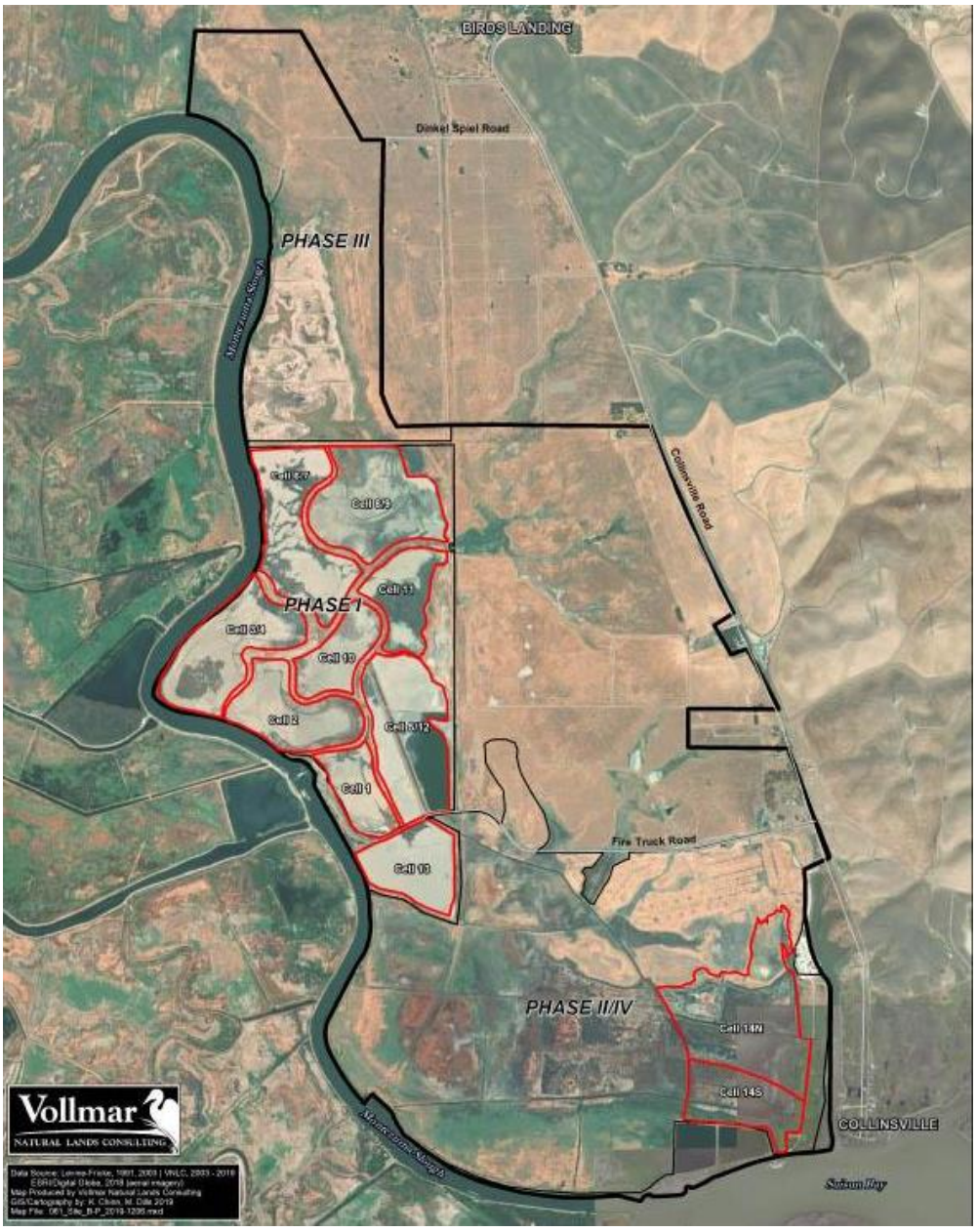

Figure 8. Phases and ponds within the Montezuma Wetlands Project Site, Solano County, CA. Image used courtesy of Vollmar Natural Lands Consulting.


Figure 9. Ponds and tidal areas within the Hamilton Wetlands and Bel Marin Keys Restoration Site, Novato, CA.

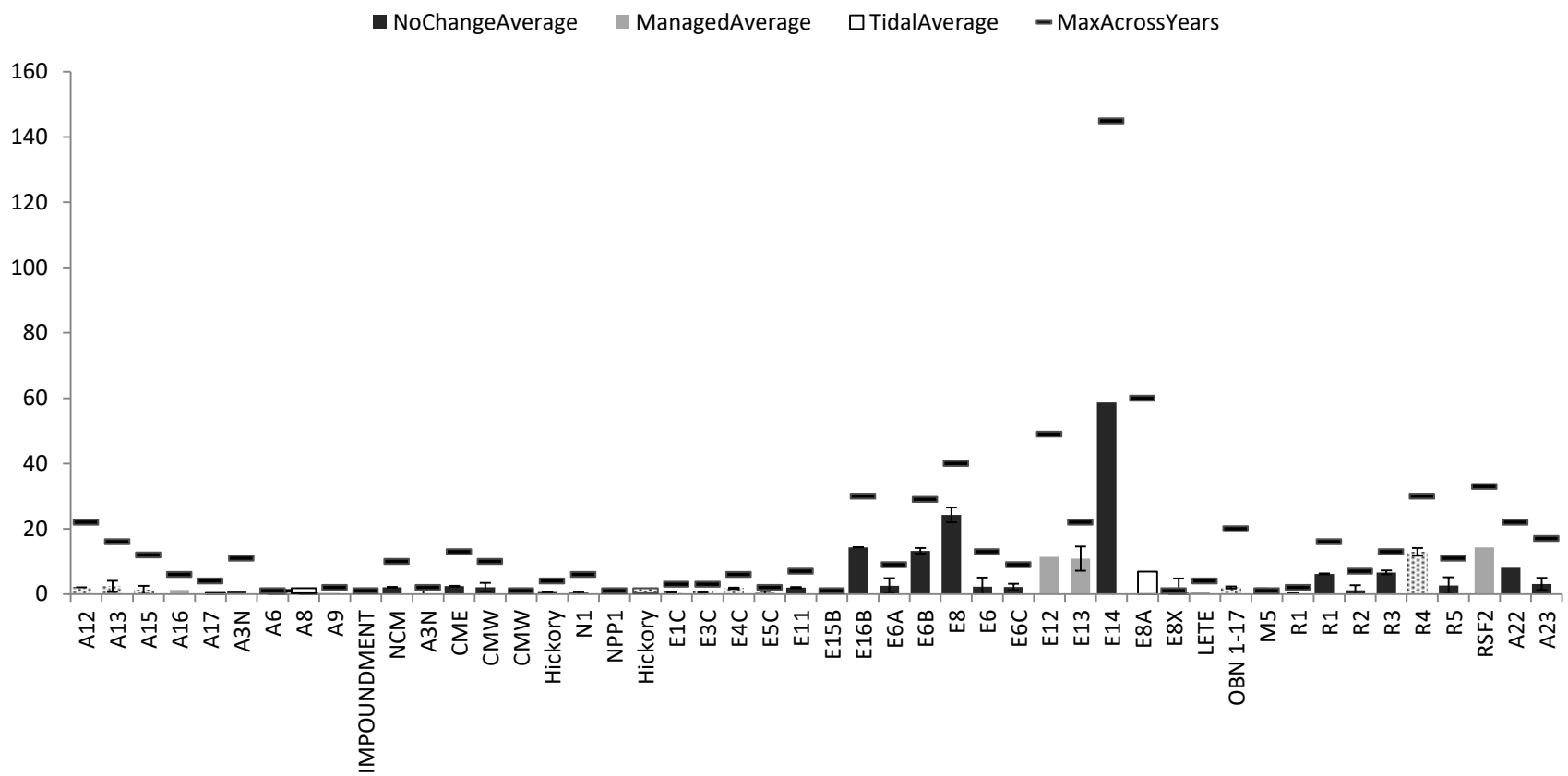


Figure 10. Average number of Snowy Plover nests initiated by pond in South SF Bay, CA from 2009-2021. Data are shown as mean + 1SD. The purpose of this figure is to illustrate which ponds have supported Snowy Plover nesting activity in recent years, and of these, which ponds were/are included in restoration plans of the South Bay Salt Pond Restoration Project. White bars denote ponds that were returned to tidal influence during Phase 1, dotted bars denote ponds that will be returned to tidal influence during upcoming tidal marsh restoration, gray bars denote ponds that are managed for multiple species (at higher water levels) with reduced Snowy Plover habitat availability, black bars denote ponds that were not/will not be directly affected by tidal marsh restoration actions in the near future, and black dashes denote the maximum number of nests at each pond across all years. Note that "NCM" = New Chicago Marsh, "CME" = Crittenden Marsh East, "CMW" = Crittenden Marsh West, and "LETE" = Hayward Least Tern Island; refer to Figs. 1-3 for the locations of ponds.


Figure 11. Ponds located in the Refuge's Warm Springs area, Fremont, California. See Figure 1 for location of Warm Springs within South San Francisco Bay.


Figure 12. Ponds in the Refuge's Dumbarton Complex, at the east end of the Dumbarton Bridge, South San Francisco Bay, California. Note that this complex includes RES Environmental Services Inc. property (Newark Slough Mitigation Bank, termed Hickory in this report). See Figure 1 for location of Dumbarton within South San Francisco Bay.

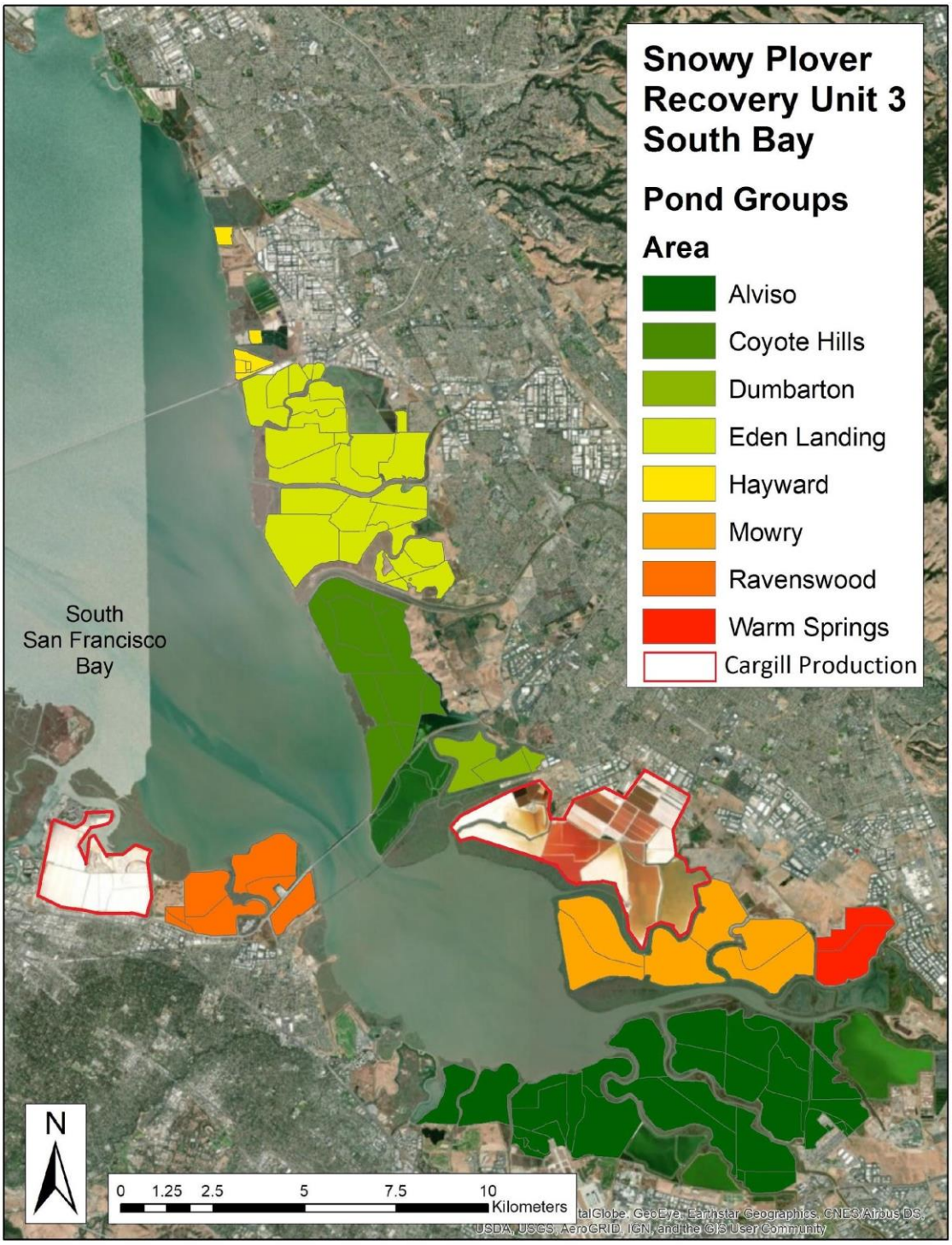


Figure 13. Cargill salt production ponds in relation to other pond groups, South San Francisco Bay, CA. The Redwood City plant is located west of the Ravenswood ponds, while the Newark plant is located between the Dumbarton and Mowry ponds.

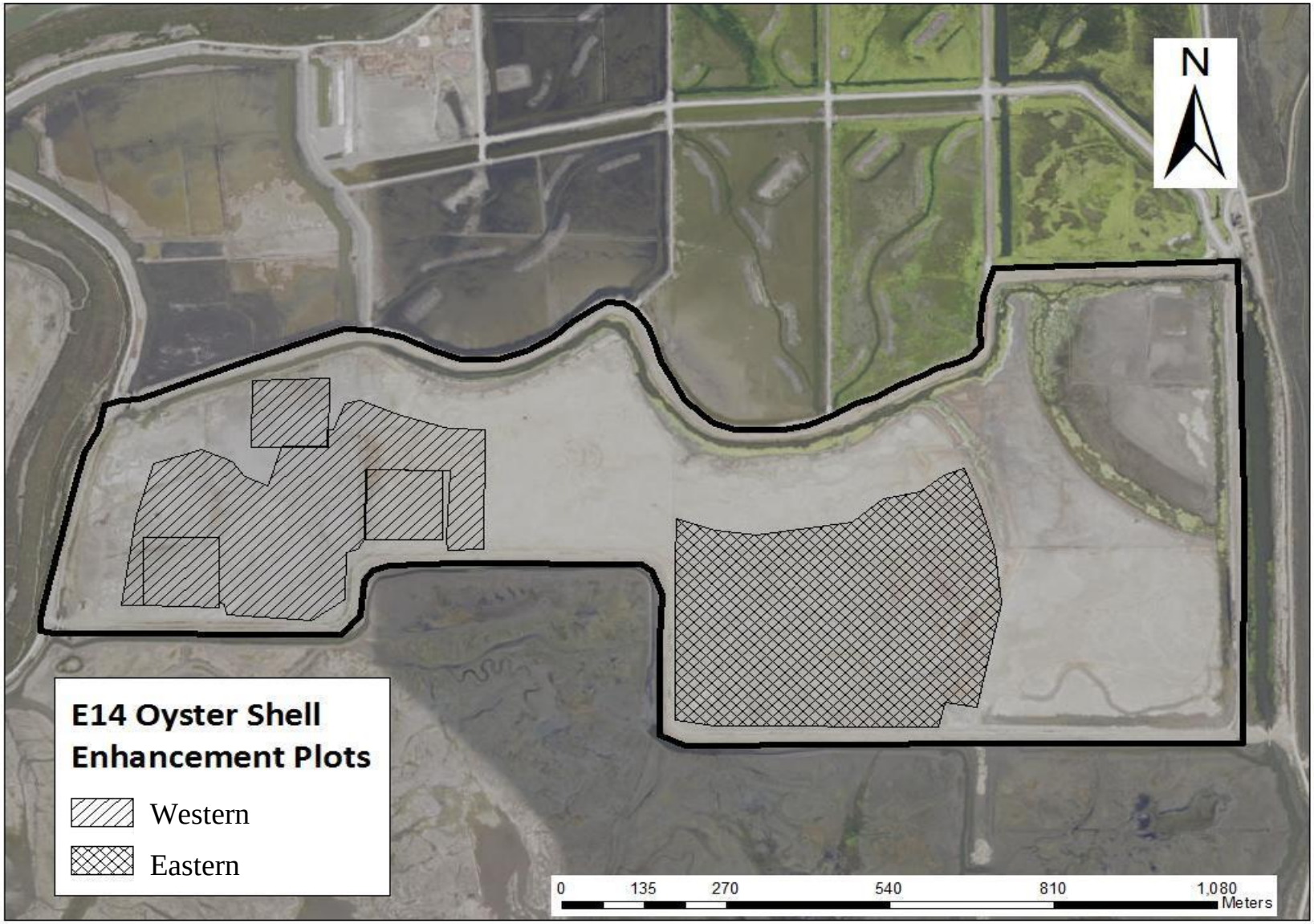


Figure 14. Oyster shell enhancement plots at Pond E14, Eden Landing Ecological Reserve, Hayward, CA.

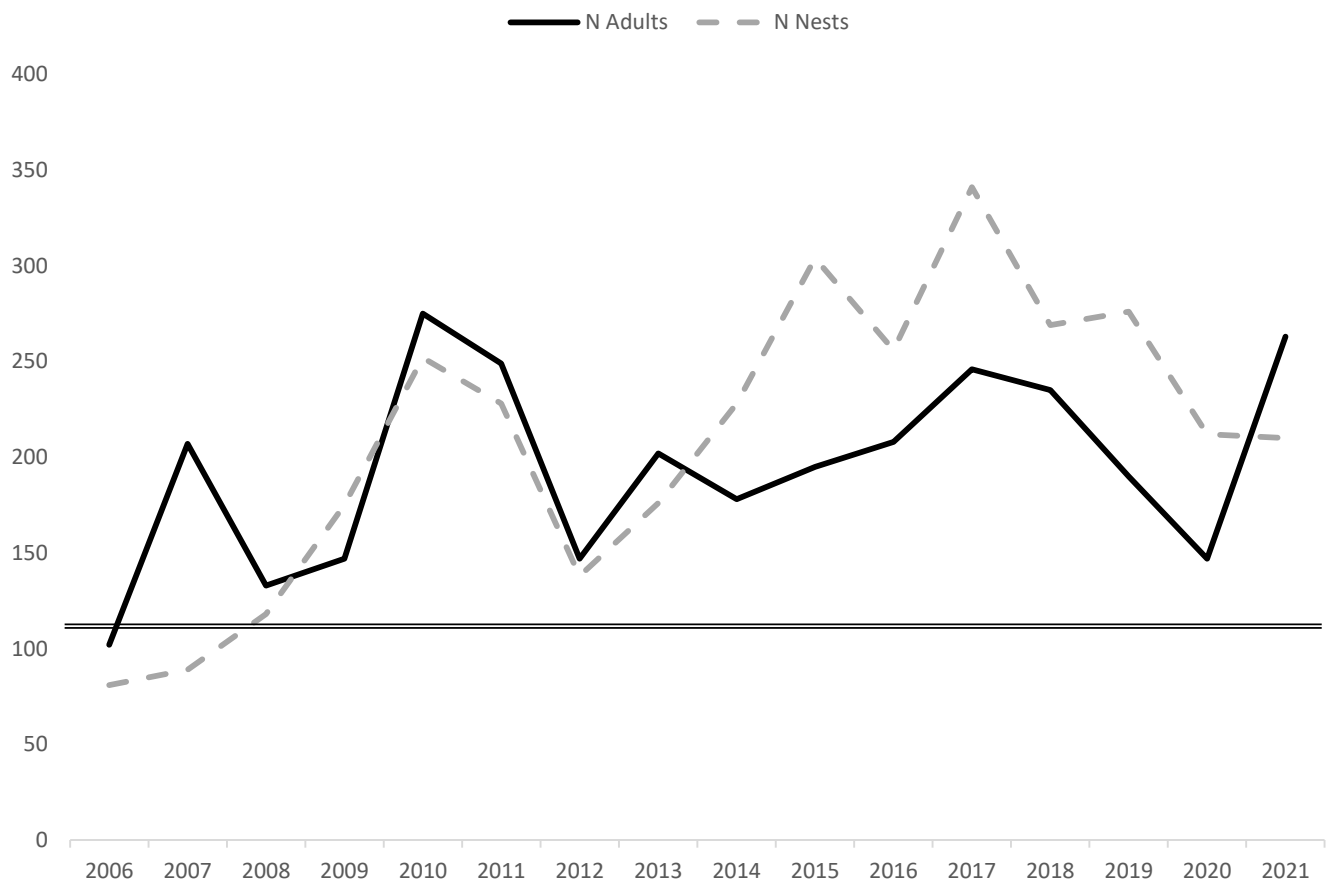


Figure 15. The total number of Snowy Plover adults counted during the breeding window survey and the total number of Snowy Plover nests counted during the season in all regularly monitored Recovery Unit 3 (RU3) areas, San Francisco Bay, from 2006-2021. The double line indicates the South Bay Salt Pond Restoration Project NEPA/CEQA baseline of 113 breeding adults on project lands, established from the average number of breeding birds from 2004-2006. Note that in 2020, due to the Covid-19 pandemic an incomplete survey that did not include Refuge Lands was conducted.

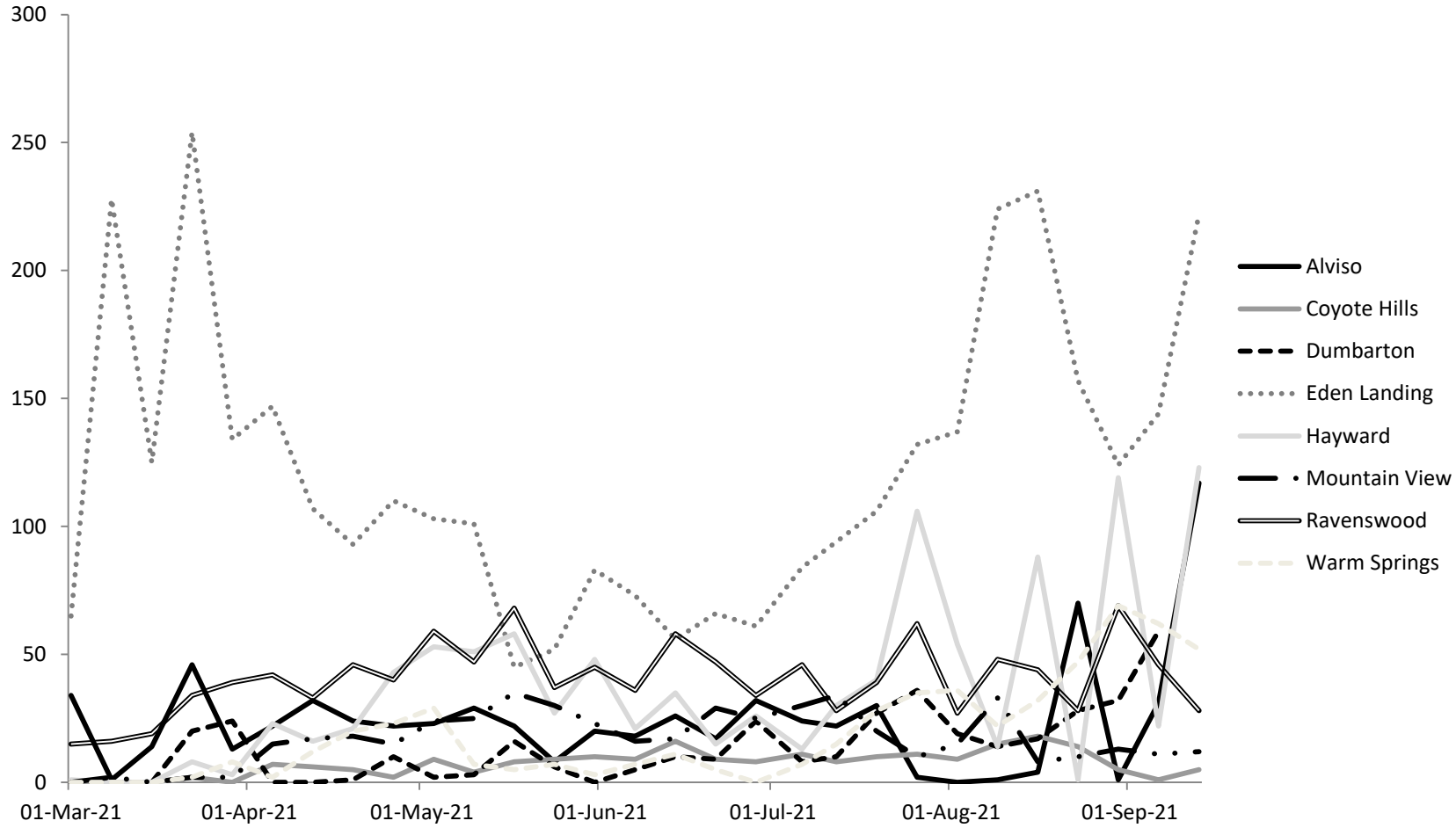


Figure 16. Weekly counts of adult Snowy Plovers by week and area, South San Francisco Bay, California, 2021. Data presented here for all locations monitored where Snowy Plovers were observed. Note the high number of Snowy Plovers observed in March, April, August, and September are presumed to be migrating and not breeding in the San Francisco Bay.

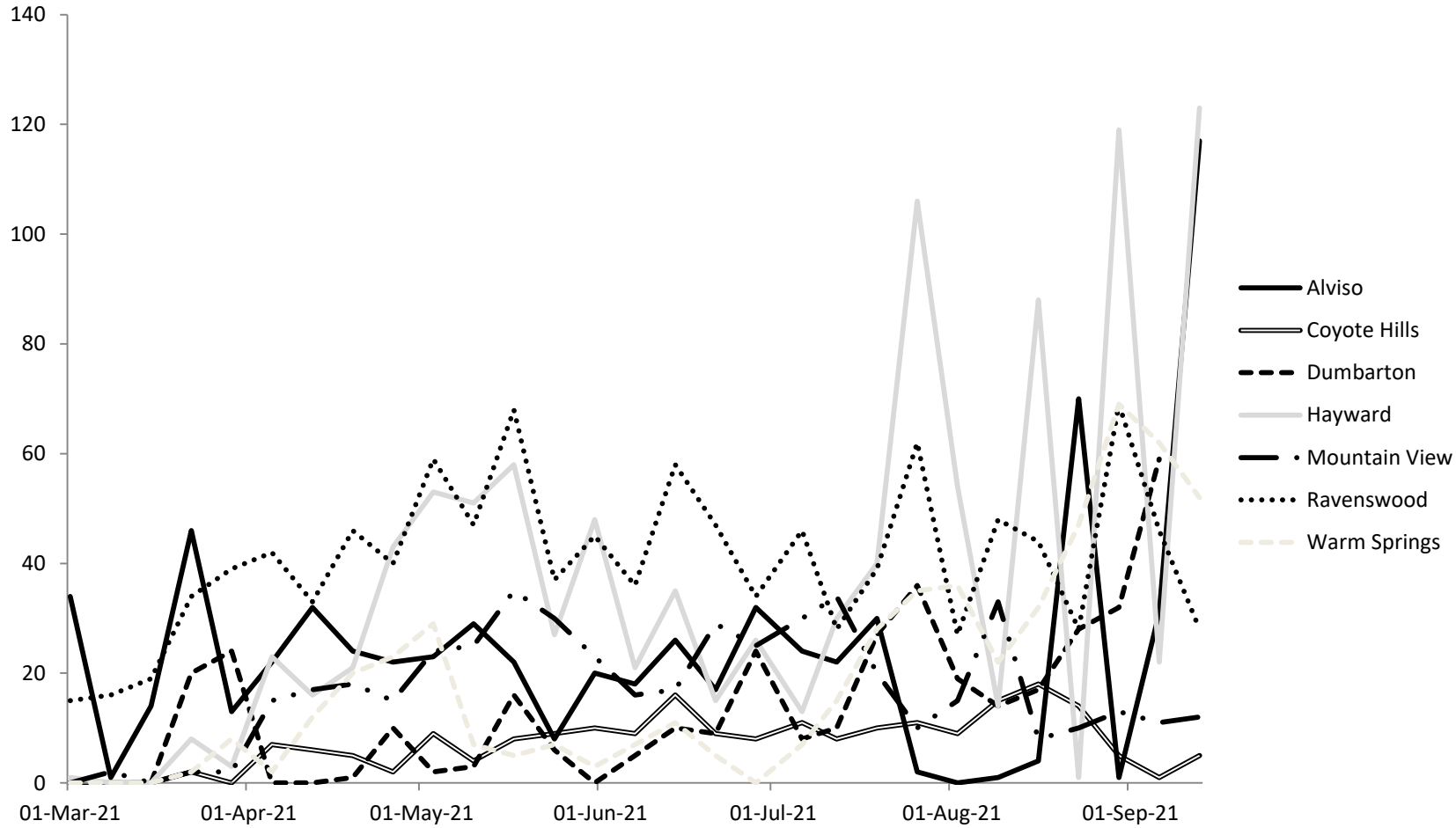


Figure 17. Weekly counts of adult Snowy Plovers by week and area, South San Francisco Bay, California, 2021. Data are presented for all locations except Eden Landing to facilitate interpretation of the data. Note the high number of Snowy Plovers observed in March, April, August, and September are presumed to be migrating and not breeding in the San Francisco Bay.

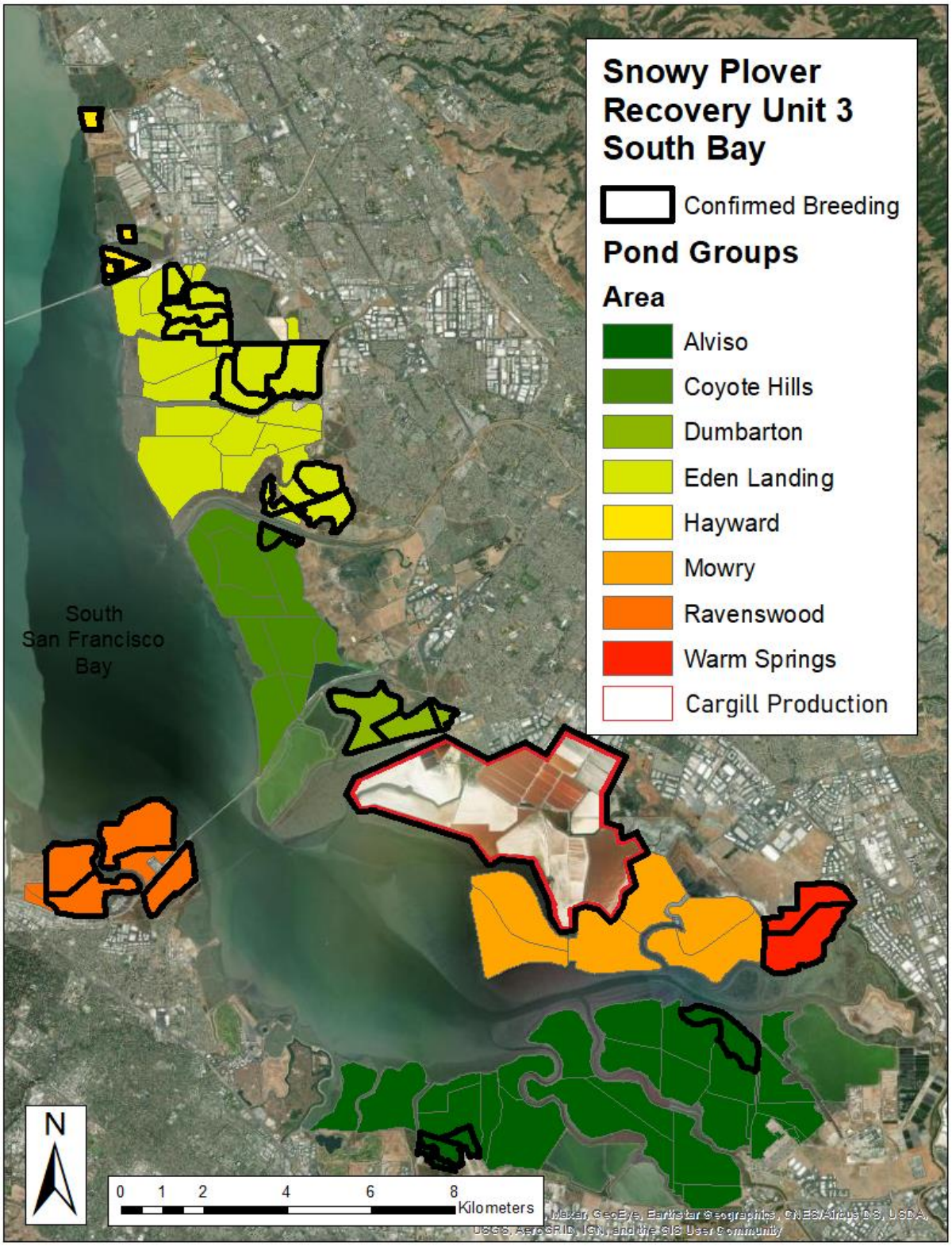


Figure 18. Areas (black outline) with documented Snowy Plover nesting activity during the 2021 breeding season, South San Francisco Bay, California.

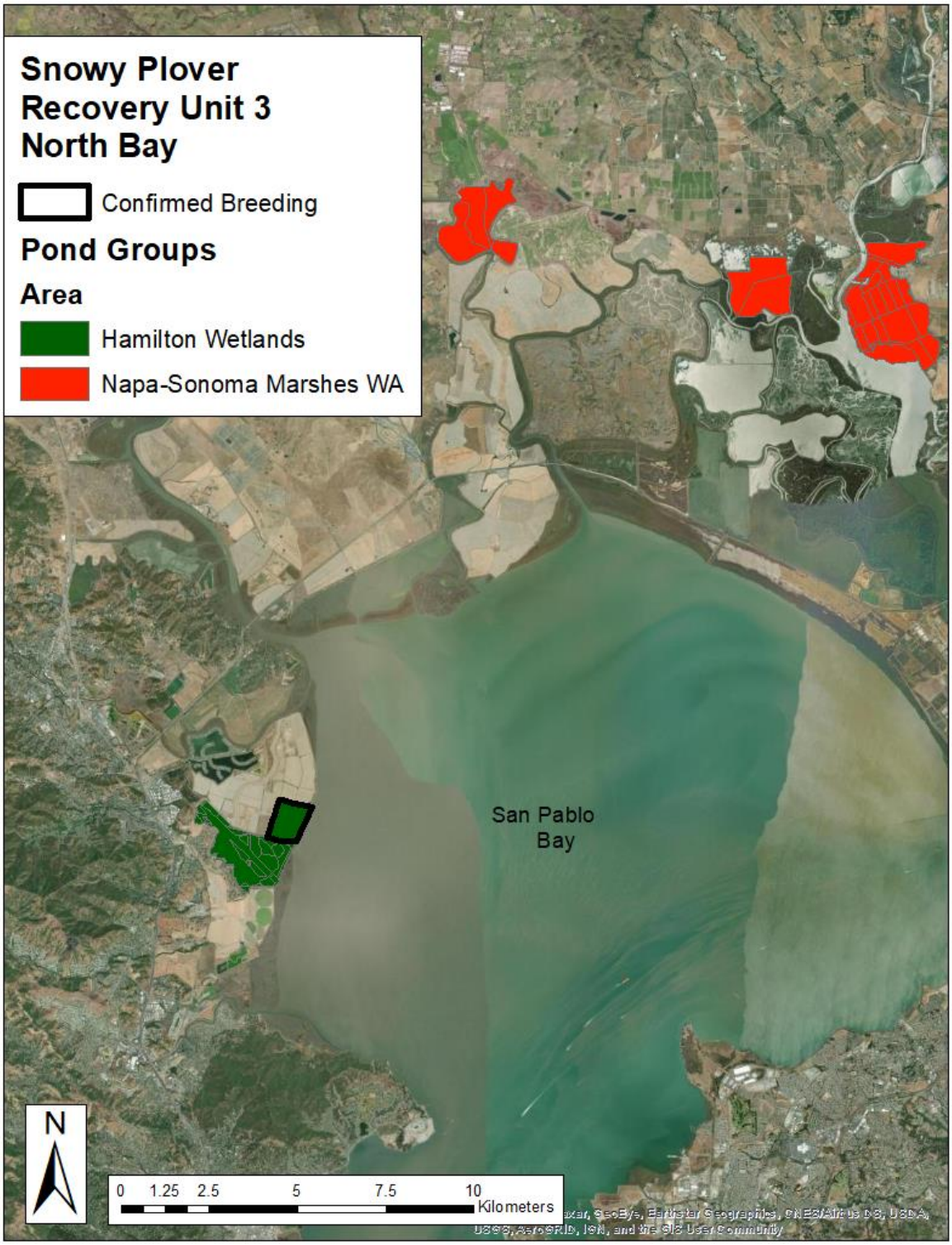


Figure 19. Areas (black outline) with documented Snowy Plover nesting activity during the 2021 breeding season, San Pablo Bay, California.

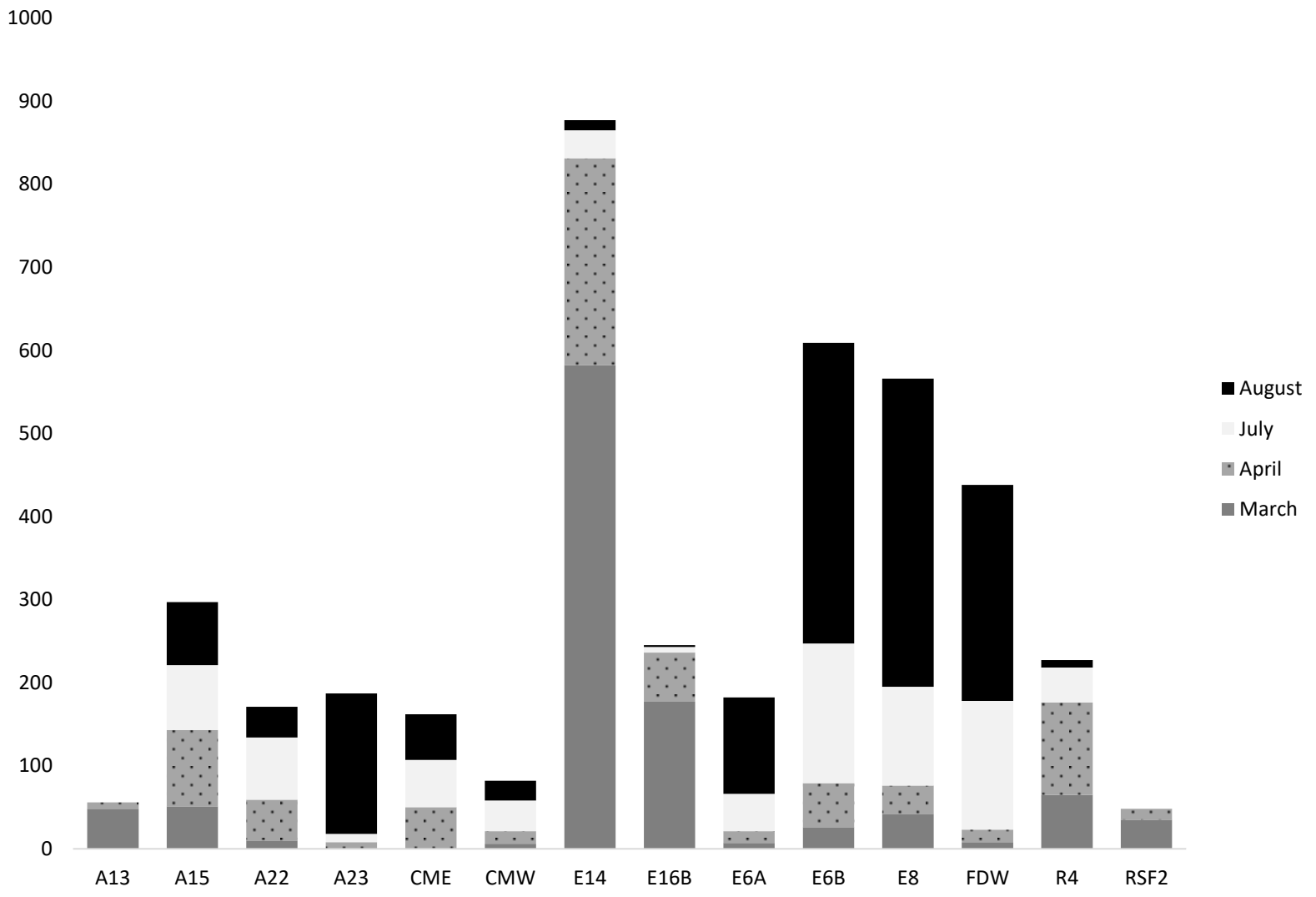


Figure 20. Sum of adult plovers observed during surveys at select ponds during March, April, July and August, 2021. The purpose of this figure is to show that ponds are used by Snowy Plovers in varying intensity during the beginning and end of the breeding season.

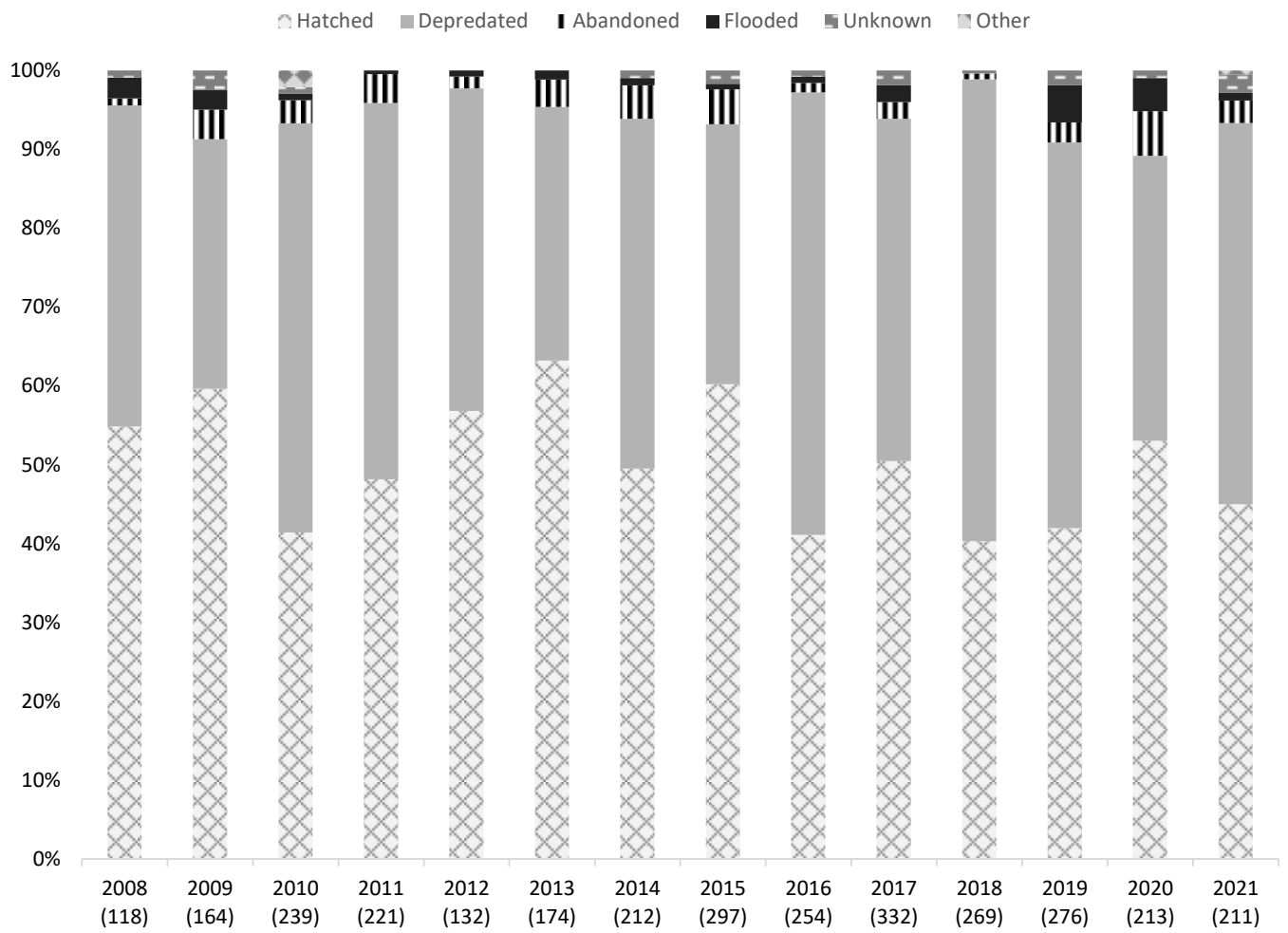


Figure 21. Annual apparent Snowy Plover nest fates in the South San Francisco Bay, California, 2008-2021. The number of nests monitored is indicated in parentheses beneath the year.

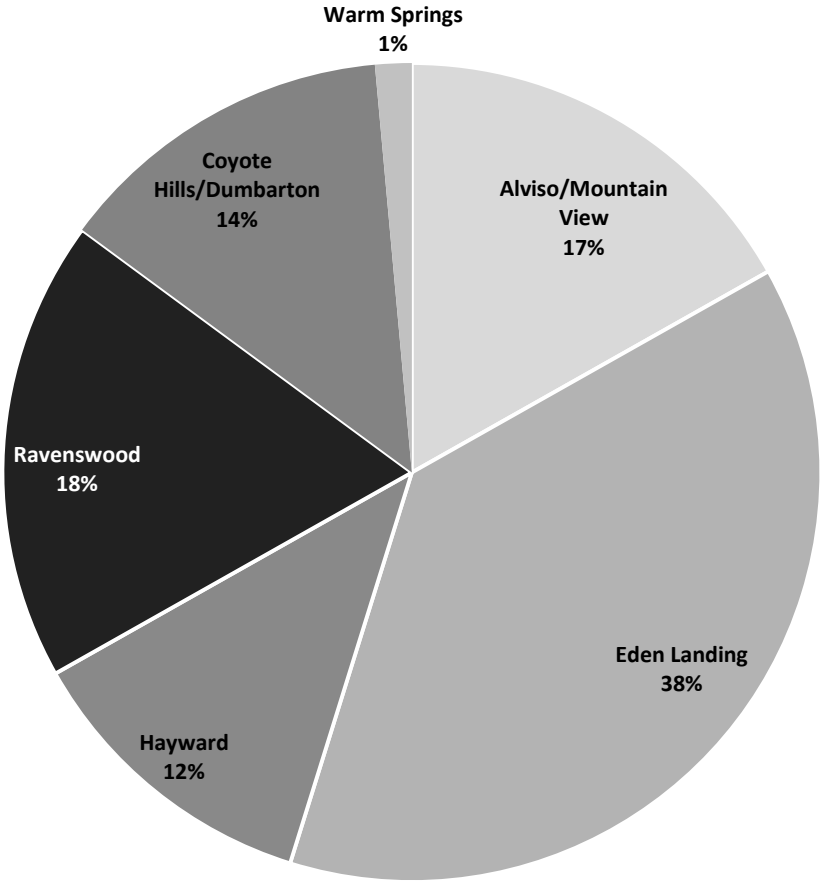


Figure 22. The proportion of Snowy Plover nests found in each pond complex in the South San Francisco Bay, California, 2021.

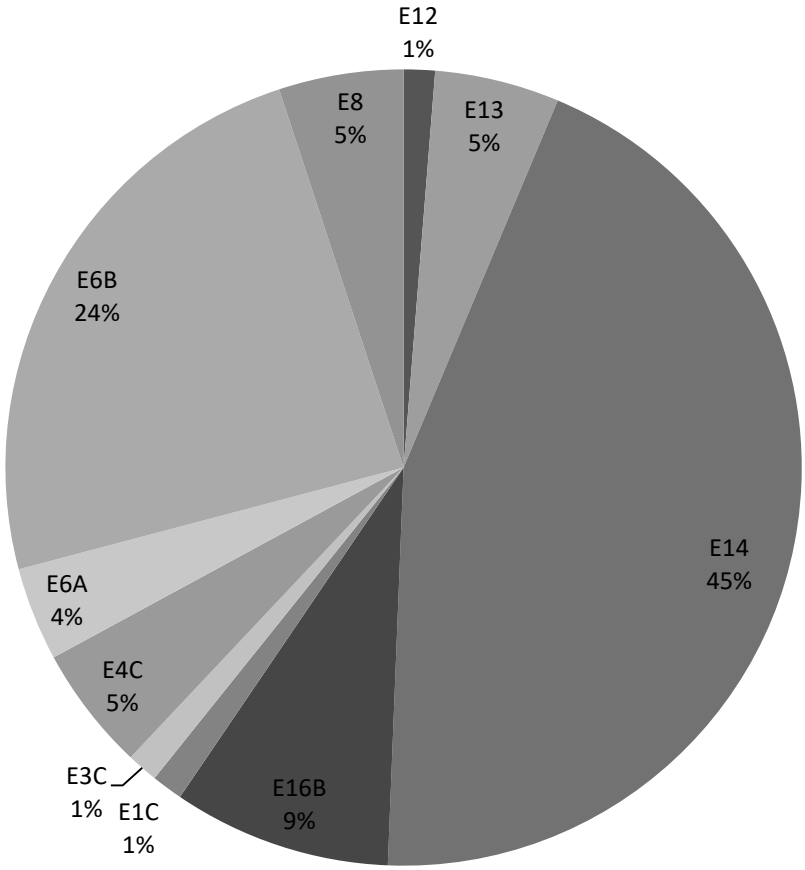


Figure 23. The proportion of Snowy Plover nests found in each pond within the Eden Landing Ecological Reserve, Hayward, California, 2021. Note that 45% of Eden Landing nests were found in pond E14.

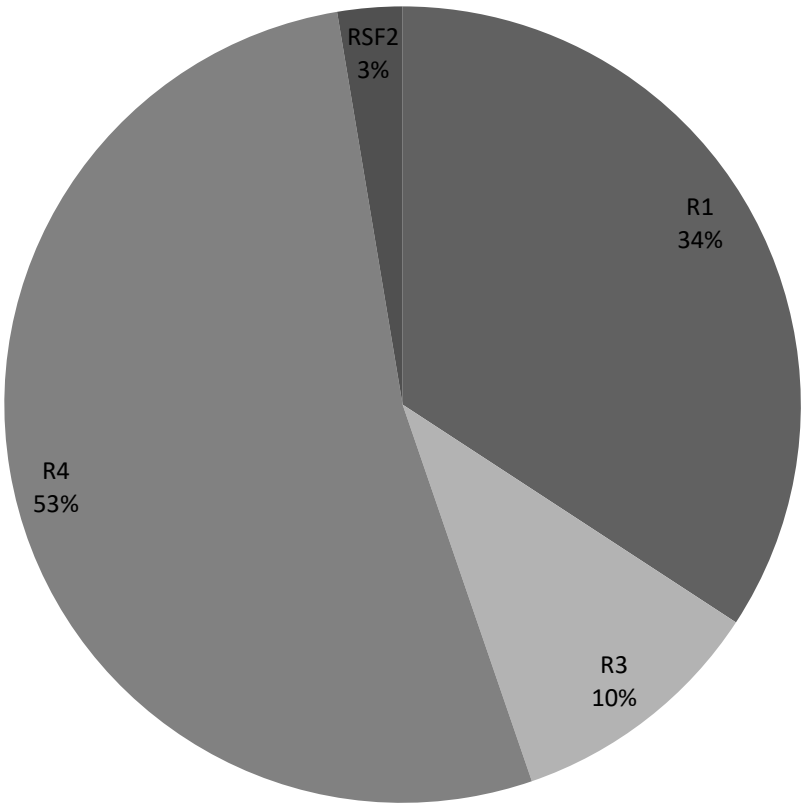


Figure 24. The proportion of Snowy Plover nests found in each pond within the Ravenswood Complex, Don Edwards San Francisco Bay National Wildlife Refuge, Menlo Park, California, 2021. Note that 53% of Ravenswood nests were found in pond R4.

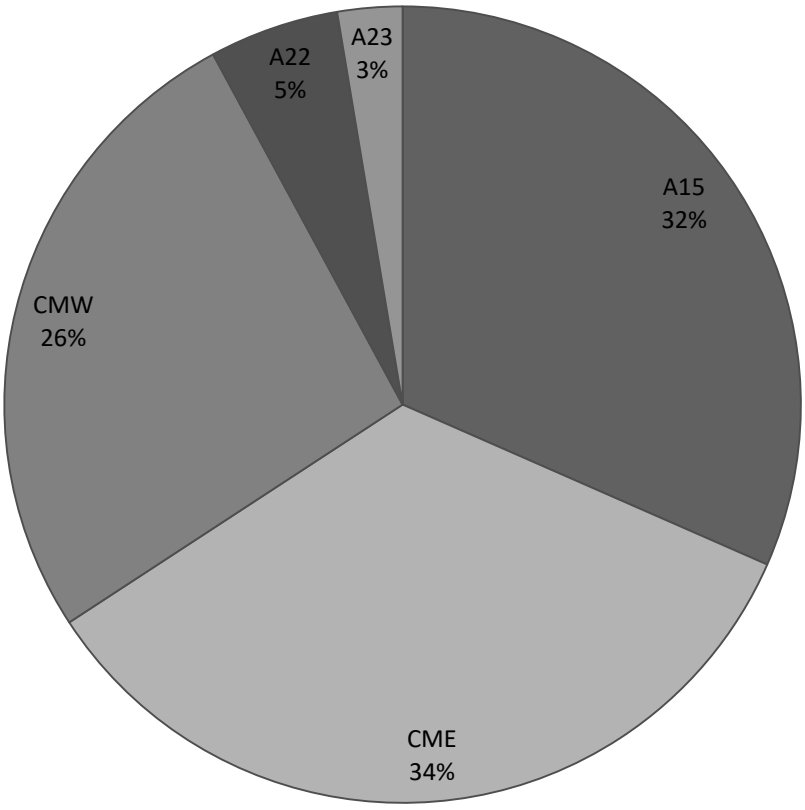


Figure 25. The proportion of Snowy Plover nests found in each pond collectively within the Alviso Pond Complex, Don Edwards San Francisco Bay National Wildlife Refuge and Midpeninsula Regional Open Space District and NASA co-owned Crittenden Marsh, Santa Clara County and Alameda County, California, 2021.

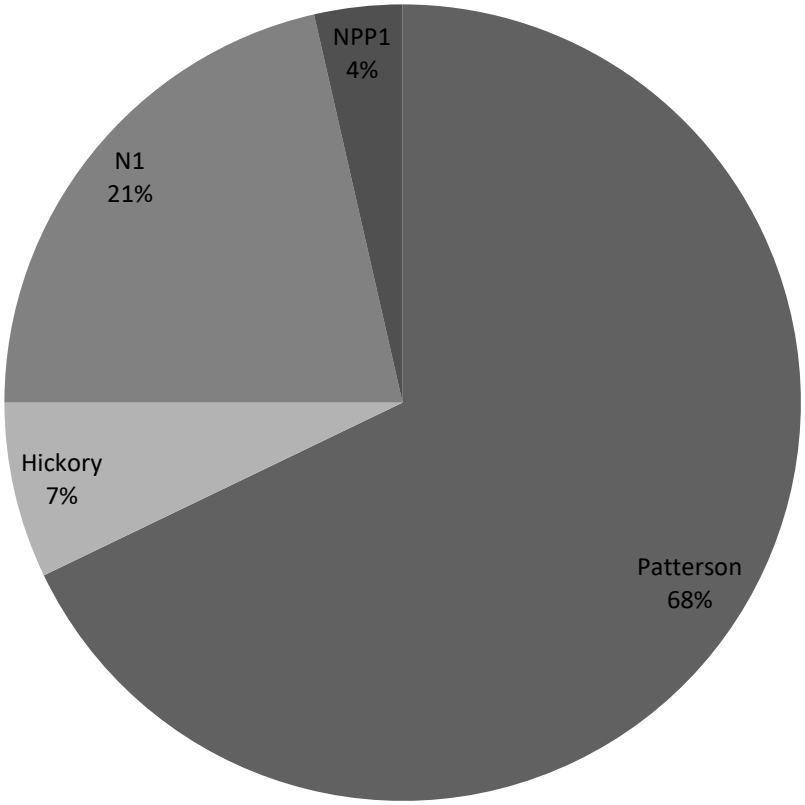


Figure 26. The proportion of Snowy Plover nests found in each pond collectively within the Dumbarton Complex, Don Edwards San Francisco Bay National Wildlife Refuge and Alameda County Flood Control District's Patterson Pond, Alameda County, California, 2021.

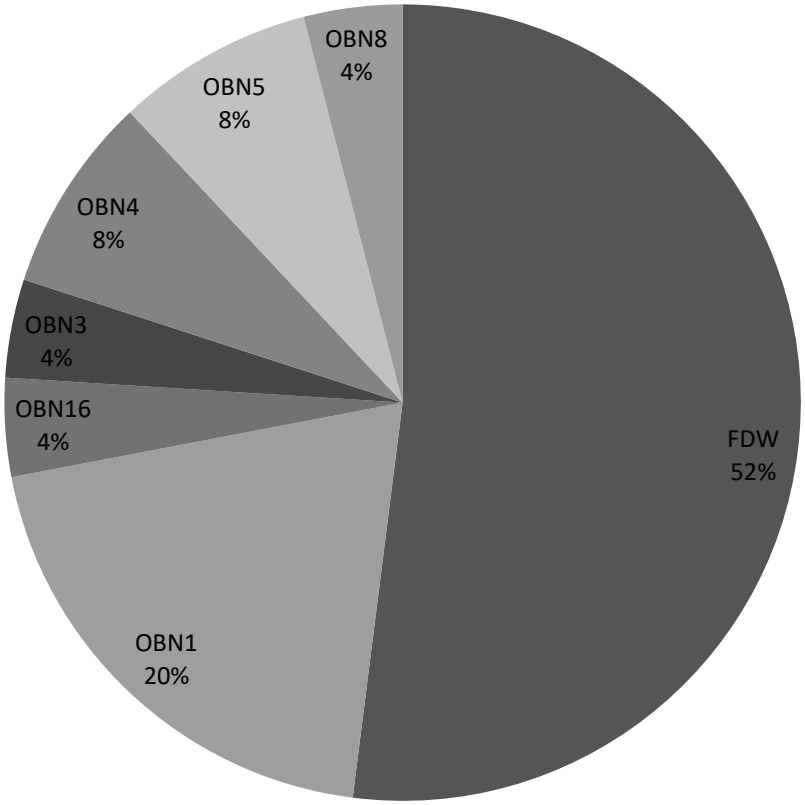


Figure 27. The proportion of Snowy Plover nests found in each pond collectively within Hayward Area Recreation District owned property at Hayward Regional Shoreline, Alameda County, California, 2021.

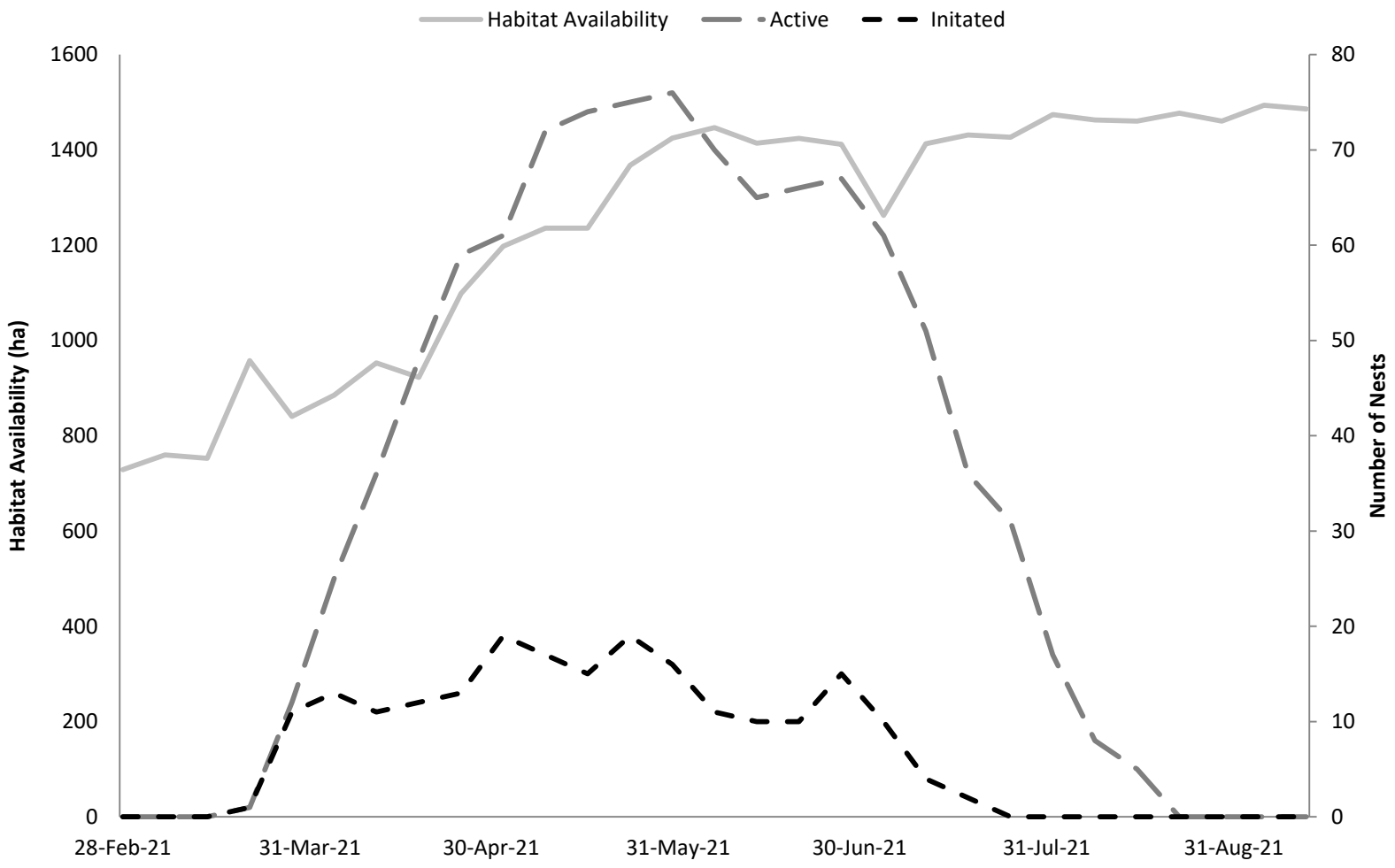


Figure 28. The weekly number of initiated and active Snowy Plover nests and estimated habitat availability in the South San Francisco Bay, California, 2021.

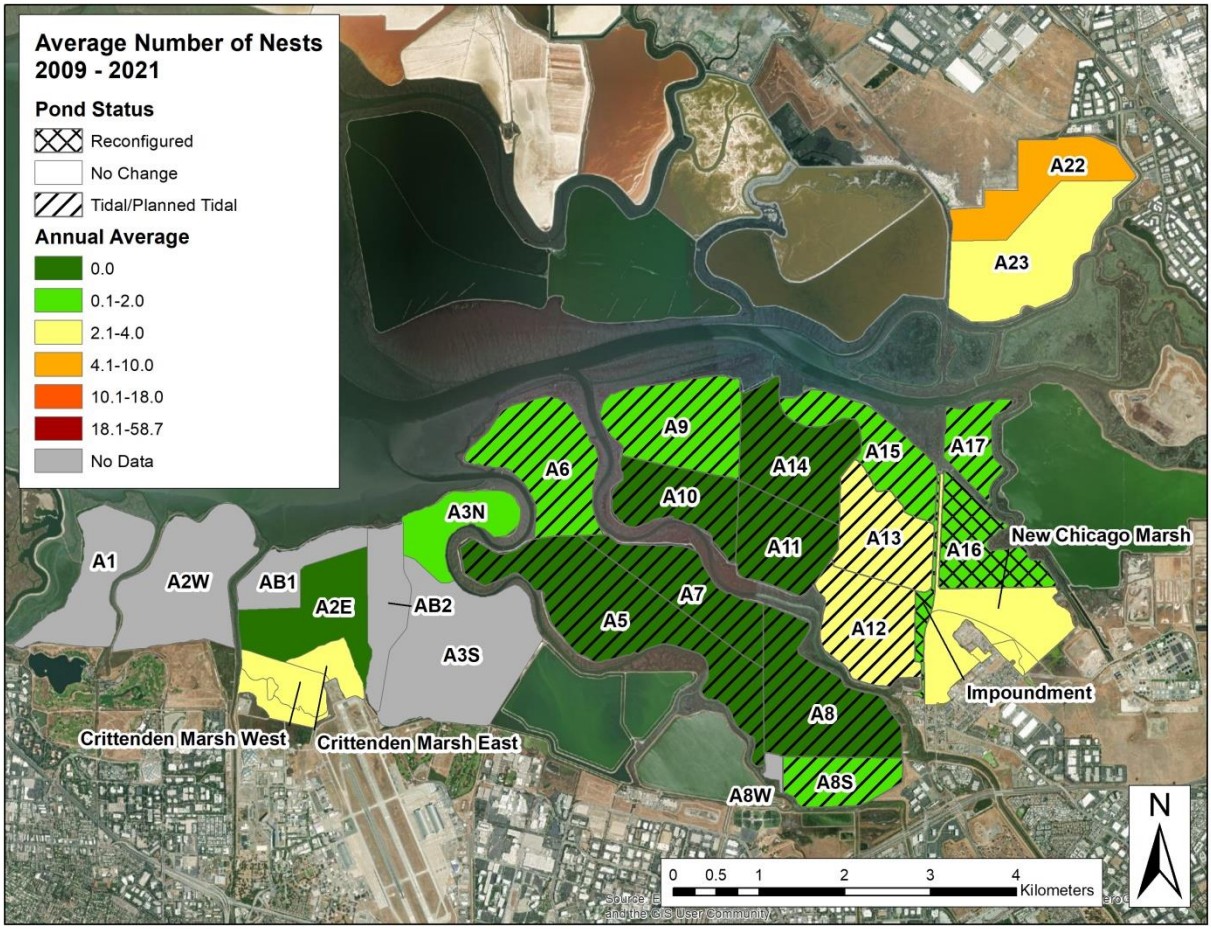


Figure 29. Average number of Snowy Plover nests initiated by pond in the Alviso Complex, South San Francisco Bay, California from 2009-2021. The purpose of this figure is to illustrate which ponds have supported Snowy Plover nesting activity in recent years, and of these, which ponds were/are scheduled for tidal marsh restoration. Diagonal lines denote ponds that have been/will be returned to tidal (or muted tidal) influence, hatch lines denote ponds that were reconfigured, and solid colors denote ponds that have not been/will not be directly affected in the near future. The gradient shading denotes the average number of Snowy Plover nests on the pond. Note that Snowy Plovers did not start nesting on ponds A16 and A17 until they were drained for construction; they did not historically provide nesting habitat.

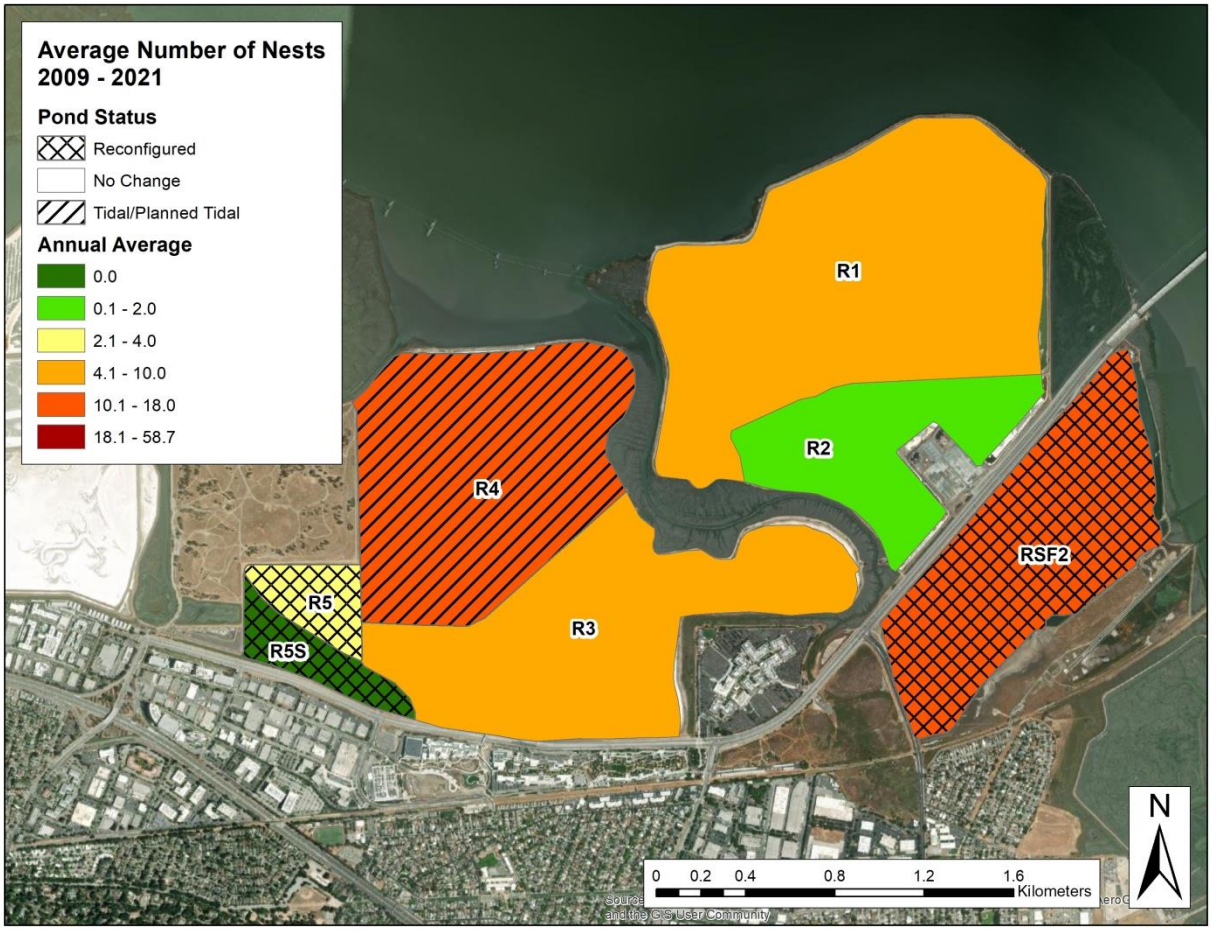


Figure 30. Average number of Snowy Plover nests initiated by pond in the Ravenswood Complex, South San Francisco Bay, California from 2009-2021. The purpose of this figure is to illustrate which ponds have supported Snowy Plover nesting activity in recent years, and of these, which ponds are included in Phase 2 restoration plans of the South Bay Salt Pond Restoration Project. Crossed hatch lines denote ponds that have been reconfigured to manage for different species and the amount of habitat available to Snowy Plovers is reduced, and solid colors denote ponds that will not be directly affected by Phase 2 actions. The gradient shading denotes the average number of Snowy Plover nests on the pond.

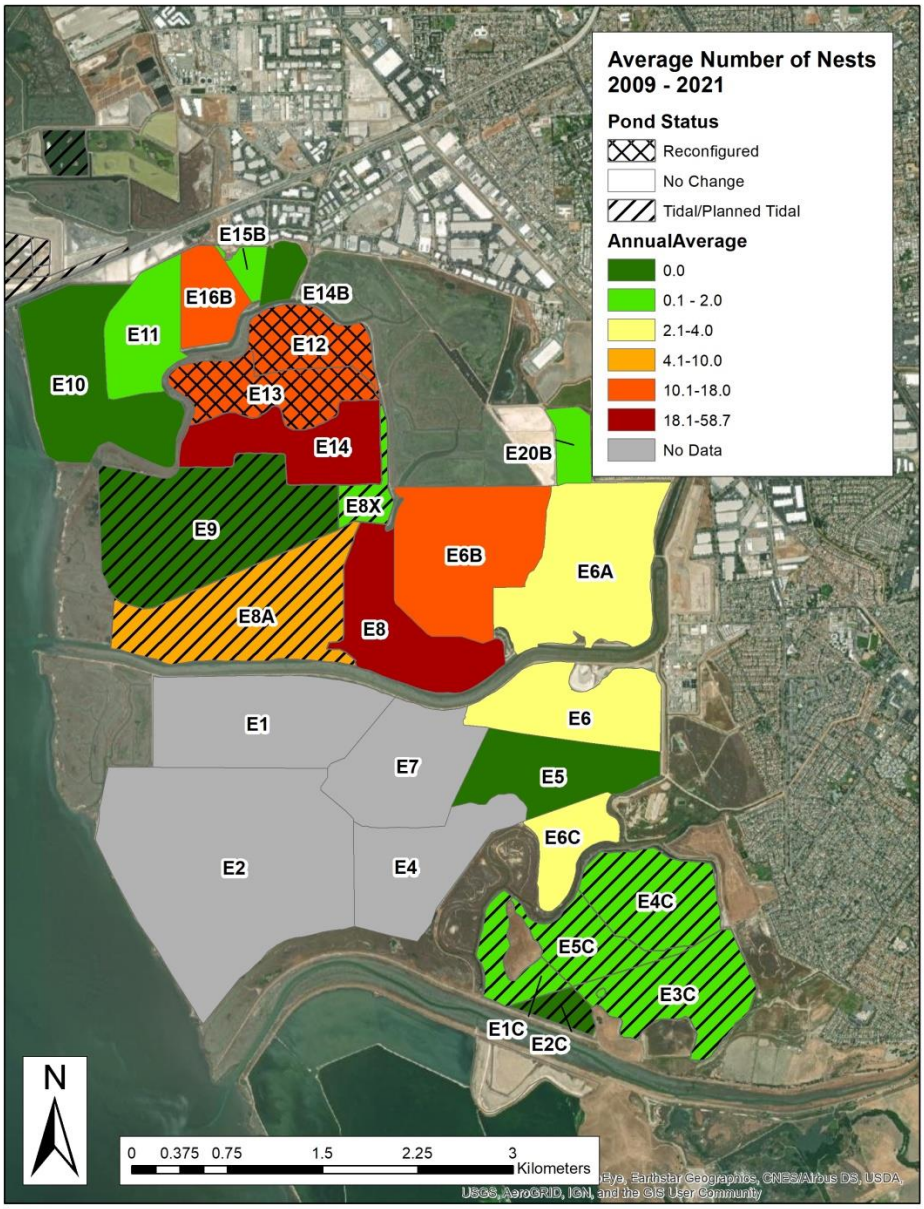


Figure 31. Average number of Snowy Plover nests initiated by pond in the Eden Landing Ecological Reserve, South San Francisco Bay, California from 2009-2021. The purpose of this figure is to illustrate which ponds have supported Snowy Plover nesting activity in recent years, and of these, which ponds were/are schedule for tidal marsh restoration. Diagonal lines denote ponds that have been/will be returned to tidal influence, crossed hatch lines denote ponds that are managed for multiple species and the amount of habitat available to Snowy Plovers was reduced, and solid colors denote ponds that will not be directly affected by tidal marsh restoration in the near future. The gradient shading denotes the average number of Snowy Plover nests on the pond. Note that pond E3C is owned by Cargill and managed largely as open water.

Table 1. Number of Western Snowy Plovers observed at Recovery Unit 3 sites during annual breeding window surveys in May, 2007-2021. Note that in 2020, due to the Covid-19 pandemic an incomplete survey that did not include Refuge Lands was conducted.

| COUNTY | SITE | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Alameda** | Eden Landing | 162 | 94 | 88 | 184 | 185 | 82 | 97 | 94 | 76 | 120 | 144 | 142 | 117 | 115 | 44 |
| | Coyote Hills | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 8 |
| | Crown Beach | - | - | - | - | - | - | - | 0 | 0 | 0 | - | - | - | - | 0 |
| | Dumbarton | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 7 | 2 | - | 16 |
| | Hayward | 0 | 1 | 4 | 12 | 8 | 9 | 32 | 7 | 2 | 4 | 0 | 7 | 12 | 19 | 56 |
| | Warm Springs | 0 | 3 | 14 | 27 | 17 | 3 | 1 | 11 | 24 | 14 | 2 | 20 | 7 | - | 5 |
| **Marin** | Hamilton Wetlands | - | - | - | - | - | - | - | - | - | 0 | - | 0 | 0 | 2 | 0 |
| **Napa** | Napa | | 0 | 12 | 10 | 1 | 0 | 3 | 10 | 10 | 0 | - | 2 | 2 | - | 0 |
| **San Mateo** | Ravenswood | 23 | 24 | 21 | 42 | 27 | 33 | 59 | 45 | 68 | 42 | 76 | 51 | 48 | - | 67 |
| **Santa Clara** | Alviso | 20 | 11 | 8 | 0 | 11 | 20 | 10 | 0 | 1 | 21 | 19 | 4 | 1 | - | 23 |
| | Mountain View | - | - | - | - | - | - | - | 11 | 0 | 0 | 0 | 2 | 0 | 8 | 35 |
| **Solano** | Montezuma Wetlands | - | - | - | - | - | - | - | - | 14 | 6 | 3 | 0 | 0 | 3 | 9 |
| **Total Unit 3** | | **207** | **133** | **147** | **275** | **249** | **147** | **202** | **178** | **195** | **208** | **246** | **235** | **190** | **147** | **263** |

Table 2. Ponds surveyed weekly in the South San Francisco Bay, 2021.

| Location | Ponds |
|---|---|
| Eden Landing | E1C-6C, E6, E6A, E6B, E8, E8XN, E10-14, E14B-E16B, E20B |
| Crittenden Marsh | CME, CMW |
| Ravenswood | R1-5S, RSF2 |
| Hayward Shoreline | FDW, FDE, OBN 1-17 |
| Alviso | A9-16, NCM |
| Dumbarton | N1, NPP1, Hickory |
| Warm Springs | A22-23 |

Table 3. Ponds in Recovery Unit 3 surveyed less frequently or by other organizations

| Location | Land Owner | Ponds |
|---|---|---|
| Least Tern Island[1] | HARD | Island 5 |
| Napa-Sonoma Marshes Wildlife Area[2] | CDFW | 7/7A, Green Island Unit, Wingo Unit |
| Hamilton Wetlands and Bel Marin Keys Restoration Site[3] | SCC | North Seasonal Wetlands, Ag. Ponds, BMK Seasonal Ponds |

[1]Surveyed weekly by EBRPD
[2]Surveyed by SFBBO staff and volunteers and CDFW staff to varying degrees
[3] Surveyed during window surveys by Hamilton Wetlands Volunteers and on two occasions by SFBBO

Table 4. Docent survey results at Eden Landing.

| Date | Location | Group Size | Type | Info. Shared | Nature of Contact | Notes |
|---|---|---|---|---|---|---|
| 3/28/21 | E12-14 | 1 | B | E,C,R,S | Very Positive | Interested in SFBBO conservation efforts |
| 3/28/21 | E12-14 | 5 | P | E,C,R,S,P | Very Positive | Interested in SFBBO conservation efforts |
| 6/27/21 | E12-14 | 1 | P | E | Positive | Live on Snowy Plover Court, didn't know what they were |
| 7/25/21 | E12-14 | 3 | P | E,C,R,S | Positive | Appreciated learning about the terns and plovers |
| 8/29/21 | E12-14 | 1 | P | E | Positive | Interested in preserving habitat and viewing wildlife |

**Type: P=Pedestrian, B=Bicyclist, O=other**
**Information Shared: E = tern/plover breeding ecology, P = salt pond history and site information, C = conservation status, R = Restoration Project, H = how to help advocate, support, S = SFBBO general info**

Table 5. Potential avian predator species.

| Common Name | Scientific Name |
|---|---|
| American Kestrel | *Falco sparverius* |
| Merlin | *Falco columbarius* |
| Peregrine Falcon | *Falco peregrines* |
| Prairie Falcon | *Falco mexicanus* |
| Bald Eagle | *Haliaeetus leucocephalus* |
| Golden Eagle | *Aquila chrysaetos* |
| Cooper's Hawk | *Accipiter cooperii* |
| Red-Tailed Hawk | *Buteo jamaicensis* |
| White-tailed Kite | *Elanus leucurus* |
| Northern Harrier | *Circus Cyaneus* |
| California Gull | *Larus californicus* |
| Western Gull | *Larus occidentalis* |
| Herring Gull | *Larus argentatus smithsonianus* |
| Glaucous-winged Gull | *Larus glaucescens* |
| Mew Gull | *Larus canus* |
| Ring-Billed Gull | *Larus delawarensis* |
| American Crow | *Corvus brachyrhynchos* |
| Common Raven | *Corvus corax* |
| Black-crowned Night-Heron | *Nycticorax nycticorax* |
| Cattle Egret | *Bubulcus ibis* |
| Great Blue Heron | *Ardea herodias* |
| Great Egret | *Ardea alba* |
| Snowy Egret | *Egretta thula* |
| Loggerhead Shrike | *Lanius ludovicianus* |

Table 6. Potential mammalian predator species.

| Common Name | Scientific Name |
|---|---|
| Coyote | *Canis latrans* |
| Domestic Cat | *Felis catus* |
| Grey Fox | *Urocyon cinereoargenteus* |
| Common Raccoon | *Procyon lotor* |
| Red fox | *Vulpes vulpes* |
| Striped Skunk | *Mephitis mephitis* |
| Virginia Possum | *Didelphis virginiana* |

Table 7. Snowy Plover nest fates by pond in the South San Francisco Bay, California, 2021.

| Location | Hatched | Depredated | Abandoned | Flooded | Failed to Hatch | Unknown | **Monitored** | Detect as Brood | **Total** |
|---|---|---|---|---|---|---|---|---|---|
| **Alviso** | | | | | | | | | |
| A15 | 9 | 2 | 0 | 0 | 0 | 1 | **12** | 4 | **16** |
| **Cargill Production** | | | | | | | | | |
| Newark | 0 | 0 | 0 | 0 | 0 | 1 | **1** | 0 | **1** |
| Redwood City | 0 | 0 | 0 | 0 | 0 | 0 | **0** | 0 | **0** |
| **Coyote Hills** | | | | | | | | | |
| Patterson Pond | 14 | 3 | 1 | 0 | 0 | 1 | **19** | 0 | **19** |
| **Dumbarton** | | | | | | | | | |
| Hickory | 2 | 0 | 0 | 0 | 0 | 0 | **2** | 0 | **2** |
| N1 | 6 | 0 | 0 | 0 | 0 | 0 | **6** | 3 | **9** |
| NPP1 | 0 | 1 | 0 | 0 | 0 | 0 | **1** | 0 | **1** |
| **Eden Landing** | | | | | | | | | |
| E6A | 1 | 2 | 0 | 0 | 0 | 0 | **3** | 0 | **3** |
| E6B | 4 | 14 | 1 | 0 | 0 | 0 | **19** | 2 | **21** |
| E8 | 1 | 3 | 0 | 0 | 0 | 0 | **4** | 3 | **7** |
| E12 | 0 | 1 | 0 | 0 | 0 | 0 | **1** | 1 | **2** |
| E13 | 1 | 2 | 0 | 0 | 0 | 1 | **4** | 0 | **4** |
| E14 | 9 | 25 | 1 | 0 | 0 | 0 | **35** | 5 | **40** |
| E16B | 0 | 7 | 0 | 0 | 0 | 0 | **7** | 3 | **10** |
| E1C | 0 | 0 | 0 | 1 | 0 | 0 | **1** | 0 | **1** |
| E3C | 0 | 1 | 0 | 0 | 0 | 0 | **1** | 0 | **1** |
| E4C | 2 | 2 | 0 | 0 | 0 | 0 | **4** | 0 | **4** |
| **Hayward** | | | | | | | | | |
| FDW | 2 | 11 | 0 | 0 | 0 | 0 | **13** | 0 | **13** |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| LETE | 3 | 0 | 0 | 0 | 0 | 0 | **3** | 0 | **3** |
| OBN1 | 1 | 4 | 0 | 0 | 0 | 0 | **5** | 0 | **5** |
| OBN3 | 1 | 0 | 0 | 0 | 0 | 0 | **1** | 0 | **1** |
| OBN4 | 0 | 1 | 0 | 0 | 0 | 0 | **1** | 1 | **2** |
| OBN5 | 0 | 2 | 0 | 0 | 0 | 0 | **2** | 0 | **2** |
| OBN8 | 1 | 0 | 0 | 0 | 0 | 0 | **1** | 0 | **1** |
| OBN16 | 1 | 0 | 0 | 0 | 0 | 0 | **1** | 0 | **1** |
| **Mountain View** | | | | | | | | | |
| CME | 3 | 10 | 0 | 0 | 0 | 0 | **13** | 2 | **15** |
| CMW | 5 | 4 | 1 | 0 | 0 | 0 | **10** | 0 | **10** |
| **Ravenswood** | | | | | | | | | |
| R1 | 10 | 0 | 0 | 1 | 1 | 1 | **13** | 4 | **17** |
| R3 | 3 | 1 | 0 | 0 | 0 | 0 | **4** | 0 | **4** |
| R4 | 13 | 5 | 2 | 0 | 0 | 0 | **20** | 4 | **24** |
| SF2 | 1 | 0 | 0 | 0 | 0 | 0 | **1** | 0 | **1** |
| **Warm Springs** | | | | | | | | | |
| A22 | 1 | 1 | 0 | 0 | 0 | 0 | **2** | 4 | **6** |
| A23 | 1 | 0 | 0 | 0 | 0 | 0 | **1** | 3 | **4** |
| Total South Bay | 95 | 102 | 6 | 2 | 1 | 5 | **211** | 39 | 250 |
| **Hamilton Wetlands** | | | | | | | | | |
| Ag. Ponds | 1 | 1 | 0 | 0 | 0 | 0 | **2** | 0 | **2** |
| **Montezuma Wetlands** | | | | | | | | | |
| Cell 14 North **NSMWA** | 2 | 0 | 0 | 0 | 0 | 0 | **2** | 1 | **3** |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 7/7A | 0 | 0 | 0 | | 0 | | **0** | 0 | **0** |
| Wingo | 0 | 0 | 0 | 0 | 0 | 0 | **0** | 0 | **0** |
| **Total North Bay** | **3** | **1** | **0** | **0** | **0** | **0** | **4** | **1** | **5** |
| **RU3 Total** | **98** | **103** | **6** | **2** | **1** | **5** | **215** | **40** | **255** |

Table 8. Nests detected at the brood stage in the South San Francisco Bay, California, 2021.

| Pond | # Nests |
|---|---|
| A15 | 5 |
| A22 | 4 |
| A23 | 3 |
| CME | 2 |
| E12 | 1 |
| E14 | 5 |
| E16B | 3 |
| E6B | 2 |
| E8 | 3 |
| N1 | 3 |
| OBN4 | 1 |
| R1 | 4 |
| R4 | 4 |
| **Total** | **40** |

Table 9. Apparent fledging success (all sites combined) of Snowy Plover chicks in the South San Francisco Bay, California, 2008-2021. Chicks were considered fledged if they survived to 31 days (2008-2016), and 28 days (2017-2020). *N* is the number of chicks banded.

| Year | N | Fledging Success |
|---|---|---|
| 2021 | 149 | 31% |
| 2020 | 85 | 27% |
| 2019 | 60 | 32% |
| 2018 | 31 | 19% |
| 2017 | 55 | 44% |
| 2016 | 66 | 27% |
| 2015 | 116 | 34% |
| 2014 | 52 | 27% |
| 2013 | 14 | 36% |
| 2012 | 8 | 50% |
| 2011 | 36 | 14% |
| 2010 | 39 | 41% |
| 2009 | 113 | 25% |
| 2008 | 83 | 29% |

Table 10. Apparent fledging success of Snowy Plover chicks by pond and chicks fledged per male in the South San Francisco Bay, California, 2021. Chicks were considered fledged if they survived to 28 days. *N* is the number of individuals banded.

| Pond | N | Fledged | Fledging Success | Males | Chicks fledged/Male |
|---|---|---|---|---|---|
| A22 | 7 | 3 | 43% | 3 | 1.0 |
| CMW | 11 | 7 | 64% | 4 | 1.75 |
| CME | 7 | 1 | 14% | 3 | 0.33 |
| E14 | 23 | 3 | 17% | 8 | 0.50 |
| E6B | 8 | 0 | 18% | 4 | 0.50 |
| E8 | 4 | 2 | 50% | 2 | 1.0 |
| FDW | 2 | 1 | 50% | 1 | 1.0 |
| N1 | 6 | 4 | 67% | 2 | 2 |
| OBN | 8 | 1 | 13% | 3 | 0.33 |
| Patterson | 13 | 3 | 23% | 5 | 0.60 |
| R1 | 23 | 10 | 43% | 8 | 1.25 |
| R3 | 3 | 0 | 0% | 1 | 0 |
| R4 | 31 | 10 | 32% | 12 | 0.83 |
| SF2 | 3 | 0 | 0% | 1 | 0 |
| **Total** | **149** | **46** | **31%** | **56** | **0.82** |

Table 11. Adult Snowy Plovers banded by pond and sex in the South San Francisco Bay, 2021.

| Pond | Male | Female |
|---|---|---|
| A22 | 1 | 0 |
| CMW | 2 | 0 |
| E14 | 2 | 1 |
| E6B | 0 | 1 |
| E8 | 1 | 0 |
| N1 | 1 | 1 |
| Patterson | 1 | 2 |
| R1 | 2 | 2 |
| R3 | 1 | 0 |
| R4 | 3 | 0 |
| **Total** | **14** | **7** |

Table 12. Snowy Plover color band combinations deployed in 2021.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ak:ay | gk:ow | ka:rw | ko:br | na:oy | on:gy | rk:aw | rk:rr | wn:wb | yv:py |
| ak:ba | gk:pw | ka:ww | ko:gr | na:ra | on:og | rk:ay | rk:rw | wn:yb | yv:rb |
| ak:by | gk:wr | ka:wy | ko:oa | ng:ag | on:or | rk:bb | rk:ry | wn:yo | yv:rg |
| ak:gy | gk:ww | ka:yo | ko:ob | ng:ay | on:ow | rk:bg | rk:wo | wn:yw | yv:rr |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ak:og | gk:yp | ka:yr | ko:og | ng:bg | on:oy | rk:bw | rk:wy | yv:ab | yv:ry |
| ak:or | gk:yw | kk:ay | ko:ow | ng:gg | on:pa | rk:gb | rk:yb | yv:ag | yv:wg |
| ak:ra | ka:aa | kk:bb | ko:oy | ng:og | on:pg | rk:gg | rk:yw | yv:ay | yv:wr |
| ak:rw | ka:ab | kk:ow | ko:pb | ng:pb | on:pr | rk:gw | wn:aa | yv:bb | yv:ww |
| ak:wo | ka:ao | kk:po | ko:pr | ng:po | on:pw | rk:ob | wn:ab | yv:br | yv:wy |
| ak:wr | ka:ar | kk:rg | ko:py | ng:ra | on:rp | rk:op | wn:ba | yv:by | yv:yb |
| ak:ww | ka:aw | kk:rr | ko:rb | ng:rb | on:rr | rk:ow | wn:bo | yv:ga | yv:yr |
| ak:yg | ka:ay | kk:rw | ko:rr | ng:rp | on:wg | rk:pa | wn:og | yv:gb | yv:yw |
| gk:bw | ka:bo | kk:yp | ko:rw | ng:rw | on:ww | rk:pb | wn:oo | yv:gr | yv:yy |
| gk:ga | ka:by | kk:yr | ko:ww | ng:wa | on:yb | rk:pg | wn:pa | yv:gy | |
| gk:gg | ka:gg | ko:aa | ko:yr | on:aa | on:yy | rk:po | wn:pb | yv:oy | |
| gk:gr | ka:oo | ko:ao | na:ba | on:br | rk:ab | rk:pr | wn:pg | yv:pg | |
| gk:gy | ka:pa | ko:ar | na:gy | on:go | rk:ag | rk:pw | wn:rw | yv:pr | |
| gk:op | ka:pw | ko:bo | na:oo | on:gr | rk:ar | rk:rg | wn:ry | yv:pw | |

a = aqua, b = blue, g = green, k = black, n = brown, o =orange, p = pink, r = red, v = violet, w = white, x =no band

Table 13. Return rates of 2020 banded fledges and all birds banded before 2020 in the South San Francisco Bay, California, 2021.

| Category | Observed in 2020 | Observed in 2021 | Return Rate |
|---|---|---|---|
| Banded and fledged in 2020 | 23 | 8 | 35% |
| Banded before 2020 | 35 | 19 | 54% |

Table 14. SFBBO Snowy Plover color band combinations from prior years observed in Recovery Unit 3, 2021

| | | | | | |
|---|---|---|---|---|---|
| ak:bw | gk:pb | ka:ag | kk:bg | ko:gb | rk:og |
| ak:rr | gk:pg | ka:bb | kk:gw | ko:gy | wn:yy |
| ak:ry | gk:pw | ka:oy | ko:or | ko:or | |
| ak:wb | gk:rr | ka:rb | ko:ab | on:bg | |
| gk:og | gk:yb | kk:ab | ko:ay | on:gw | |

Table 15. The average number of predators observed per survey at the Ravenswood Complex, South San Francisco Bay, California, March-September 2021.

| **Predator Species** | **R1 (20)** | **R2 (20)** | **R3 (29)** | **R4 (29)** | **R5 (29)** | **R5S (29)** | **RSF2 (26)** |
|---|---|---|---|---|---|---|---|
| California Gull | 5.8 | 0 | 0.21 | 17.72 | 2.03 | 0 | 20.73 |
| Snowy Egret | 0.85 | 0 | 0 | 0 | 0 | 0 | 12.69 |
| Unidentified Gull | 1.65 | 0 | 0 | 0 | 0 | 0 | 11.12 |
| Great Egret | 0.75 | 0 | 0.07 | 0.03 | 0 | 0 | 3.58 |
| Common Raven | 0.1 | 0 | 1.52 | 1.83 | 0.10 | 0.07 | 0.65 |
| American Crow | 0.35 | 0.05 | 1.14 | 0.76 | 0.24 | 0.35 | 0.15 |
| Ring-billed Gull | 0.65 | 0 | 0 | 0.03 | 0 | 0 | 0.85 |
| Great Blue Heron | 0.6 | 0.1 | 0 | 0.07 | 0 | 0 | 0.35 |
| Peregrine Falcon | 0 | 0 | 0.07 | 0.76 | 0 | 0 | 0.08 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Red-tailed Hawk | 0 | 0 | 0.07 | 0.14 | 0 | 0 | 0.42 |
| Western Gull | 0 | 0 | 0 | 0 | 0 | 0 | 0.46 |
| Northern Harrier | 0.05 | 0.05 | 0 | 0.17 | 0 | 0 | 0.04 |
| White-tailed Kite | 0.05 | 0.1 | 0.03 | 0.07 | 0 | 0 | 0 |
| American Kestrel | 0 | 0 | 0.03 | 0.07 | 0.03 | 0 | 0.04 |
| Burrowing Owl | 0 | 0 | 0 | 0.14 | 0 | 0 | 0 |
| Red Fox | 0 | 0 | 0 | 0.10 | 0 | 0 | 0 |
| Black-crowned Night-Heron | 0 | 0 | 0 | 0 | 0 | 0 | 0.04 |
| Golden Eagle | 0 | 0 | 0 | 0 | 0 | 0 | 0.04 |
| Merlin | 0 | 0 | 0 | 0.03 | 0 | 0 | 0 |
| Skunk | 0 | 0 | 0 | 0.03 | 0 | 0 | 0 |

Table 16. The average number of predators observed per survey at the Alviso Complex, Don Edwards SF Bay Santa Clara County, California, March-September 2021.

| **Predator Species** | **A12 (29)** | **A13 (29)** | **A15 (29)** | **A16 (29)** | **A9 (7)** | **IMP (29)** | **NCM (29)** |
|---|---|---|---|---|---|---|---|
| Unidentified Gull | 79.59 | 539.10 | 2.72 | 48.38 | 4 | 0.10 | 21.10 |
| California Gull | 36.55 | 44.66 | 8.83 | 62.76 | 236 | 1.07 | 25.45 |
| Western Gull | 6.31 | 2.21 | 0.03 | 2.93 | 0 | 0 | 0.03 |
| Black-crowned Night-Heron | 0 | 0 | 0 | 6.10 | 0 | 0 | 0 |
| Common Raven | 0.59 | 0.28 | 2.76 | 1.28 | 0 | 0.17 | 0 |
| Great Egret | 0 | 0.07 | 0 | 3.17 | 0 | 0 | 0 |
| Great Blue Heron | 1.21 | 0 | 0 | 1.86 | 0 | 0 | 0.07 |
| Snowy Egret | 0 | 0.03 | 0.03 | 2.28 | 0.14 | 0 | 0.07 |
| Herring Gull | 0.03 | 0.55 | 0 | 0.62 | 0 | 0 | 0 |
| Peregrine Falcon | 0 | 0.03 | 1 | 0.03 | 0 | 0 | 0 |
| Ring-billed Gull | 0.52 | 0.21 | 0 | 0.10 | 0 | 0 | 0 |
| Iceland Gull | 0.77 | 0 | 0 | 0.03 | 0 | 0 | 0 |
| Northern Harrier | 0.10 | 0 | 0.17 | 0.28 | 0 | 0 | 0 |
| American Crow | 0 | 0.10 | 0.03 | 0.03 | 0 | 0 | 0 |
| Bald Eagle | 0 | 0 | 0.07 | 0 | 0 | 0 | 0 |
| Cooper's Hawk | 0 | 0 | 0 | 0 | 0 | 0.03 | 0 |
| Gray Fox | 0 | 0 | 0 | 0.03 | 0 | 0 | 0 |
| Red-tailed Hawk | 0.03 | 0 | 0 | 0 | 0 | 0 | 0 |
| White-tailed Kite | 0 | 0 | 0 | 0 | 0 | 0 | 0.03 |

Table 17. The average number of predators observed per survey at the Warm Springs Unit, Don Edwards SF Bay National Wildlife Refuge, Alameda County, California, March-September 2021.

| **Predator Species** | **A22 (29)** | **A23 (29)** |
|---|---|---|
| Unidentified Gull | 1 | 57.07 |
| California Gull | 7.45 | 0.41 |
| American Crow | 5.21 | 0.31 |

| | | |
|---|---|---|
| Common Raven | 1.24 | 0.21 |
| Red-tailed Hawk | 0.59 | 0.41 |
| Northern Harrier | 0.24 | 0.14 |
| Peregrine Falcon | 0.10 | 0.17 |
| Snowy Egret | 0.17 | 0.10 |
| American Kestrel | 0.21 | 0.03 |
| Great Egret | 0.17 | 0.03 |
| Bald Eagle | 0.10 | 0.03 |
| White-tailed Kite | 0.03 | 0.03 |
| Black-crowned Night-Heron | 0.03 | 0 |
| Great Blue Heron | 0 | 0.03 |
| Loggerhead Shrike | 0.03 | 0 |
| Skunk | 0.03 | 0 |

Table 18. The average number of predators observed per survey at the Dumbarton Complex, Don Edwards SF Bay NWR, and adjacent salt panne habitat, Alameda County, California, March-September 2021.

| Predator Species | Hickory (27) | N1 (17) | NPP1 (27) |
|---|---|---|---|
| California Gull | 0.19 | 23.71 | 79.70 |
| Unidentified Gull | 0.00 | 0.00 | 9.04 |
| American Crow | 0.48 | 0.06 | 0.00 |
| Red-tailed Hawk | 0.15 | 0.06 | 0.04 |
| Great Egret | 0.00 | 0.24 | 0.00 |
| Common Raven | 0.07 | 0.12 | 0.00 |
| White-tailed Kite | 0.00 | 0.18 | 0.00 |
| Peregrine Falcon | 0.04 | 0.06 | 0.04 |
| Northern Harrier | 0.00 | 0.06 | 0.00 |
| Snowy Egret | 0.00 | 0.06 | 0.00 |
| American Kestrel | 0.04 | 0.00 | 0.00 |
| Merlin | 0.04 | 0.00 | 0.00 |

Table 19. The average number of predators observed per survey at Mountain View Ponds, South San Francisco Bay, California, March-September 2021.

| Predator Species | A2E (3) | CME (28) | CMW (28) |
|---|---|---|---|
| California Gull | 216.67 | 7.82 | 3.46 |
| Snowy Egret | 8.33 | 0.71 | 1.21 |
| Great Egret | 6 | 0.36 | 1 |
| Western Gull | 6.67 | 0.57 | 0 |
| Great Blue Heron | 3 | 0.04 | 0.14 |
| Common Raven | 0 | 1.61 | 1.25 |
| Black-crowned Night-Heron | 1 | 0 | 0 |

| | | | |
|---|---|---|---|
| Herring Gull | 0.33 | 0 | 0.04 |
| Red-tailed Hawk | 0 | 0.07 | 0.18 |
| American Crow | 0 | 0.21 | 0 |
| American Kestrel | 0 | 0 | 0.18 |
| Northern Harrier | 0 | 0 | 0.18 |
| Peregrine Falcon | 0 | 0.07 | 0.07 |
| Red Fox | 0 | 0.07 | 0.04 |
| Cooper's Hawk | 0 | 0 | 0.04 |
| Feral Cat | 0 | 0 | 0.04 |
| Sharp-shinned Hawk | 0 | 0 | 0.04 |
| White-tailed Kite | 0 | 0 | 0.04 |

Table 20. The average number of predators observed per survey in South Eden Landing Ecological Reserve, Hayward, California, March-September 2021.

| **Predator Species** | **E1C (27)** | **E2C (27)** | **E3C (27)** | **E4C (27)** | **E5C (27)** | **E6 (26)** | **E6C (4)** |
|---|---|---|---|---|---|---|---|
| California Gull | 3.04 | 0.07 | 49.67 | 10.56 | 56.15 | 19.08 | 2 |
| Unidentified Gull | 5.93 | 0 | 59.04 | 0 | 11 | 6.42 | 0 |
| Snowy Egret | 0 | 0.96 | 1.85 | 0 | 0 | 3.23 | 0 |
| Great Egret | 0.04 | 0.78 | 1.85 | 0 | 0 | 1.73 | 0.25 |
| Short-billed Gull | 0 | 0 | 0 | 0 | 0 | 1.65 | 0 |
| Common Raven | 0.37 | 0 | 0 | 0 | 0.04 | 0 | 0 |
| Peregrine Falcon | 0.04 | 0 | 0.04 | 0 | 0.04 | 0 | 0.25 |
| Red-tailed Hawk | 0.11 | 0 | 0.07 | 0 | 0.04 | 0.04 | 0 |
| Great Blue Heron | 0 | 0.04 | 0 | 0 | 0 | 0.15 | 0 |
| Northern Harrier | 0.04 | 0 | 0 | 0.11 | 0 | 0 | 0 |
| American Crow | 0.07 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ring-billed Gull | 0 | 0 | 0 | 0 | 0 | 0.04 | 0 |
| White-tailed Kite | 0 | 0 | 0 | 0 | 0 | 0.04 | 0 |
| Iceland Gull | 0 | 0 | 0 | 0 | 0 | 0.04 | 0 |
| Bald Eagle | 0 | 0 | 0.04 | 0 | 0 | 0 | 0 |
| Gopher Snake | 0 | 0 | 0 | 0 | 0.04 | 0 | 0 |

Table 21. The average number of predators observed per survey at the Whale's Tail loop, Eden Landing Ecological Reserve, Hayward, California, March-September 2021.

| **Predator Species** | **E12 (29)** | **E13 (29)** | **E14 (29)** | **E8XN (29)** |
|---|---|---|---|---|
| California Gull | 8.04 | 0.77 | 0.92 | 0 |
| Great Egret | 0.69 | 0.85 | 0.27 | 0.42 |
| Snowy Egret | 1.15 | 0.81 | 0.19 | 1 |
| Unidentified Gull | 0.58 | 0.31 | 0 | 0 |
| Western Gull | 0.81 | 0.08 | 0 | 0 |
| Northern Harrier | 0.04 | 0.15 | 0.69 | 0 |
| Common Raven | 0.04 | 0.27 | 0.46 | 0 |

| | | | | |
|---|---|---|---|---|
| Great Blue Heron | 0.15 | 0.12 | 0.04 | 0.31 |
| Ring-billed Gull | 0.42 | 0.04 | 0 | 0 |
| American Crow | 0.35 | 0.08 | 0 | 0 |
| Herring Gull | 0.35 | 0 | 0 | 0 |
| Peregrine Falcon | 0.04 | 0 | 0.27 | 0 |
| Red-tailed Hawk | 0 | 0.04 | 0.08 | 0 |
| White-tailed Kite | 0 | 0.04 | 0.08 | 0 |
| Red Fox | 0.04 | 0.08 | 0 | 0 |
| Black-crowned Night-Heron | 0 | 0.08 | 0 | 0 |
| Burrowing Owl | 0 | 0.08 | 0 | 0 |
| Merlin | 0 | 0 | 0.08 | 0 |
| Bald Eagle | 0 | 0 | 0.04 | 0 |
| Short-eared Owl | 0 | 0 | 0.04 | 0 |

Table 22. The average number of predators observed per survey at the Old Alameda Creek Loop, Eden Landing Ecological Reserve, Hayward, California, March-September 2021.

| **Predator Species** | **E20B (29)** | **E6A (29)** | **E6B (29)** | **E8 (29)** |
|---|---|---|---|---|
| California Gull | 0 | 21.55 | 0.10 | 13.35 |
| Snowy Egret | 0.03 | 17.72 | 3.35 | 4.28 |
| Great Egret | 0.03 | 6.17 | 1.52 | 2.83 |
| Unidentified Gull | 0.03 | 8.03 | 0.07 | 0.07 |
| Great Blue Heron | 0 | 0.72 | 0.10 | 0.52 |
| Northern Harrier | 0 | 0.17 | 0.21 | 0.52 |
| Peregrine Falcon | 0 | 0.24 | 0.28 | 0.21 |
| Red-tailed Hawk | 0.14 | 0.41 | 0 | 0.07 |
| Black-crowned Night-Heron | 0.03 | 0.52 | 0 | 0 |
| White-tailed Kite | 0 | 0 | 0.03 | 0.24 |
| Common Raven | 0 | 0.10 | 0.03 | 0.10 |
| Iceland Gull | 0 | 0.10 | 0 | 0 |
| Human | 0 | 0.10 | 0 | 0 |
| Herring Gull | 0 | 0.03 | 0.03 | 0.03 |
| Ring-billed Gull | 0 | 0.03 | 0.03 | 0 |
| Bald Eagle | 0 | 0 | 0.03 | 0.03 |
| American Crow | 0 | 0.03 | 0 | 0 |
| American Kestrel | 0 | 0 | 0 | 0.03 |

Table 23. The average number of predators observed per survey at the Mount Eden Creek Loop, Eden Landing Ecological Reserve, Hayward, California, March-September 2021.

| **Predator Species** | **E10 (29)** | **E11 (29)** | **E14B (29)** | **E15B (29)** | **E16B (29)** |
|---|---|---|---|---|---|
| Unidentified Gull | 42.36 | 0.84 | 0 | 0 | 0.04 |
| California Gull | 9.04 | 5.08 | 0 | 0.04 | 0.4 |

| | | | | | |
|---|---|---|---|---|---|
| Snowy Egret | 2.4 | 1.52 | 0.4 | 0 | 0.04 |
| Great Egret | 2.08 | 1.08 | 0.12 | 0 | 0.04 |
| Ring-billed Gull | 0 | 1.92 | 0.08 | 0 | 0 |
| Western Gull | 0.12 | 1.12 | 0 | 0 | 0 |
| Great Blue Heron | 0.64 | 0.16 | 0.04 | 0.04 | 0 |
| Peregrine Falcon | 0.36 | 0.04 | 0 | 0 | 0.2 |
| Common Raven | 0.12 | 0.04 | 0 | 0.04 | 0.2 |
| Herring Gull | 0 | 0.28 | 0 | 0 | 0.04 |
| Northern Harrier | 0.12 | 0.04 | 0 | 0.04 | 0.08 |
| White-tailed Kite | 0 | 0 | 0 | 0.04 | 0.12 |
| Black-crowned Night-Heron | 0 | 0 | 0.12 | 0 | 0 |
| Red Fox | 0 | 0 | 0 | 0 | 0.12 |
| Red-tailed Hawk | 0.08 | 0 | 0 | 0 | 0 |
| Glaucous-winged Gull | 0 | 0.08 | 0 | 0 | 0 |
| Feral Cat | 0 | 0 | 0 | 0.04 | 0 |

Table 24. The average number of predators observed per survey at Franks Dump West, Franks Dump East, and Oliver Brothers North Ponds, Hayward Regional Shoreline, Hayward, California, May-September 2021.

| **Predator Species** | **FDE (26)** | **FDW (26)** | **OBN 1-17 (24)** |
|---|---|---|---|
| Unidentified Gull | 0.15 | 4.96 | 0.21 |
| California Gull | 0 | 1.27 | 0.04 |
| Common Raven | 0.04 | 0.23 | 0.29 |
| American Crow | 0.42 | 0.04 | 0.08 |
| Peregrine Falcon | 0.04 | 0.04 | 0.21 |
| Ring-billed Gull | 0 | 0.19 | 0 |
| Northern Harrier | 0 | 0.04 | 0.13 |
| White-tailed Kite | 0 | 0.12 | 0.04 |
| Red-tailed Hawk | 0.12 | 0 | 0 |
| Domestic Dog | 0 | 0.08 | 0 |
| Great Egret | 0 | 0 | 0.04 |
| Short-eared Owl | 0 | 0 | 0.04 |
| Herring Gull | 0 | 0.04 | 0 |

*OBN ponds with zero observed predators: OBN 5-8, OBN 14

Table 25. The average number of predators observed per survey at Patterson Pond, Alameda County, California, March-September 2021.

| **Predator Species** | **Patterson Pond (27)** |
|---|---|
| California Gull | 2 |

| | |
|---|---|
| Great Egret | 0.52 |
| Common Raven | 0.19 |
| Northern Harrier | 0.19 |
| Snowy Egret | 0.19 |
| Ring-billed Gull | 0.15 |
| Great Blue Heron | 0.11 |
| Red-tailed Hawk | 0.04 |
| Unidentified Gull | 0.04 |
| Unidentified Hawk | 0.04 |

Table 26. The average number of predators observed per survey at the Wingo Unit, Napa-Sonoma Marshes Wildlife Area, Sonoma County, California, March-July 2021.

| Predator Species | Wingo Unit (15) |
|---|---|
| Common Raven | 1.44 |
| American Kestrel | 0.67 |
| Northern Harrier | 0.67 |
| American Crow | 0.44 |
| Red-tailed Hawk | 0.33 |
| Great Egret | 0.22 |
| Peregrine Falcon | 0.11 |
| Snowy Egret | 0.11 |

Table 27. Predators recorded by trail cameras at Eden Landing during the 2021 breeding season.

| Date | Time | Species | Pond | Location | Description |
|---|---|---|---|---|---|
| 4/25/21 | 12:03 a.m. | Skunk | E14 | Southwest corner | Walked by camera |
| 5/02/21 | 12:10 a.m. | Coyote | E6A | Near PG&E towers | Walked by camera |
| 5/04/21 | 5:21 a.m. | Coyote | E16B | Wooden footbridge | Walked by camera |
| 5/04/21 | 11:39 p.m. | Raccoon | E16B | Wooden footbridge | Walked by camera |
| 5/06/21 | 3:54 a.m. | Coyote | E16B | Wooden footbridge | Walked by camera |
| 5/08/21 | 7:53 p.m. | Red fox | E16B | Wooden footbridge | Walked by camera |
| 5/15/21 | 11:44 p.m. | Red fox | E13 | Near saltworks | Juvenile runs by camera |
| 6/28/21 | 09:53 p.m. | Red fox | E14 | Southwest corner | In front of camera |
| 7/20/21 | 2:37 a.m. | Red fox | E13 | High salinity island | Incubating male flushed, fox runs by camera, male returned, no sign of depredation at nearby CLTE nests |

Table 28. Recorded depredation events determined with nest cameras at Eden Landing Ecological Reserve, Hayward, California, 2009-2011, 2015-2019. No depredation events were recorded in 2020 due to limited deployment of nest cameras.

| Year | Pond | Predator Spp. | Count |
|---|---|---|---|

| | | | |
|---|---|---|---|
| 2009 | E16B | RTHA | 2 |
| 2009 | E8X | UNID | 1 |
| 2009 | E12 | CORA | 1 |
| 2009 | E8 | NOHA | 1 |
| 2009 | E8A | NOHA | 1 |
| 2009 | E12 | NOHA | 1 |
| 2010 | E6B | RUTU | 1 |
| 2010 | E8 | CAGU | 1 |
| 2010 | E6 | CAGU | 1 |
| 2010 | E6B | GRFO | 1 |
| 2011 | E12 | CAGU | 1 |
| 2011 | E8A | CAGU | 1 |
| 2011 | E13 | CAGU | 1 |
| 2011 | E8 | RTHA | 1 |
| 2015 | E14 | CORA | 6[1] |
| 2015 | E14 | UNID | 1 |
| 2016 | E14 | CORA | 30[1] |
| 2017 | E14 | CORA | 5 |
| 2017 | E14 | UNID | 1 |
| 2017 | E14 | REFO | 2[2] |
| 2018 | E14 | CORA | 2 |
| 2018 | E14 | REFO | 9 |
| 2018 | E14 | REFO | 1[3] |
| 2019 | E14 | CORA | 2 |
| 2019 | E14 | NOHA | 1[4] |
| 2019 | E14 | MEME | 1 |
| 2021 | E8 | CORA | 1 |
| 2021 | E14 | CORA | 2 |

[1]One nest hatched after partial depredation event
[2]One nest depredated after one chick hatched
[3]At least two of three chicks depredated after hatch
[4]Visual observation of nest depredation

Table 29. Snowy Plover nests fates in E14 by habitat treatment. Western and Eastern plots were enhanced with oyster shell in 2014, all other areas are termed Unshelled.

| Plot | Hatched | Depredated | Abandoned | Flooded | Total |
|---|---|---|---|---|---|
| Western | 2 | 7 | 1 | 0 | **10** |
| Eastern | 6 | 12 | 0 | 0 | **17** |
| Unshelled | 1 | 6 | 0 | 0 | **7** |
| **Total** | **9** | **25** | **1** | **0** | **35** |

Table 30. Chi-square analyses for nest habitat type selection at pond E14.

| Treatment | Observed | Expected | $\chi 2$ | df | **p-value** |
|---|---|---|---|---|---|
| Western | 10 | 6.2 | 22.9 | 2 | ***1.06E-05*** |
| Eastern | 18 | 8.2 | | | |
| Control | 7 | 20.6 | | | |

Table 31. Snowy Plover averaged apparent nest densities (nest/ha) by pond at all locations surveyed throughout the season in the South San Francisco Bay, 2021. We calculated nest densities (nest/ha) in each pond every week using data from habitat availability surveys; weekly densities were then averaged.

| Location | Pond | Average Nests/Ha |
|---|---|---|
| All | All | 0.06 |
| Alviso | A15 | 0.04 |
| Warm Springs | A22 | < 0.01 |
| Warm Springs | A23 | < 0.01 |
| Mountain View | CME | 0.10 |
| Mountain View | CMW | 0.11 |
| Eden Landing | E12[1] | 0.12 |
| Eden Landing | E13[1] | 0.10 |
| Eden Landing | E14 | 0.08 |
| Eden Landing | E16B | 0.03 |
| Eden Landing | E1C | 0.01 |
| Eden Landing | E3C | 0.02 |
| Eden Landing | E4C | 0.03 |
| Eden Landing | E6A | 0.02 |
| Eden Landing | E6B | 0.04 |
| Eden Landing | E8 | 0.01 |
| Dumbarton | Hickory | 0.01 |
| Dumbarton | NPP1 | 0.02 |
| Hayward | FDW | 0.37 |
| Hayward | OBN | 0.04 |
| Coyote Hills | Patterson Pond | 0.12 |
| Ravenswood | R1 | 0.02 |
| Ravenswood | R3 | < 0.01 |
| Ravenswood | R4 | 0.03 |
| Ravenswood | RSF2 | < 0.01 |

[1]Density artificially increased by small amount of habitat provided by islands, salt panne, levees, and berms.

Table 32. Daily nest survival (DSR) outputs for all plover nests in pond E14 in Eden Landing Ecological Reserve, Hayward, California in 2021. Note: confidence intervals containing zero are

not significant; negative intervals indicate a decrease in survival; positive intervals indicate an increase in survival. *indicates significance.

| Model | Parameters | Estimate | SE | Lcl | Ucl | DSR Day 1 | DSR Day 182 |
|---|---|---|---|---|---|---|---|
| Dot | | 2.7127 | 0.2175 | 2.2863 | 3.1290 | 0.9378 | 0.9378 |
| Distance to Levee | | -0.0032 | 0.0036 | -0.0103 | 0.0038 | 0.9371 | 0.9371 |
| Nest Age | | -0.0088 | 0.0331 | -0.0738 | 0.0561 | 0.9688 | 0.8734 |
| Time | | 0.0128 | 0.0066 | $-9.9361e^{-05}$ | 0.0258 | 0.8423 | 0.9793 |
| Time by Treatment | Time * Western | -0.0123 | 0.0149 | $-4.1552\ e^{-02}$ | 0.0169 | 0.9203 | 0.9625 |
| | Time * Eastern | 0.0155 | 0.0137 | -0.0113 | 0.0424 | 0.7257 | 0.9904 |
| | Time * Control | -0.0069 | 0.0172 | $-4.0820\ e^{-02}$ | 0.0269 | 0.8970 | 0.9692 |

Table 33. Snowy Plover egg fates by pond in the South San Francisco Bay, California, 2021.

| Location | Hatched | Depredated | Abandoned | Flooded | Failed to Hatch | Unknown | **Monitored** | Detected as Chick | **Total** |
|---|---|---|---|---|---|---|---|---|---|
| **Alviso** | | | | | | | | | |
| A15 | 20 | 6 | 0 | 0 | 0 | 3 | **29** | 7 | **36** |
| **Cargill Production** | | | | | | | | | |
| Newark | 0 | 0 | 0 | 0 | 0 | 1 | **1** | 0 | 1 |
| Redwood City | 0 | 0 | 0 | 0 | 0 | 0 | **0** | 0 | 0 |
| **Coyote Hills** | | | | | | | | | |
| Patterson Pond | 37 | 8 | 3 | 0 | 5 | 3 | **56** | 0 | **56** |
| **Dumbarton** | | | | | | | | | |
| Hickory | 6 | 0 | 0 | 0 | 0 | 0 | **6** | 0 | **6** |
| N1 | 17 | 0 | 0 | 0 | 0 | 0 | **17** | 7 | **24** |
| NPP1 | 0 | 3 | 0 | 0 | 0 | 0 | **3** | 0 | **3** |
| **Eden Landing** | | | | | | | | | |
| E6A | 3 | 6 | 0 | 0 | 0 | 0 | **9** | 0 | **9** |
| E6B | 11 | 38 | 1 | 0 | 0 | 0 | **50** | 5 | **55** |
| E8 | 2 | 9 | 0 | 0 | 1 | 0 | **12** | 8 | **20** |
| E12 | 0 | 3 | 0 | 0 | 0 | 0 | **3** | 1 | **4** |
| E13 | 3 | 6 | 0 | 0 | 0 | 3 | **12** | 0 | **12** |
| E14 | 25 | 62 | 3 | 0 | 2 | 0 | **92** | 14 | **106** |
| E16B | 0 | 20 | 0 | 0 | 0 | 0 | **20** | 5 | **25** |
| E1C | 0 | 0 | 0 | 2 | 0 | 0 | **2** | 0 | **2** |
| E3C | 0 | 3 | 0 | 0 | 0 | 0 | **3** | 0 | **3** |
| E4C | 5 | 6 | 0 | 0 | 0 | 0 | **11** | 0 | **11** |
| **Hayward** | | | | | | | | | |
| FDW | 5 | 33 | 0 | 0 | 1 | 0 | **39** | 0 | **39** |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| LETE | 9 | 0 | 0 | 0 | 0 | 0 | **9** | 0 | **9** |
| OBN1 | 2 | 12 | 0 | 0 | 1 | 0 | **15** | 0 | **15** |
| OBN3 | 3 | 0 | 0 | 0 | 0 | 0 | **3** | 0 | **3** |
| OBN4 | 0 | 3 | 0 | 0 | 0 | 0 | **3** | 3 | **6** |
| OBN5 | 0 | 6 | 0 | 0 | 0 | 0 | **6** | 0 | **6** |
| OBN8 | 3 | 0 | 0 | 0 | 0 | 0 | **3** | 0 | **3** |
| OBN16 | 3 | 0 | 0 | 0 | 0 | 0 | **3** | 0 | **3** |
| **Mountain View** | | | | | | | | | |
| CME | 8 | 30 | 0 | 0 | 1 | 0 | **39** | 4 | **43** |
| CMW | 13 | 11 | 2 | 0 | 1 | 0 | **27** | 0 | **27** |
| **Ravenswood** | | | | | | | | | |
| R1 | 28 | 0 | 0 | 3 | 5 | 3 | **39** | 10 | **49** |
| R3 | 9 | 3 | 0 | 0 | 0 | 0 | **12** | 0 | **12** |
| R4 | 38 | 15 | 6 | 0 | 2 | 0 | **61** | 11 | **72** |
| SF2 | 3 | 0 | 0 | 0 | 0 | 0 | **3** | 0 | **3** |
| **Warm Springs** | | | | | | | | | |
| A22 | 1 | 5 | 0 | 0 | 0 | 0 | **6** | 11 | **17** |
| A23 | 3 | 0 | 0 | 0 | 0 | 0 | **3** | 7 | **10** |
| Total South Bay | 257 | 288 | 15 | 5 | 19 | 13 | **597** | 93 | 690 |
| **Hamilton Wetlands** | | | | | | | | | |
| Ag. Ponds | 3 | 3 | 0 | 0 | 0 | 0 | **6** | 0 | **6** |
| **Montezuma Wetlands** | | | | | | | | | |
| Cell 14 North **NSMWA** | **6** | 0 | 0 | 0 | 0 | 0 | **6** | 3 | **9** |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 7/7A | 0 | 0 | 0 | 0 | 0 | 0 | **0** | 0 | **0** |
| Wingo | 0 | 0 | 0 | 0 | 0 | 0 | **0** | 0 | **0** |
| **Total North Bay** | **9** | **3** | **0** | **0** | **0** | **0** | **12** | **3** | **15** |
| **RU3 Total** | **266** | **291** | **15** | **5** | **19** | **13** | **609** | **96** | **705** |