SAN FRANCISCO BAY
BIRD OBSERVATORY

Western Snowy Plover Monitoring in the San Francisco Bay
Annual Report 2020

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SUMMARY

The San Francisco Bay Bird Observatory (SFBBO), 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), Bay Delta Fish and Wildlife Office, USDA-Wildlife Services, and EcoBridges Environmental 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 2020 breeding season, SFBBO and EBRPD staff 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 12-22), we counted 147 adult Snowy Plovers in the San Francisco Bay (Table 1, Figures 1-3). Due to the COVID-19 pandemic, we were not able to survey all sites; therefore, this represents an incomplete survey. Over the course of the breeding season (March-September), SFBBO staff determined and documented the fates of 210 Snowy Plover nests in Recovery Unit 3, all located in the South Bay (Figure 1, Table 2). EBPRD documented the fate of three Snowy Plover nests at Hayward Shoreline. EcoBridges Consulting Biologists documented the fate of four nests at Montezuma Wetlands in Suisun Bay near the Sacramento-San Joaquin Delta (Figure 3). Apparent nest success (defined as the percentage of nests that successfully hatched at least one egg out of the total nests monitored) was 53%, representing the highest rate since 2005 (Table 2). Of the remaining nests, 36% were depredated, 6% abandoned, 4% flooded, and the fate of 1% was unknown. A summary of 2020 nesting activity by pond complex or management unit follows:

On Refuge property, we monitored one nest in the Alviso Complex (Figure 4) before surveys were stopped after March 10 due to the COVID-19 Pandemic, and 18 nests in the Ravenswood Complex (Figure 5). Apparent nest success was unknown at Alviso due to the COVID-19 Pandemic preventing access, and 83% in the Ravenswood Complex.

On Midpeninsula Regional Open Space District/NASA property, we monitored 15 nests between Crittenden Marsh West and East (Figure 4), documenting 66% nest success.

On HARD property, EBRPD reported three Snowy Plover nests on Least Tern (*Sterna antillarum browni*) island at Hayward Regional Shoreline, with a hatch rate of 66% (D. Riensche, pers. comm.)(Figure 6). SFBBO documented 11 nests at the Oliver Brother's North ponds and 18 nests at Franks Dump West, with an apparent nest success of 46% and 83%, respectively.

We found 69% of Snowy Plover nests in Recovery Unit 3 at CDFW's Eden Landing Ecological Reserve (Eden Landing; Figure 7). We determined the fate of 147 nests and found that apparent nest success was 45%.

Across the South Bay, 24 undetected successful nests were inferred by the presence of the same number of unaccounted for broods (Table 3).

At Montezuma Wetlands in Solano County, four nests were monitored in Cell 14N (Figure 8), with two determined to have hatched and two depredated (A. Wallace, pers. comm.). No nests were found at Napa-Sonoma Marshes Wildlife Area (K. Taylor, pers. comm.), and although a pair was observed in the North Seasonal Wetlands during the breeding window survey, no breeding activity was confirmed at Hamilton Wetlands in Novato (Avocet Research Associates, J. Evans, pers. comm.)(Figure 9).

In 2020, SFBBO banded 85 Snowy Plover chicks from nests that successfully hatched within Eden Landing, Mountain View, Ravenswood, and Hayward nesting ponds (Table 4-6). From band re-sighting surveys, we determined that at least 23 of these 85 chicks survived to fledging (28 days post-hatching) as of December 1st 2020. Our estimated apparent fledging success was 27%. For the first time since 2016, we banded Snowy Plover adults, successfully trapping and banding four adults (Table 6). Comparing adult band resighting and fledged juvenile data from 2019, we found return rates of 66% (n=36) for adults banded before 2019 and 42% (19) for 2019 fledges (Table 8-9).

We provided construction monitoring services in 2020 for Ducks Unlimited (DU) in support of South Bay Salt Pond Restoration Project Phase II activities at both Ravenswood and Eden Landing. Due to the COVID-19 pandemic, construction at Ravenswood ponds R3-5S didn't begin during the breeding season until mid-June. From mid-June through the end of September, we provided weekly nest and brood maps to DU for construction activity planning, physically cleared the site each day before construction activity began, and stayed onsite to confirm that construction activities didn't cause disturbance to breeding Snowy Plovers. At Eden Landing we provided similar services, where cultural resource analysis and hydrological drilling work were sporadically performed by sub-contractors. In addition to DU, we provided similar construction monitoring services at R1 for Water, Civil, and Environmental Inc., who was contracted by the Refuge to perform levee maintenance work along the R1 outboard levee; at A22 for Alameda County Flood Control District (ACFCD), who was working on a flood control project in adjacent Laguna Creek; and NPP1 for Cargill Inc., who needed to flood the pond for routine production purposes and could not do so until it was confirmed that Snowy Plovers were not breeding on the pond.

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 (Table 10-16). 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 (Table 10-16). 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 in E14 (Table 17), as well as tracks observed early in the season, indicated that Coyotes frequently hunted in the pond. Out of concern for attracting predators, nest cameras were deployed on only several occasions, thus no depredation events were documented as had been the case in the past (Table 18).

Based upon our past research that indicated that oyster shell habitat enhancement increased Snowy Plover nest abundance and nest success, 20.23 ha of oyster shell were spread in two plots (Western = 6.47ha; Eastern = 13.76ha) as a large scale habitat enhancement project in September of 2014 at Eden Landing pond E14. Monitoring in 2020 showed that at least 62 Snowy Plover nests were established in the pond, with 46 nests found within one of the shell plots (Table 19). Chi-square analyses indicated that based upon available habitat, these nests were not randomly located in the shell plots, but were selected for by breeding plovers (Table 20). Nest survival analyses found the Daily nest survival (DSR) to be 92.7%, with the only model that showed any significance indicating that nest survival increased with increasing distance from levees (Table 21). Logistic regression models tested did not show any significance (Table 22-23).

2020 marked the fourth consecutive year that California Least Terns (*Sternula antillarum browni;* Least Terns) nested at Eden Landing pond E14, as well as the first year of a three year social attraction project conducted by SFBBO. On March 7, 2020, we led a volunteer event to remove predator perches and spread 70 wooden chick shelters, 50 terra cotta chick shelters, and 50 Least Tern decoy within the Western shell plot in a square measuring approximately 2.3 ha. On March 30, SFBBO staff setup a social attraction sound system among the shelters and decoys. Least Terns were first observed on-site on April 27, when two adults were observed flying over E14. The maximum number of adults recorded on-site was 20, which was observed on both May 18 and May 28. One nest was located at E14 on May 13, but was depredated by May 18. Additional signs of breeding activity, including courtship and mate provisioning, were observed on the pond through June 15, but no additional nests were located. Northern Harriers, Peregrine Falcons, and coyotes likely were responsible for the low breeding effort observed. For additional information on Least Tern breeding at Eden Landing in 2020, refer to *California Least Tern and Snowy Plover Recovery at Eden Landing Ecological Reserve, Hayward, CA Progress Report 2020* (Pearl et al. 2020).

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 (Figure 10). Since completion of Phase I activities at Eden Landing in early 2015, the Recovery Unit 3 population has averaged 221±20 adults (2015-2019) (Table 1). E14 has supported 34.8±9.4% 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±12.5%) compared to the rest of RU3 (51.3±7.1%). Correspondingly, the Recovery Unit 3 population has declined in recent years, from 246 in 2017 to 190 in 2019 (Table 1). Due to an incomplete survey, 2020 data was not included, however

the similar population size observed at sites that were surveyed indicate that the population was likely similar to 2019 levels. In order to reverse this trend and 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 at the Refuge includes 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 for Phase 2 actions at the Refuge, there will still be an additional 8% loss of remaining available breeding habitat from 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. A reduction in habitat size could result in increased predation pressure at the Ravenswood Complex, especially by American Crows and Common Ravens, both of which have been frequently observed in the Complex in recent years and believed to be major nest and chick predators. Increased development adjacent to these restoration sites artificially inflates commensal predator populations such as skunks, feral cats and Common Ravens by supplying new food resources, while also confounding 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.

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 habitat when construction activities impact or eliminate Snowy Plover nesting ponds and scheduling construction activities before or after Snowy Plover breeding season. In conjunction, the Project should seek to better coordinate with other landowners considering restoration projects throughout RU3 to ensure that adequate Snowy Plover breeding habitat will remain to support recovery.

As more Project areas are opened to tidal action or converted to ponds with islands, we recommend that the Project and local land managers maintain adequate Snowy Plover nesting habitat to preserve and increase the number of nesting Snowy Plovers in the South Bay as outlined in the Recovery Plan (USFWS 2007). Management actions currently undertaken along these lines 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. We observed high rates of trespass at E14 in 2020 (Table 17), and correspondingly, observed the highest rate nest of abandonment in a pond in RU3 since we began monitoring in 2003 (13%, Table 8). As such, we recommend that no additional levee trails within 164m of Snowy Plover nesting habitat be opened to the public until impacts to Snowy Plover nest site selection, nest fate, and brood foraging habitat use can be further

assessed. We also propose continued research, adaptive management and/or enhancement of Snowy Plover nesting sites to reduce impacts from tidal restoration projects and improve recovery efforts in the future.

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 portion 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 on Refuge lands.

From 2003-2020, 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 (Table 1). 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 previous pilot studies from 2008-2013, on Eden Landing pond E14. Enhancements were made in September and October 2014, and 2020 marked the sixth year of monitoring the enhancement project.

As the South Bay Salt Pond Restoration Project continues to restore tidal marshes in the Bay, more areas will become open for public and recreational use. 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 2020 breeding season; this includes data on Snowy Plover nest distribution and habitat use, nest (hatching) success, fledging success, oyster shell enhancement studies, 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 2 to September 18, 2020, SFBBO staff and volunteers conducted Snowy Plover and avian predator surveys at Eden Landing and Crittenden Marsh, and beginning May 12, at Hayward Shoreline (Figure 1, Table 24). We surveyed at all Refuge ponds from March 2- March 10 (Figure 1, Table 24), after which most Refuge ponds, including at Alviso, Dumbarton, and Warm Springs, were not surveyed again in 2020 due to the Covid-19 pandemic. Surveys at Ravenswood ponds R1-S5 resumed on June 10 and continued through September 18 (Figure 1, Table 24). In the North Bay CDFW biologists surveyed and contributed nesting information for Napa-Sonoma Marsh Wildlife Area (Figure 2, Table 25), while Avocet Research Associates and EcoBridges Environmental Consulting contributed window survey information at Hamilton Wetlands and Montezuma Wetlands, respectively (Figure 2, Table 25). Due to pandemic restrictions, these surveys provided coverage of most, but not all Snowy Plover breeding habitat in Western Snowy Plover Recovery Unit 3.

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 locations: Alviso (Figure 4), Mountain View (Figure 4), Ravenswood (Figure 5), Coyote Hills, Dumbarton (Figure 1), 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 owns Hayward Regional Shoreline (Hayward Shoreline), located directly north of Highway 92 on the east side of the San Francisco Bay (Figures 1, 6). Hayward Shoreline is owned by HARD and 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, Hamilton Wetlands Restoration site is located in Novato at the former Hamilton Army Airfield and is owned by the State Coastal Conservancy (Figure 2). Prior to levee breach early in the 2015 breeding season, this area provided Snowy Plover foraging and nesting habitat on a dry area within the tidal restoration site. As a result of the breach, much of the former nesting habitat is now tidal; however, there remains a portion of suitable nesting habitat in the North 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 breeding and winter window surveys were performed here by EcoBridges Consulting Biologists, as well as opportunistic observations, and 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

Snowy Plovers in the San Francisco Bay nest predominantly on dry pannes, berms, and levees located within former salt production ponds. 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. We surveyed other ponds with less suitable (i.e., ponds without dry salt panne) habitat monthly.

From March 2 to September 18, 2020, SFBBO biologists, interns, and volunteers surveyed all accessible potential breeding ponds weekly by driving slowly on the levees or walking levees without vehicle access. Beginning in the second week of March, access to Refuge ponds was restricted due to the COVID-19 pandemic. Access was not allowed at select areas until the

second week of June, resulting in large gaps in data for certain pond complexes. SFBBO staff surveyed the HARD ponds weekly from May 11 to September 13, 2020.

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 Plover sighted. Any observed instances of interspecies aggression between Snowy Plovers and other nesting shorebirds and/or seabirds were recorded.

Volunteers surveyed some low-priority Eden Landing ponds monthly, and staff surveyed Alameda County Flood Control District's (ACFCD) Patterson Pond (located in the Coyote Hills ponds, Figure) to check for possible nesting activity during the season (Table 25).

From May 12-22, 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 (excluding the Refuge) 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 January, June, and July 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. In January, 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 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 26).

In June and July, docents did not attempt to interact with pedestrians and cyclists due to the COVID-19 pandemic. Instead, docents surveyed the ponds for Least Terns and Snowy Plovers, and opportunistically recorded any observations of trespass into sensitive areas.

Construction Monitoring

SFBBO provided construction monitoring services to Ducks Unlimited (DU) at Ravenswood Ponds in support of the Projects Phase II construction and at Eden Landing in support of Phase II planning-related fieldwork. At Ravenswood, from June 10-September 18 we physically cleared all areas each morning before work began and stayed on-site to confirm that construction activity didn't disturb breeding Snowy Plovers. We provided weekly breeding updates to DU,

including maps that detailed nest and associated 600ft nest buffer locations, as well as brood locations. This information allowed DU to coordinate construction activity with Pacific States, the construction company contracted for Phase II construction at Ravenswood, to ensure no disturbance to breeding Snowy Plovers. At Eden Landing, we provided monitoring as necessary to allow contractors to conduct cultural resource analyses in the 2C system and drilling at the 2C System and E6C.

At Ravenswood ponds R1-2, we provided similar construction monitoring services to Water, Civil, and Environmental Inc., who was contracted by the Refuge for outboard levee maintenance work.

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 2020. 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 2019 and 2020 to calculate the proportion of 2019 fledges that were observed in 2020, and the proportion of banded adults observed in 2019 that were observed in 2020.

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 began 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, totals 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 are termed non-shelled in this report. We designed a spatial configuration in which the shell blocks alternated with the non-shelled blocks in order to avoid clustering treatments in one region of the pond, as well as to address pre-existing variation in habitat quality for breeding Snowy Plovers.

Avian 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 24-25). 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 27) found within Snowy Plover breeding habitat in Recovery Unit 3. While there are a number of potential mammalian predators (Table 28), 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 to 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 2020. Coyotes appeared to be present at Eden Landing for much of the season, therefore only one Snowy Plover nest at E14 had a camera on it. 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 each time the nest was checked, typically once per week, at which time the memory card and batteries were replaced as needed.

In order to provide an index of mammalian predator activity at ponds E12-14, 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, habitat availability surveys were continued during the 2020 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 (2015-20) 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 used a logistic regression model to determine if nest success (hatched, not hatched) could be predicted by variables including treatment type (shelled, non-shelled), nearest neighbor distance, number of nest neighbors within 100m, date of nest initiation, and date nest found.

In addition, we conducted a nest survival analysis for all nests in E14 during the 2020 breeding season in program R (version 3.5.3, 64 Bit; R Studio 1.1) using Package RMark (Rotella 2016). 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), and distance to nearest levee (m) as additional covariates in order to determine their effect on nest survival rates.

RESULTS

Snowy Plover Surveys

Recovery Unit 3

During the 2020 Pacific Coast breeding season window survey (May 12-22), a total of 147 adult Snowy Plovers were counted in the South Bay, North Bay, and Delta (Table 1, Figure 15). Refuge sites were not surveyed due to access restrictions related to the COVID-19 pandemic.

Overall

Among sites that were surveyed for at least half of the breeding season (Crittenden Marsh, Eden Landing, Hayward, Ravenswood), we consistently observed the greatest numbers of Snowy Plovers at Eden Landing (Figure 16a). We documented Snowy Plover nesting activity at 28 South Bay ponds (Figure 17, Table 2).

Refuge

We observed a mean of 60 birds per week in the Ravenswood complex (Figure14b). Due to COVID-19 related restrictions, the complex was not surveyed between the weeks of March 16 and June 1. Surveys of ponds R3-S5 and R1-2 resumed during the week of June 8, however RSF2 was not surveyed for the remainder of the breeding season.

Crittenden Marsh

We observed a mean of 16 Snowy Plovers per week at Crittenden Marsh West and East (Figure 16b). Apart from the week of March 16, these ponds were surveyed weekly throughout the breeding season.

Eden Landing

We observed a mean of 143 birds per week from March 2 through September 15 at Eden Landing (Figure 16a). Pond E14 supported the largest numbers of Snowy Plovers during the breeding season again this year.

Hayward

We observed a mean of 57 Snowy Plovers per week from May 11 through September 15 at FDW and OBN ponds (Figure 16b).

Early and Late Season Trends

In March, we observed large flocks at E16B and E14, averaging 26 and 107 Snowy Plovers per week during this period, respectively. In August, we observed large flocks at E6A and E6C, averaging 76 and 102 Snowy Plovers per week for the month, respectively (Figure 18). 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).

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 first two months of the breeding season. Zero incidences of aggression were observed during the 2020 breeding season.

Snowy Plover Docent Surveys

In 2020, SFBBO volunteers conducted one normal docent survey and two modified docent surveys at ponds E12-14 (Table 26). Zero contacts were made during the normal survey, and no incidences of trespass were noted during the two modified surveys.

Snowy Plover Nest Abundance and Success

South Bay Overall

In 2020, SFBBO determined the fate of 210 Snowy Plover nests and EBRPD determined the fate of three nests. Of these, 115 nests hatched (apparent nest success = 53.1%), 78 nests were depredated (36.2%), ten were abandoned (4.7%), 11 were flooded (4.5%), and the fate of two nests were unknown (0.9%; Table 2, Figure 19). Across all surveyed areas, we documented 27 broods from undetected nests, indicating that despite our best efforts, some breeding went undetected (Table 3). We documented the greatest amount of breeding activity at Eden Landing, followed by Hayward, Ravenswood, Mountain View, and Alviso (Figure 20). Since we were unable to survey at most of the Refuge throughout the breeding season, it is likely that a moderate amount of breeding activity was missed, especially at Alviso and Warm Springs ponds.

Refuge

In 2020, SFBBO determined the fate of 18 Snowy Plover nests on Refuge lands (Table 2). In the Alviso Complex (A15) the fate of one nest was unknown (100%). At the Ravenswood Complex (R1, R3, and R4), 15 hatched (83%), two were depredated (11%), and one was abandoned (6%). The Ravenswood Complex contained 8% of all nests found in RU3 (Figure 20), and we found the most nests in the Ravenswood Complex on pond R1 (8 nests; Figure 19). At least nine additional successful nests in R4, three in R3, and one in R1 were inferred by unaccounted for broods in the aforementioned ponds (Table 3).

Crittenden Marsh

Within ponds CME and CMW, we determined the fate of 15 nests, representing 7% of all nests found in RU3 (Figure 20). Ten hatched (67%) and five were depredated (33%) (Table 2).

Eden Landing

We determined the fate of 147 Snowy Plover nests at Eden Landing, comprising 69% of all nests found in RU3 (Figure 20). Of these, 66 hatched (45%), 61 were depredated (41%), 11 were flooded (7%), and nine were abandoned (6%; Table 2). At E13, one nest was manually raised by SFBBO staff to prevent flooding, and was later confirmed hatched. E14 supported the most nests (62 nests), followed by E16B (18 nests), E6B (17 nests) and E8 (16 nests; Table 2). E14 alone comprised 42% of the nests found in Eden Landing (Figure 21) and 29% of the nests found in the entire South Bay in 2020.

Hayward

EBRPD reported three Snowy Plover nests on the California Least Tern Island at HARD, two of which hatched, and one was likely depredated by a California gull (*Larus californicus*; D. Riensche, pers. comm.; Table 2). SFBBO monitored 11 nests this season at the Oliver Brothers North Salt ponds, of which 5 hatched (45%), 5 were depredated(45%), and the fate of one nest was unknown (10%; Table 2). We monitored 18 nests at Franks Dump West, of which 15 hatched (83%) and three were depredated (27%).

Napa-Sonoma Marshes Wildlife Area

In 2020, two Snowy Plover adults were observed during the breeding window survey, however no breeding activity was observed by CDFW during broad monthly surveys of the area (K. Taylor, pers. comm.; Table 2).

Montezuma Wetlands

In 2020, four Snowy Plover nests were monitored at Montezuma Wetlands, with two nests confirmed to have hatched and two depredated. This site was specifically monitored for breeding Least Terns, with targeted Snowy Plover surveys only occurring during window surveys, therefore it remains possible that additional breeding occurred (A. Wallace, pers. comm.). Targeted Snowy Plover surveys throughout the breeding season are scheduled to begin in 2021.

Hamilton Wetlands Restoration Area

A pair of Snowy Plovers were observed during the May Breeding Season Window in the North Seasonal Wetlands, and although breeding was not confirmed, this site is not surveyed regularly for Snowy Plovers by trained biologists. High water levels within the seasonal wetlands continue, and may preclude successful Snowy Plover nesting at this site until the identified issues have been corrected (J. Evens, pers. comm.).

Cargill Salt Evaporation Ponds

At Cargill's Newark Plant Site, one brood was reported. Due to the size of the Newark Plant Site and lack of targeted surveys, it is possible that additional plover breeding occurred there in 2020. Zero Snowy Plover breeding activity was observed 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 0.10 nests per hectare (Table 29). The highest apparent nest density was observed at Franks Dump West (0.70 nests per hectare), followed by Crittenden Marsh West (0.18 nests per hectare), and E14 (0.17 nests per hectare; Table 29). Although E13 had a higher mean nest density (0.26 nests per hectare), only six nests were 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 recorded three periods of high nest initiation during the breeding season (Figure 22). Between the weeks of April 19 and April 26, a mean of 12.5±0.7 nests were initiated per week, for a total of 25 nests. Between the weeks of May 10 and May 17, a mean of 17.0±1.4 nests were initiated per week, for a total of 24 nests. Between the weeks of May 31 and July 5, a mean of 16.5±4.3 nests were initiated per week, for a total of 99 nests.

For the fourth 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 17 and July 19, a mean of 73.9±11.2 nests were active, with a high of 89 nests active during the week of July 5 (Figure 22).

Snowy Plover Color Banding

Chick Fledging Success

As part of our efforts to document breeding success within the San Francisco Bay, we banded 85 Snowy Plover chicks in 2020. At least 23 chicks fledged (27%, Table 4-5) from 35 separately banded broods, resulting in a chicks fledged per male rate of 0.64 (Table 5). 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 to wild raised fledges, SFBBO released three banded juveniles that had been raised in captivity. On May 2, SFBBO brought three eggs from an abandoned nest at E14 to Monterey County SPCA, who hatched and raised the chicks. The chicks were banded with SFBBO color combinations by Carleton Eyester of Point Blue Conservation Science on June 8 to reduce the amount of disturbance on June 11, when they were released at E14 by SFBBO biologists.

Adult Banding

On May 2, biologists successfully trapped and banded an adult male (ak:wb, Table 6) at a nest in northwest E14, not far from the public trail between E13 and E14. On May 19, biologists unsuccessfully attempted to trap a male in E14 (Table 6). It would not cross the noose mats surrounding it's nest. This male had been previously banded but was missing a band on the right leg. On June 11, biologists successfully trapped and banded an adult male (wn:yy) and

female (ak:rr) attending to a nest on E6B that had just hatched (Table 6). The three chicks were banded immediately afterwards, with two later confirmed to have fledged. On July 7, a female that had been previously banded by SFBBO as a chick in 2016 was recaptured and tape reapplied to cover the metal service band (Table 6).

Return Rates

During 2020 surveys, we observed a total of eight out of 19 banded 2019 fledges, resulting in an apparent return rate of 42% (Table 8). Of 36 previously banded adults observed in 2019, 24 were observed in 2020, resulting in a return rate of 66% (Table 8).

Oyster Shell Habitat Enhancements

During the sixth season following large scale enhancement at pond E14, we documented a total of 62 nests in pond E14; 19 nests in Western (which includes the three 1-ha pilot plots), 27 nests in Eastern, and 16 nests in the non-shelled areas of the pond (Control) (Table 19).

Examining the treatments individually, apparent nest success was 42% in Western, 44% in Eastern, and 31% in Control (Table 19). Depredation was the most significant cause of nest failure in all areas of E14 (Western=58%, Eastern=41%, and Control=40%). Nest abandonment in Eastern (15%) and Control (16%) were notably high.

Nest Site Selection

Our chi-squared analysis indicated that plovers at E14 selected for nest locations in oyster shell plots in 2020 ($p=3.23e^{-06}$)(Table 20). While New1+New2 accounted for 41% of available nesting area in E14 during 2020, these areas accounted for 61% (n=62) 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 2020 was 92.7%, with a 8.2% probability that a nest would survive for 33 days to hatch (Table 21). The only model that showed significance included distance from levee, and showed a positive effect upon DSR with increasing distance.

We tested several different logistic regression models in R to examine the influence of four variables on nest survival, including date of nest initiation, number of Snowy Plover nest neighbors within 100m, nearest nest distance, and habitat type (Table 22). The model with the lowest Akaike's Information Criterion, which indicated the best fit, included only habitat type(Table 23). However, neither this model nor any of the other models (single variable and interactions) showed any significance, indicating that nest survival was impacted by other factors not considered.

Avian Predators

Refuge

California Gulls and unidentified gulls (presumably mostly California Gulls given time of year and location) were the most abundant avian predators at Ravenswood (Table 10). Excluding gulls, Common Ravens, American Crows, Snowy Egrets, and Great Egrets were the most abundant predators observed. At Ravenswood, we frequently observed corvids walking on ponds R3 and R4 and flying over the ponds (Table 10). Northern Harriers were the most frequently sighted raptor at Ravenswood, and were occasionally observed hunting over R4.

Crittenden Marsh

California Gulls were the most numerous predators at Crittenden Marsh (Table 11). Snowy Egrets and Great Egrets were the next most frequently observed predator atCrittenden Marsh. Common Ravens were frequently observed hunting in Crittenden Marsh West or perched on an old structure in adjacent Moffett AirField. Northern Harriers were the most frequently observed raptor, where they were occasionally seen hunting in Crittenden Marsh West.

Eden Landing

California Gulls and unidentified gulls were the most numerous predators at Eden Landing (Tables 12-15). Great Egrets and Snowy Egrets were the next most frequently observed predators at Eden Landing. They were especially numerous at pond E6A (Table 14) and ponds E10 and E11 (Table 15), 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 frequently observed hunting in pond E14 (Table 21), and less frequently observed hunting in ponds E6A, E6B, and E8 (Table 14). White-tailed Kites were the most frequently observed predator in E16B, and were often observed perched on remnant salt production fencing (Table 15).

In January of 2016, hunting blinds in adjacent ponds E14 and E9 that were used extensively 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 2020 breeding season, the landscape cloth was still intact, resulting in no observed raptor nesting or perching on these blinds.

Hayward

Common Ravens and American Crows were the most frequently observed predators at Hayward Regional Shoreline (Table 16). American Crows were frequently observed hunting on the capped landfill bordering to the south of FDW, while Common Ravens were frequently observed hunting in the OBN ponds. California Gulls were the next most frequently observed predator, and were exclusively observed at FDW, particularly when surveys first began in May when water levels were higher. Northern Harriers were the most frequently observed raptor, and were occasionally observed hunting at FDW and OBN ponds.

Predator data was not collected for any other regions in RU3 during the 2020 breeding season.

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 at E6A, while red fox were observed on several occasions at the Oliver Brothers North ponds. Striped Skunks were observed on several occasions at R4 and RS5. To provide an index of mammal presence on the ponds, trail cameras were placed at E14 and E16B access points and along the narrow E12/13 levee from April-July. We recorded nine instances of Coyote at these cameras (Table 17).

At Eden Landing, USDA-Wildlife Services removed 34 mammals at Eden Landing in 2020, including skunks, feral cats, possums, and raccoons (E. Covington, pers. comm.).

Human Disturbance

Humans and off-leash dogs were captured by trail cameras trespassing on five occasions at E12-14, and at nearby E8, one image of a motorcyclist riding on the pond was captured (Table 17). New tracks from the motorcyclist were observed on E8 throughout July and August. On May 5, a motorcyclist (likely the same individual), was observed by Wildlife Services riding on the levee between ponds E13 and E14. 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.

Pedestrian presence was much higher at Hayward Shoreline in 2020 compared to prior years (M. Taylor pers. comm.). At FDW, we frequently observed off-leash dogs along the Sulphur Creek trail and Bay Trail, and found evidence that dogs trespassed onto the pond.

DISCUSSION

Population Size

During the May breeding window survey, we counted 147 breeding adult Snowy Plovers (Table 1). Due to access restrictions imposed in response to the COVID-19 pandemic, the Refuge was not surveyed as part of the window survey, therefore the survey provides an incomplete picture of the RU3 breeding population. Nevertheless, observing year to year trends among areas that were surveyed may provide insight into population trends.

In the South Bay, Eden Landing remained stable, with 115 adults counted in 2020 compared to 117 in 2019 (Table 1). The Hayward Shoreline breeding population appeared to grow in 2020, with 19 adults counted compared to 12 in 2019. This is also the second most adults observed at Hayward since window surveys began in 2005 (32 in 2013). At Crittenden Marsh, eight

adults were observed, the second most since window surveys began there in 2014, when 11 adults were observed.

In the North Bay, two adults were observed at Hamilton Wetlands, the first time that adults have been observed at Hamilton Wetlands during a breeding window survey (conducted 2016, 2018-20). Since the site is not regularly surveyed by trained biologists, it is unknown if the pair attempted to nest on-site. Regardless, this indicates that if issues with high tides overtopping berms, and subsequently, flooding the seasonal wetlands, are corrected, the area can potentially support breeding plovers. Due to the lack of suitable habitat in the North Bay, correcting these issues should be considered a priority for promoting Snowy Plover recovery throughout RU3.

Nest Abundance and Success

In 2020, we monitored 210 nests in the South Bay, and an additional three nests were monitored each by EBRPD at Hayward Shoreline and four nests by EcoBridges Consulting at Montezuma Wetlands. As with population size, since most of the Refuge was not surveyed throughout the season, it is not possible to compare the number of nests monitored to previous years at the RU3 level, however breeding success and effort can be assessed among areas that were surveyed. Nest totals should be viewed as an index rather than a precise total since not all successful nests are detected and unsuccessful nests are even less likely to be detected (Mayfield 1975). This is exemplified by our observation of at least 27 broods from unknown nests across the South Bay (Table 3). It is likely that a number of unsuccessful nests also went undetected.

Apparent nest success varied greatly by pond. Across the South Bay, the ponds with the highest depredation rates (minimum 8 nests) were E6B (59%; n=17), E12-13 (56%; n=9) and OBN1-17 (46%; n=11) (Table 2). The ponds with the lowest depredation rate (minimum 8 nests) were E8 (38%, n=16), FDW (17%; n=18), and R1 (13%; n= 19). E6C (9%, n=9) had the lowest depredation rate, but this was due to six nests being flooded out by rising water levels.

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). Better understanding of the different factors influencing predator abundance throughout RU3, including pond accessibility, predator perches, proximity to predator source populations, as well as the overall impact of mammalian predators on breeding success, is pivotal to creating more successful breeding sites throughout RU3, which will provide greater stability and protect against localized population decline.

Refuge

Due to the COVID-19 pandemic and associated access restrictions, zero surveys were conducted at any Refuge sites between the weeks of March 16 and June 1. Surveys at Ravenswood ponds R3-S5 and R1-2 resumed during the week of June 8. During these first surveys, a large amount

of Snowy Plover breeding activity was observed, including 2, 2 and 5 broods observed at R1,R3, and R4, respectively. This indicates that a moderate to large amount of breeding activity occurred at these ponds during the time when the ponds were not surveyed. Once surveys resumed, an additional 8, 3, and 7 nests were monitored at R1, R3, and R4, respectively. As has been observed in recent years, these ponds had high apparent nest success, with hatching rates of 88%, 100%, and 71%, respectively (Table 2).

Despite high apparent nest success, apparent nest initiation ended earlier at Ravenswood compared to other areas, with the last nests at R1, R3, and R4 initiated on 7/2, 6/28, and 6/15, respectively. After 7/2, 16 additional nests were initiated at Eden Landing through 7/22, two were initiated at Crittenden Marsh through 7/7, and two were initiated at Hayward Shoreline through 7/11. It's unclear why Snowy Plovers didn't continue to establish new nests at Ravenswood, but one potential reason is lack of foraging habitat. At both R3 and R4, water levels were very low by the time surveys resumed in June, providing minimal foraging habitat as the season progressed. With little foraging habitat, relatively few adults not already associated with a nest or brood were found on these two ponds. At R1, where nest initiation occurred latest, the pond provided a large amount of foraging habitat, with a foraging flock observed there on initial surveys. However, by July 2, water levels were noted to have risen slightly due to a leaking water control structure. While this did not affect any known nests, it is possible that undetected or newly initiated nests were flooded out. The reduced area to nest in, where there were already two active nests and five broods, may have influenced lack of nest initiation on the pond. Measures to better control water levels, including the removal of the leaking R1 water control structure in the Fall of 2020 and installation of water control structures at R3 as part of the South Bay Salt Pond Restoration Project, will allow for more consistent management of these areas to promote high quality breeding habitat throughout the year.

It is important to note that our ability to detect breeding Snowy Plovers in R3 and R4 was significantly aided by the ability to drive the All-American Canal. Of the 10 nests monitored in R3 and R4, due to their location in the middle of the pond it is likely that seven of them would not have been observed had the All-American Canal not been driveable. Surveying from the American Canal allowed us to survey a large area of the pond from much closer range, and more importantly, to survey the pond without looking into the sun.

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 the Fall of 2020, which will 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 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

In 2020, we monitored the largest amount of nests ever documented at Crittenden Marsh since surveys began in 2014 (15, previous high of 14 in 2014). 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. Precipitation totals during the winter of 2019-20 were relatively low, resulting in a greater amount of available breeding habitat in both ponds compared to recent years (Figure 20, Pearl et al. 2015-19). Despite this, water levels restricted breeding activity during the first half of the season to the central western area of CMW, on MROSD property known as Stevens Creek Shoreline Nature Study Area. The first two nests were initiated on 5/1 in this area, with two more initiated in the area on 5/16 and 5/31. These nests were found in loose association with several breeding American Avocets, Black-necked Stilts, and Killdeer. Beginning in June, as both ponds began to further dry and expose pond bottom, Snowy Plovers spread to other areas, including CME, where the first documented nest since 2014 was initiated on 6/3. The receding water levels also provided a large amount of foraging habitat for both broods and adults.

Crittenden Marsh provided good quality Snowy Plover breeding habitat in 2020, with high apparent hatching and fledging success observed. This site represents one of the last Snowy Plover breeding locations in Santa Clara County not slated for tidal marsh restoration. As such, it is critical that this area be enhanced to maximize the quality of habitat. Simple measures that could be enacted with minimal cost include removal of wooden perches that are found on both ponds, as well as conducting a mud stomp and spreading oyster shells, gravel, or other material to increase texture on the pond bottom. These actions could help to improve both hatching and fledging success in both areas. Other measures that may be more complex and/or costly that should be considered include vegetation management on CMW and installation of water control structure(s). Over ten years ago, a positive trapping of Salt Marsh Harvest Mouse (SMHM) occurred at CMW, and as a result, vegetation management has been restricted on the pond. To our knowledge, no SMHM trapping effort has been spent at CMW since, and it is unknown if the pond currently supports them. It is important that SMHM trapping be conducted at CMW in the near future to guide management efforts. With removal of small amounts of pickleweed in targeted areas, the pond could support a greater amount of Snowy Plover breeding to start the breeding season before water levels have subsided. While installation of water control structure(s) is a much more complex and costly endeavor, and would require a large amount of coordination between numerous agencies, nevertheless it should be considered as an option to greatly improve breeding habitat. Water control structures would allow managers to provide breeding habitat in both ponds throughout the breeding season, while also ensuring that there is adequate foraging habitat. This level of

control would allow for more specific enhancement actions, and would ensure that there is quality breeding habitat in Santa Clara County. 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 6 years at E14 highlights that "placing all the eggs in one basket" is not an effective long-term strategy for meeting recovery goals.

Eden Landing

For the seventh consecutive season, the majority of Snowy Plover breeding activity at Eden Landing was found at E14 (n=62, Table 2). Despite this, we observed a significant decline in Snowy Plover breeding activity at E14, with 43% less nests found in 2020 compared to 2019 (Pearl et al. 2019). Nest initiation during the first half of the season followed a similar trend observed since oyster shell enhancement in late 2014, with 41 nests initiated March 9-May 15 (Figure 23). However, only 21 more nests were initiated May 16-June 29 (Figure 30), and the number of adults observed on the pond steadily declined from 66 on May 19 to 5 adults on July 6 (Figure 24). Within the rest of Eden Landing, an additional 21 nests were initiated from June 30-July 27 (Figure 25), indicating that E14 was abandoned by plovers as a nesting area after June 29. The consistent presence of Northern Harriers and Peregrine Falcons hunting in the pond (Table 13), which have been previously identified by SFBBO as significant predators of Snowy Plover adults, eggs, and chicks at E14, likely played a significant role in this observed trend. Coyotes may have also depressed breeding activity in E14.

The observed hatch rate of Snowy Plover nests in E14 in 2020 (40%) was nearly identical to that observed in 2019 (41%), however we observed the largest rate of nest abandonment (13%, Table 4) of any site monitored by SFBBO since 2003. This was likely due to increased human disturbance. Although Eden Landing has seen relatively light foot traffic since opening, and COVID-19 restrictions initially kept the number of people using the trails low, by mid-April Eden Landing received larger numbers of pedestrians and cyclists than usual (pers. obs.), including numerous trespassers onto levees in sensitive areas closed to the public (Table 26). The eight abandoned nests were located within a mean of 66.9±39.9m from the levee, well within the 164m mean distance at which Snowy Plovers have been observed flushing from nets when approached by pedestrians (Trulio et al. 2012). It's likely that at least some of these nests were abandoned due to human disturbance from trespassers.

Snowy Plover breeding activity in ponds E12 and E13 declined significantly in 2020 (n=9), with 64% less nests observed in the ponds compared to 2019, when 25 nests were monitored (Pearl et al. 2019). The decline in breeding activity may have been due to the presence of coyotes throughout the season, which would have frequently traveled on berms and levees where Snowy Plovers have nested in the past.

Snowy Plovers experienced poor nest success at E16B in 2020 (n=18, hatch rate = 44%; Table 2). Coyote tracks were frequently observed on the pond early in the season, and their presence on the pond was confirmed throughout the season by trail cameras (Table 17). Five of the eight depredated nests were found near the pond access point that coyotes appeared to use,

indicating that they may have been responsible in part for the poor nest success. White-tailed Kites were the most frequently observed predator on the pond, where they were often observed perched on remnant salt production fencing (Table 15). The other three depredated nests were found near these perches, therefore it is possible White-tailed Kites also impacted hatch success on the pond. Removal of perches throughout the pond could reduce the ability of White-tailed Kites and other raptors to hunt in the pond, potentially resulting in increased nest and fledging success.

Nests in ponds E6B experienced moderate hatching success in 2020, at 41% (n=17), while nests in E8 experienced high hatch success, at 63% (n=16). This is a major improvement over hatch success in these ponds in recent years, when hatch success was consistently below 40% in both ponds (Pearl et al. 2019). In 2020, these ponds were managed to provide more dry pond bottom and less open water, resulting in a greater amount of suitable breeding habitat and less open water. As a result, less egrets, herons, and gulls were observed in these ponds (Table 14), which may have reduced the likelihood of these generalist predators opportunistically depredating Snowy Plover nests. Nevertheless, both ponds contained a large amount of predator perches, including remnant salt production structures, and in E6B, an abandoned house and numerous hunting blinds. Peregrine Falcons were the most frequently observed raptor in these ponds (Table 14), and were often observed hunting from these perches. After the 2020 breeding season, SFBBO staff removed the majority of predator perches on E6B, including over 30 wood posts, and demolished the abandoned house. At E8, two socially distanced volunteer events were held on September 26 and October 3, resulting in the removal of close to 100 wood posts.

At E6C, where zero Snowy Plover nests were monitored in 2019, we monitored the fate of nine nests in 2020. Since water control is suboptimal in this pond, breeding habitat is not usually available until the second half of the season, when enough water has evaporated to expose dry pond bottom. This was the case in 2020, when all nine nests were initiated between 6/4 and 7/9 (Figure 25). Unfortunately, due to an inability to quickly adjust water levels at this pond, six of these nests were flooded out during one event (Table 2). This pond is planned to be managed for Snowy Plover breeding as part of Phase II actions, including installation of water control structures. More precise control of water is critical to both preventing nests from flooding, and since the neighboring E1C-5C ponds are planned for tidal marsh restoration, providing suitable breeding habitat throughout the breeding season as well.

Nest Raised at E13

Although SFBBO's 10a1A permit allows for the raising of Snowy Plover nests at risk of being flooded, until 2020 we had not attempted to do so. Since the majority of the Pacific Coast population of Snowy Plovers breed on sandy beaches, our permit advises burying a tire under the sand to raise the nest height. RU3 nesting habitat, which is composed of dry pond bottoms and nesting islands, is not compatible with this method due to the hard substrate and large amount of digging that would be required to bury a tire. We were especially concerned that the large amount of disturbance to the pond bottom would attract the attention of predators

and increase the risk of nest depredation. However, on July 1, after determining that a nest in the mixing basin of E13 was at risk of being flooded out by rising tides, and consulting with Eden Landing manager John Krause to discuss management options, it was decided that raising the nest was the best option. After receiving approval from the Bay Delta Fish and Wildlife Office, on July 2 SFBBO biologists raised the nest by using a shovel to create a mound approximately 6 inches in height next to the nest scrape. To minimize disturbance, soil was gathered from 30m or farther away from the nest, and dried algae was added to the mound sides to blend in with the surrounding pond bottom. The female initially appeared to be stressed by the disturbance to her nest, however she resumed incubation within 15 minutes after biologists left the area, and the nest was later confirmed to have hatched.

Although not all nests in RU3 at risk of being flooded can be raised, we learned that despite substrate constraints, nests can be safely raised. In future breeding seasons, we will more readily consider this an option to prevent nest loss due to flooding.

Hayward

For the first time since 2003, SFBBO staff monitored Snowy Plover breeding activity at Hayward Shoreline. In 2020, we documented the largest amount of Snowy Plover breeding activity in this area since RU3 was formed. Surveys began during the breeding window survey, when two active nests were located at FDW and two active nests and a depredated nest were located at OBN. Due to access restrictions at the Refuge reducing SFBBO's field schedule, and since breeding activity was observed, we were able to continue surveys through the end of the breeding season. Through the rest of the breeding season, we monitored 18 nests at FDW and 11 at OBN, finding apparent hatch rates of 83% and 45%, respectively (Table 2). Although American Crows were frequently observed on-site at FDW(Table 16), they were observed foraging on the adjacent capped landfill rather than the pond, and didn't appear to have a major impact on Snowy Plover breeding. Northern Harriers were the most frequently observed raptor at FDW, and considering their documented impact in RU3 and elsewhere, may have impacted Snowy Plover breeding success at this site as well. At OBN, Common Ravens were the most frequently observed predator (Table 16), and may have played a major role in the lower hatch success observed at the ponds. Red fox were also frequently observed on the ponds, and based upon the sighting locations, it appears that a den may have been present on the outboard levee of OBN 3 and OBN 4. Removal of red fox at OBN should be considered a priority, as this would likely benefit both Snowy Plovers at OBN and Least Terns and Snowy Plovers at nearby Least Tern Island.

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 an SFBBO volunteer observed three adults and two young broods at the pond, indicating that the pond had supported at least two nests. In future seasons, we will ensure that the pond is surveyed at least monthly by staff and volunteers to reduce the likelihood that breeding activity goes undetected.

North Bay

A small amount of breeding activity was detected at Montezuma Wetlands in 2020 (n=4, Table 2). Since targeted Snowy Plover surveys were not conducted in 2020, but rather their presence was opportunistically recorded during the course of Least Tern surveys, it is possible that additional breeding activity took place away from the Least Tern colony. Montezuma Wetlands plans to conduct targeted surveys for Snowy Plovers in 2021, therefore the amount of breeding activity in this area will be more accurately depicted in 2021. 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 be documented and management action taken to support breeding.

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 2020 (K. Taylor, pers. comm.) However, it should be noted that the area is not systematically surveyed for Snowy Plovers throughout the breeding season, but instead opportunistically observed during Least Tern surveys at ponds 7/7A and Green Island Unit. The Wingo Unit, which has supported breeding activity in recent years and provides the best potential Snowy Plover breeding habitat in the area, was only visited a few times, therefore breeding activity at this site is unknown. In the future, targeted surveys throughout the breeding season, especially at the Wingo Unit, may allow for more complete knowledge of Snowy Plover breeding at the site.

At Hamilton Wetlands, a pair of Snowy Plovers were observed on-site during the breeding season for the first time since a nest was detected by Point Blue Conservation Science biologists in 2013. However, no targeted follow-up surveys were conducted to determine if the pair attempted to nest on-site. Furthermore, the flooding issues that have precluded breeding in the North Seasonal Wetlands have not yet been addressed, thus it is unlikely that suitable habitat remained. If these issues are addressed, Hamilton Wetlands may support a small amount of Snowy Plover breeding activity.

Chick Fledging Success

We color banded 85 Snowy Plover chicks in 2020, the third most since we began color banding in 2008 (Table 4). Banded Snowy Plover chicks experienced poor fledging success, with only 27% confirmed to have fledged, resulting in an estimate of 0.66 chicks fledged per male (Table 5), well short of the USFWS goal of 1.0 chicks fledged per male. This aligns with poor anecdotal chick survival at most locations in 2020, when broods were often not observed a second time and presumed to have perished. We banded over 28% of all chicks that hatched from monitored nests (Table 2), representing the fourth highest proportion of chicks banded since our program began. Therefore, we believe that this data may more accurately reflect Snowy Plover fledging success in the South Bay, especially at Eden Landing where most chicks were banded. The combination of poor hatching and fledging success observed in recent years poses a major problem to both RU3 and rangewide population recovery goals, as evidenced by an apparent population decline from 2017-2019 (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

In 2020, we again focused our banding efforts at E14, where nearly one third of all Snowy Plover chicks banded in 2020 were hatched (n=27, Table 5). We were able to band 41% of all nests known to have hatched at E14, and as in recent years, found that Snowy Plover chicks experienced poor fledging success (19%, 0.45 chicks fledged/male; Table 5) in this pond. Despite a Least Tern colony not forming at E14 in 2020, predator presence was high throughout the season, indicating that predators recognized the concentration of breeding Snowy Plovers in the pond. Northern Harriers and Peregrine Falcons, which were both frequently observed hunting in the pond (Table 21), likely accounted for a large amount of chick predation in the pond, while Common Ravens and Coyotes likely also predated upon chicks. In adjacent E13, one chick was banded and determined to have fledged, and one of the banded chicks from E14 known to fledge moved to E13 within one week after banding. Despite the fact that E13 provides both less and lower quality habitat for plovers, the observed lack of the aforementioned predators may have provided better brood rearing habitat in 2020.

Aside from E14, we banded the largest amount of chicks in ponds E6B (n=11) and E8 (n=6), representing 37% of all nests known to hatch in these ponds together. Although separate ponds, broods readily move between both ponds, thus fledging success is more accurately considered collectively. As with E14, banded Snowy Plover chicks experienced poor fledging success in these ponds (18%, 0.43 chicks fledged/male; Table 5). Although Peregrine Falcons and Northern Harriers were observed less frequently compared to E14, they were still the most numerous raptors observed in these ponds (Table 21), and likely had a major impact on chick survival. In 2020, both ponds contained a large amount of perches that Peregrine Falcons frequently hunted from, and with very little habitat complexity on the pond, chicks would not have been readily able to hide from either Peregrine Falcons or Northern Harriers. Coyote

tracks were frequently observed in E8 and adjacent E6A early in the season, indicating that they likely impacted chick survival in these two ponds as well.

In order to reduce the ability of Peregrine Falcons and other perching predators to hunt chicks in the most consistently used breeding ponds at Eden Landing, all remaining perches that are not considered historical artifacts should be removed as soon as possible from ponds E12-14, E15B-16B, E6A, E6B, and E8. Although SFBBO has conducted numerous volunteer events and staff from CDFW, Refuge, and SFBBO have spent time removing old hunting blinds and perches throughout the ponds over many years, recent work began in earnest in 2020 with the volunteer Least Tern Habitat Enhancement Event at E14 in early March, staff work in E6B in September, and a volunteer perch removal event in both September and October. Depending upon current local Covid-19 health orders, we plan to conduct additional staff work and volunteer habitat events prior to the season in February and March, and after the season in September and October. In addition to perch removal, conducting a mud stomp to increase pond texture and spreading shell, especially near foraging areas, may also reduce the ability of other predators to hunt chicks.

The only Eden Landing pond where banded Snowy Plover chicks experienced high fledging success was pond E4C (43%, 1.0 chicks fledged/male; Table 5). We were able to band all three nests that hatched out of six total nests monitored (Table 2), finding that of seven chicks banded, one chick from each brood survived to fledge. The first brood (two chicks) was banded on 5/19, and although they were not observed again as chicks, one of them was confirmed fledged at E6A on 6/30. The second and third broods were banded on 8/03 and 8/06, respectively, and although they were observed up to two weeks after banding, were not observed the third week post-banding. Knowing that one banded chick fledged earlier in the season despite not being observed again, we decided to walk to the back of the pond to determine if the banded broods had moved to this area. To our surprise, we found both broods, an active nest, and an additional unbanded brood that may have come from a known hatched nest in E5C. E4C is a very large pond, and within 450m of the levee road from which surveys are normally conducted, and where all three hatched nests were located, there are hundreds of perches that render the habitat poor in quality. Until this year, we were unaware that the back of the pond, located approximately 750m from the levee where surveys are conducted, has far less perches and provides much better foraging habitat. Our banding efforts at E4C reinforced two important lessons, the first being that perches near foraging habitat reduce habitat quality and should be removed wherever possible to improve fledging success. More importantly, the results of our banding reiterated that it is critical to provide Snowy Plover breeding habitat in as many ponds as possible to reduce breeding density, thereby limiting the ability of predators to hunt exclusively in high density Snowy Plover breeding ponds, as well as allowing breeding Snowy Plovers in low density ponds a greater chance at breeding success.

Ravenswood

In the past, we avoided banding chicks at R3 and R4 due to the documented difficulties in surveying for breeding Snowy Plovers in these ponds and concern over our ability to resight banded Snowy Plover chicks. The filling of the All-American Canal as part of SBSPRP construction activity allowed us to drive the new levee and greatly improved our detection ability on the interior of the pond. Therefore, for the first time we deemed it possible to keep track of banded Snowy Plover chicks in these ponds. Although our detection ability was greatly improved, and we were initially able to resight most of the broods during the following survey after banding, we still did encounter some difficulties in detecting broods and reading bands in this pond. This was largely due to low water levels in the pond, which appeared to force broods to search for foraging habitat, often in the far interior of the pond and bottom of remnant slough traces where they were difficult to detect and color bands were nearly impossible to read. Although this may occur in the next 1-2 breeding seasons, once water control structures are installed on R3 this will no longer be an issue. We plan to continue color banding at both R3 and R4 in 2021.

Although we observed seven broods of all ages between the two ponds during our first survey on June 10, and many of these broods appeared to fledge, Snowy Plover chicks that hatched after this date appeared to have low fledging success. We banded five chicks in R3 and seven chicks in R4, finding that zero fledged in R3 and one fledged in R4 (0.33 chicks fledged/male; Table 5). In part owing to the issues associated with resighting broods, the only chick known to fledge was observed at 5 days old as a chick, and next observed at 56 days old as a juvenile on nearby pond R1 during the course of a targeted band resighting survey. The lack of water in both ponds resulted in juveniles and non-breeding adults leaving the pond, therefore it is possible that additional banded chicks fledged and moved to R1 or R2, where large flocks were observed, or RSF2, which SFBBO was not provided access to survey in 2020. Nevertheless, our frequent sightings of Common Ravens on R3 (1.9/survey) and R4 (1.0/survey), and American Crows on R3 (3.9/survey; Table 10), when there were very few other breeding birds or other prey on the pond, indicate that both corvid species may have been targeting breeding Snowy Plovers, especially chicks.

Crittenden Marsh

For the third year in a row, we color banded Snowy Plover chicks at Crittenden Marsh in an attempt to determine the value of this breeding site to Snowy Plovers, as well as to hopefully begin to establish a population of banded adults on-site. Of the ten nests known to hatch, we were able to band two broods totaling 5 chicks, all of which were confirmed to have fledged (Table 5). Two additional broods were attended by banded males, allowing us to keep track of these chicks as well. The first nest initiated on the pond, which hatched by 6/2, was initiated by male ka:ag, who was banded at CMW as a chick in 2018 and fledged one banded chick on the pond in 2019. In 2020, three chicks hatched from his nest, and we confirmed that at least one of these chicks fledged based upon observation of the chick associated with ka:ag over 28 days since the nest was confirmed to have hatched. In the other instance, ko:gy, a male originally

banded at the nest as an adult at RSF2 in 2015, was observed with a three chick brood from one of the last nests to hatch on CME, of which two were confirmed to have fledged. Including this data with banded chick data provides an updated estimate of 73% fledging success and 2.0 chicks fledged/male. Anecdotally, the other unbanded chicks also experienced a high rate of survival. Between the two ponds, Crittenden Marsh provided high quality brood rearing habitat and appeared to contribute substantially to Snowy Plover population recruitment.

The importance of Crittenden Marsh to RU3 plovers was highlighted by a number of band observations. gk:xx (no bands on right leg) was banded at E6B on 6/11, but was not seen again as a chick after 6/18. On 8/20, we observed gk:xx foraging among a flock of 25 adults and juveniles on CME, and on 10/6, Point Blue biologists observed gk:xx at the Pajaro Dunes, Santa Cruz County. Although ko:gy had been observed late in the breeding season each year at Eden Landing, and was observed wintering at both Ocean Beach and/or Crissy Field in San Francisco each winter, this marked the first time that he was confirmed breeding since being banded in 2015. We also observed gk:pg, who was part of the same brood as ka:ag, for the first time since 2018. He was observed scraping in Crittenden Marsh East, however it is unclear if he initiated a nest since he was not observed copulating or with chicks. Regardless, our monitoring data and color band sightings collectively indicate that Crittenden Marsh provides both important breeding and post-breeding habitat, and Snowy Plover adults show at least some site fidelity, which may be an indication of habitat quality.

Hayward

We banded Snowy Plovers chicks for the first time at FDW in 2020. Out of 15 nests known to have hatched, only two broods were banded, with three out of five chicks banded determined to have fledged (Table 5). Anecdotally, Snowy Plover chicks experienced high fledging success at FDW, with a large number of broods present on the pond each week, and thus many unbanded chicks likely fledged. Assuming Snowy Plovers again breed at FDW in 2021, we plan to band a greater proportion of hatched nests to better document Snowy Plover breeding success at this important site.

Adult Banding

For the first time since 2016, we attempted to trap and band adult Snowy Plovers at Eden Landing. We were successful in trapping on three out of four attempts, including two males and two females (Table 6). In the case of one male, ak:wb, he had not returned to the nest after six hours, and as a precaution, biologists collected the eggs and delivered the eggs to Monterey County SPCA to be hatched and raised. These chicks were released at Eden Landing on June 11, 2020. It is unknown why the male had not returned to the nest, however biologists will carefully consider all known information prior to deciding to trap an adult to prevent incidences like this in the future.

On another occasion, a male that had been previously banded but missing a band would not cross the mats, therefore we were unable to determine his complete combination. Use of

other trap types requested but not yet approved by USFWS, including spring traps, may allow for trapping individuals more easily in situations such as this.

The fouradults that were banded in 2020 were resighted after banding at ponds throughout Eden Landing. One of the females, ak:rr, was observed in September at R1, further highlighting that although Snowy Plovers may breed at one location in RU3, they may use habitat elsewhere in RU3, especially during the non-breeding season. It is important that we increase the proportion of color banded adults in RU3 to shed further light on habitat use and movement of Snowy Plovers in RU3, therefore we plan to continue to trap and band adults in 2021 as time allows.

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 higher in 2020 when compared to pre-enhancement conditions (prior to 2015). Nest abundance and density patterns in 2020 were also similar to the first five years of the enhancement (2015-2019), and overall water levels and management in nearby ponds were comparable. This suggests that large-scale oyster shell enhancement was the primary factor in the rise of nest abundance and density in 2015-2020.

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. Future research should seek to address the effect of mammalian predators on Snowy Plover breeding success on the pond, and document how removal of predator perches may affect the frequency of raptor observations on 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 need to increase in order to maintain or increase breeding numbers within a smaller habitat footprint (Figure 26-28). 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 as the default when restoration actions are considered, and attempts should be made to provide multiple breeding sites within each region of RU3.

Where high density habitat is appropriate, 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. The closing of Drake's Bay Oyster Company in Marin County in 2014 means that a large amount of local oyster shells are no longer available, necessitating the need for an alternative source. Establishment of an oyster collection program in local restaurants may provide a consistent shell source. However, since Drake's Bay oyster shells were grown to a larger size for canning, it is unclear if the smaller size oyster shells found in restaurants may affect Snowy Plover breeding in a different way. 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.

Avian Predators

Northern Harriers

Northern Harriers were the most frequently observed raptor at E14 and E8 in 2020, and were often flushed by biologists driving during the course of their survey. At E14, they were frequently perched on levee sides with mustard and other vegetation that provided cover for them. Recent research into the relative importance of different predators of shorebird chicks, including the closely related Marsh Harrier (Circus aeruginosus), found that their rate of predation on chicks was directly linked to the activity of predators onsite (Mason et al. 2018). Early in the season, one male and up to two female Northern Harriers were frequently observed hunting on the pond. Later in the season, only the male was observed, and since Northern Harriers are often polygynous (Simmons et al. 1986), it is possible that there were multiple Northern Harrier nests near E14 in 2020. On May 18, the male was observed successfully hunting for a Dunlin that was roosting in the middle of the enhanced colony area.

Although Northern Harriers were not observed depredating Least Tern or Snowy Plover adults, eggs, or chicks during the 2020 breeding season, our past observations at E8A (Robinson-Nilson and Demers 2009) and E14(Pearl et al. 2019) and their consistent presence on the pond lead us to believe that they were again the most significant predators of Snowy Plovers at E14. They likely also played a major role in the depression of Least Tern nesting at E14. Due to their documented history of impacts to both species at E14 and across the Pacific Coast, trapping and relocation of Northern Harriers should be considered a priority at this highly critical site to support both species recovery.

Peregrine Falcons

Peregrine Falcons were the second most frequently observed raptor on E14 (0.9/survey, Table 13), and sightings of juveniles in June and July indicate that they likely nested at a location in or around Eden Landing. They were often observed perched on abandoned salt production and hunting structures within the shell plots. These perches allowed Peregrine Falcons to hunt prey undetected at a much closer distance than would normally occur at salt panne or beach habitat, likely resulting in high hunt success rates. Although SFBBO removed numerous perches from the enhanced colony area during the March habitat enhancement event, and has conducted similar work at volunteer events in the past, there remain a large amount of predator perches throughout E14. Removal of these perches will be a primary focus of future volunteer habitat enhancement events at E14.

Common Ravens

Although Common Ravens have been previously documented as significant predators at E14 and suspected of the same at other Eden Landing ponds, in 2020 their impact upon breeding Snowy Plovers appeared to be more limited. This was likely due to the efforts of USDA- APHIS, who conducted targeted efforts to remove both Common Ravens and American Crows from the reserve throughout the season. Common Ravens were consistently observed hunting at R3 and R4, and based upon the lack of sightings of other avian predators, we believe that they may have had the most significant impact upon Snowy Plover breeding success in these ponds. Due to these ponds' location next to both Bedwell Bayfront Park and the San Francisco Bay Trail, there are often pedestrians in the vicinity, which may pose a challenge to USDA-APHIS conducting targeted corvid removal. Ravens were also frequently observed at CMW and OBN, and likely impacted Snowy Plover breeding success in these areas as well.

Power Tower Nest Removal

We frequently observed Common Ravens, Peregrine Falcons, and Red-tailed Hawks perched in transmission towers near Snowy Plover breeding ponds throughout the South Bay. In early February, the Refuge coordinated with Pacific Gas and Electric (PG&E) to remove an active but empty Peregrine Falcon nest located in a power tower along Highway 92 that had been used by Peregrine Falcons in 2019. However, due to COVID-19 staff restrictions, the Refuge was unable to coordinate any additional predator removal with PG&E. Whether nest removal occurs in 2021 will depend upon current health orders related to COVID-19.

Egrets and Heron Spp.

Aside from gulls, Snowy Egrets and Great Egrets were the two most commonly observed predators throughout Recovery Unit 3. 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 2020, E8 and E6B were both managed at a lower water level, resulting in less suitable hunting habitat for these species and potentially lower risk of egg and chick predation by herons and egrets in these ponds.

California Gulls

Due to COVID-19 related access restrictions, SFBBO was unable to conduct surveys to estimate the California Gull breeding population in the South Bay in 2020. In 2019, the total number of California Gulls nesting in the South Bay was 45,026 breeding birds, a decrease of 1,750 from 2018 (Tarjan & Burns 2019). It is likely that the population was not significantly different from this number. At Eden Landing, large California Gull flocks (up to 122) were frequently observed at E12-13 during the early (March-April) and late (July-August) part of the breeding season, and at E6A, large flocks (up to 425) were observed late in the season. Especially late in the season, these gull flocks may opportunistically depredate Snowy Plover eggs and chicks due to the narrow width of levees, berms, and nesting islands and resulting 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, striped skunk were observed once each at R4 and RS5. 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 may also create an easier access to skunks 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. At the OBN ponds, red fox were observed on three separate occasions. Each time, they retreated to the outboard levee near OBN4, and may have had a den located in the area. At Eden Landing, we observed one feral cat, but otherwise mammals were not observed on surveys.

Trail cameras placed at strategic locations on ponds and levees in Eden Landing indicated that coyotes were frequently present at E12-14 and E16B. From March through May, when the ponds were wet enough to leave prints, coyote tracks were observed in E8, E14, and E16B, further confirming their presence in these ponds. Coyotes have been identified as a significant predator of Least Terns (Marschalek 2009) and Snowy Plovers across the Pacific Coast (Page et al. 2009) and interior population (Ellis et al. 2020). Although we can't confidently determine the number of eggs and chicks depredated by coyotes, they likely had a significant impact upon

breeding success at E12-14, E16B, and potentially at E8 as well. Wildlife Services removed numerous striped skunks and feral cats throughout Eden Landing during trapping efforts (E. Covington, pers. comm.), and may have also affected Snowy Plover and Least Tern breeding success. It is vital that mammal trapping efforts to remove medium sized mammals, as well as targeted efforts to remove coyotes and red fox, continue at all sites throughout the South Bay.

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 2020, both FDW and OBN hosted the largest amount of Snowy Plover breeding activity ever observed at each site, as well as supporting large post breeding flocks on both ponds. FDW provided especially high quality breeding habitat, with the highest observed hatch success among all ponds in RU3, and what appeared to be the highest fledging success based upon a small sample of color banded chicks and the consistently high number of broods observed on-site each week. Although FDW was identified by SFBBO as suitable habitat in 2003 (Strong & Dakin 2003), the pond had never been consistently surveyed for Snowy Plovers. More importantly, until 2020, HARD, the landowners, and EBRPD, who manage the site, had not been adequately engaged with to convey the potential importance of both FDW and OBN to Snowy Plover conservation, and thus the habitat value of these areas was largely ignored. The Hayward Area Shoreline Planning Agency, which includes HARD, EBRPD, and the City of Hayward, is in the process of finalizing a Shoreline Adaptation Master Plan that could result in the loss of these areas for breeding Snowy Plovers. Although both SFBBO and USFWS have provided input on these plans, it is critical that both continue to provide input on the plan to ensure that future restoration projects adequately consider Snowy Plover breeding habitat needs.

Crittenden Marsh, similar to FDW, provided high quality breeding habitat and supported the largest ever documented amount of Snowy Plover breeding on-site. NASA-ARC, who owns all

of CME and approximately ⅔ of CMW, uses these ponds as a stormwater retention basin, while MROSD, who own the remaining portion of CMW, do not currently have any stated goals for management of their property. To the greatest degree possible, both SFBBO and USFWS should continue to engage with both agencies to find common ground on management goals that will support both agencies' needs and those of breeding Snowy Plovers.

Human Disturbance

We observed a large apparent increase in use of trails at E12-14 by pedestrians and cyclists in 2020. This increase was also observed at nearby Hayward Regional Shoreline (M. Taylor, pers. comm.), and was likely due to COVID-19 pandemic stay-at-home health orders significantly altering people's schedules, allowing people more time to explore local open spaces. Along with the increased traffic, we observed numerous occurrences of trespass onto levees seasonally closed to protect breeding Snowy Plovers. The rate of nest abandonment observed at E14 (13%) was the highest observed at any site in RU3 since SFBBO began monitoring in 2003. The nests that were abandoned were located 66.9±39.9 m from the levee, well within the average distance at which Snowy Plovers in the San Francisco Bay were observed flushing from nests when approached directly (164m) or tangentially (145.6m) (Trulio et al. 2012).

Although the impact of motorcycle riding near breeding Snowy Plovers and Least Terns at Eden Landing is unknown, this type of activity would likely cause significant disturbance, negatively affecting both species' recovery. Considering all available information, it seems apparent that human disturbance played a larger role in Snowy Plover breeding outcomes than is typical in the San Francisco Bay. This increase in both visitation to locations with breeding Snowy Plovers, and trespassing into sensitive areas, is likely to continue for as long as the COVID-19 pandemic forces stay-at home health orders and restricts long distance travel. Increasing the amount of signage in sensitive areas, and potentially providing more detail to justify closure of these areas, could result in increased compliance and reduce the impact of human disturbance on breeding Least Terns and Snowy Plovers.

RECOMMENDATIONS

Management Recommendations

1. USFWS, CDFW, HARD, and EBRPD 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. Demolition and removal of non-historical or non-functional structures on the pond should be prioritized. Those that are historical or functional should be treated with a perching deterrent such as bird spikes.
3. USFWS, SFBBO, and the South Bay Salt Pond Restoration Project, should continue to engage with landowners whose lands support breeding Snowy Plovers in the South Bay

outside the Project footprint. These include MROSD and NASA-ARC at Crittenden Marsh, ACFCD at Patterson Pond, and HARD and EBRPD at Hayward Shoreline. In order to reach RU3 goals, the aforementioned areas are critical to providing additional habitat.

4. Relocation of Northern Harriers and Peregrine Falcons identified as targeting breeding Snowy Plovers, especially at Eden Landing, must be seriously considered to reduce high rates of predation.
5. 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.
6. The predator management and gull hazing programs should continue in 2021 in the South Bay, with increased focus on removing mammals and preventing gulls from roosting near plover breeding and foraging habitat.
7. 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 adding interior channels, should be implemented to increase the amount of foraging habitat in the pond.
8. Addition of oyster shell or other materials such as 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. Raising water levels and increasing water connectivity between the borrow ditch and interior channels will create more foraging habitat.
9. Since bulk oyster shells may be hard to come by, alternative habitat enhancement materials, such as gravel and cobble, should be spread. Ideally, they would be spread in areas that will not be flooded on a consistent basis.
10. 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 during working hours to minimize impacts to Snowy Plovers.
    - Actions should be taken to deter Snowy Plover nesting on ponds where heavy equipment will be operating. Focusing the construction in a small footprint and keeping human disturbance constant (5-7 days a week during daylight hours) may reduce the number of Snowy Plovers attempting to nest in the vicinity of construction.
    - 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.
11. Increase 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 public 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 and/or gps 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. Changing Northern Harrier population size, territory size and habitat use and impacts on nesting Snowy Plovers as tidal marsh nesting habitat increases for harriers.
3. Examine the recent expansion of coyote populations into Eden Landing and the Refuge, identify impact to 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. Monthly surveys should include scouting areas that are not consistently used by breeding Snowy Plovers, including Patterson Pond in Coyote Hills, Frank's Dump in Hayward, 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 within the South Bay.

3. Surveys in the North Bay should be conducted more frequently to better document Snowy Plover breeding effort.

ACKNOWLEDGEMENTS

In 2020, 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, 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, and Mark Taylor of EBRPD for logistical support at the Refuge, Eden Landing, and Hayward Shoreline, respectively. We thank SFBBO Biologists Jessica Gonzalez, Parker Kaye, Gabbie Burns, Cole Jower, Josh Scullen, Dan Wenny and Anjou Kato for their hard work throughout the season. We also thank our dedicated volunteers, Diane and Tom Bennett, Bill and Tanya Hoppes, Richard Jeffers, Mike Mammoser, Mike Rogers, Sue Morgan and Ronnie Eaton 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, Anne Wallace of EcoBridges Environmental Consulting, and Jules Evens of Avocet Research Associates 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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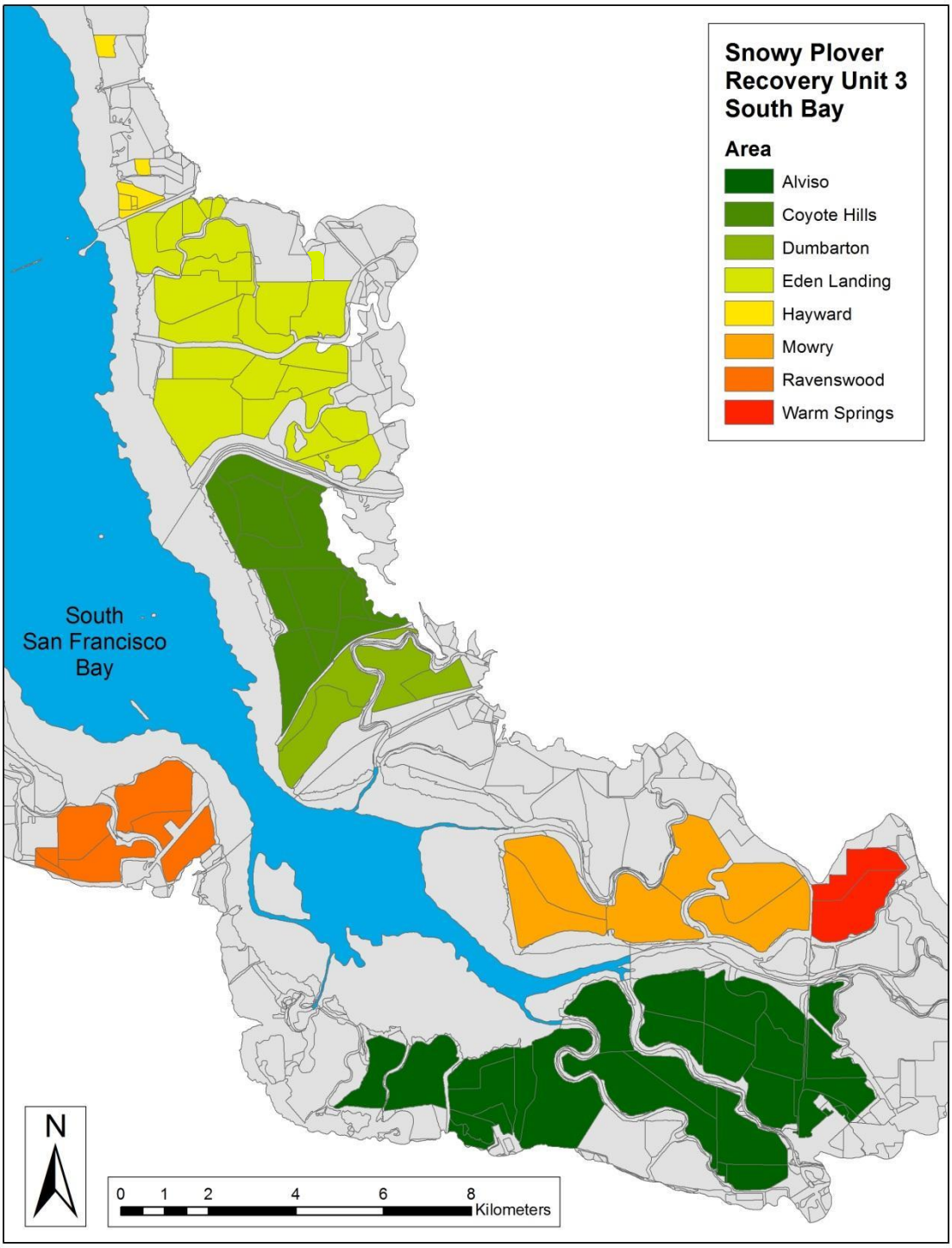

Figure 1. The Don Edwards San Francisco Bay National Wildlife Refuge, CDFW's Eden Landing Ecological Reserve, East Bay Regional Park District and Hayward Area Recreation and Park District lands in the South San Francisco Bay, California.

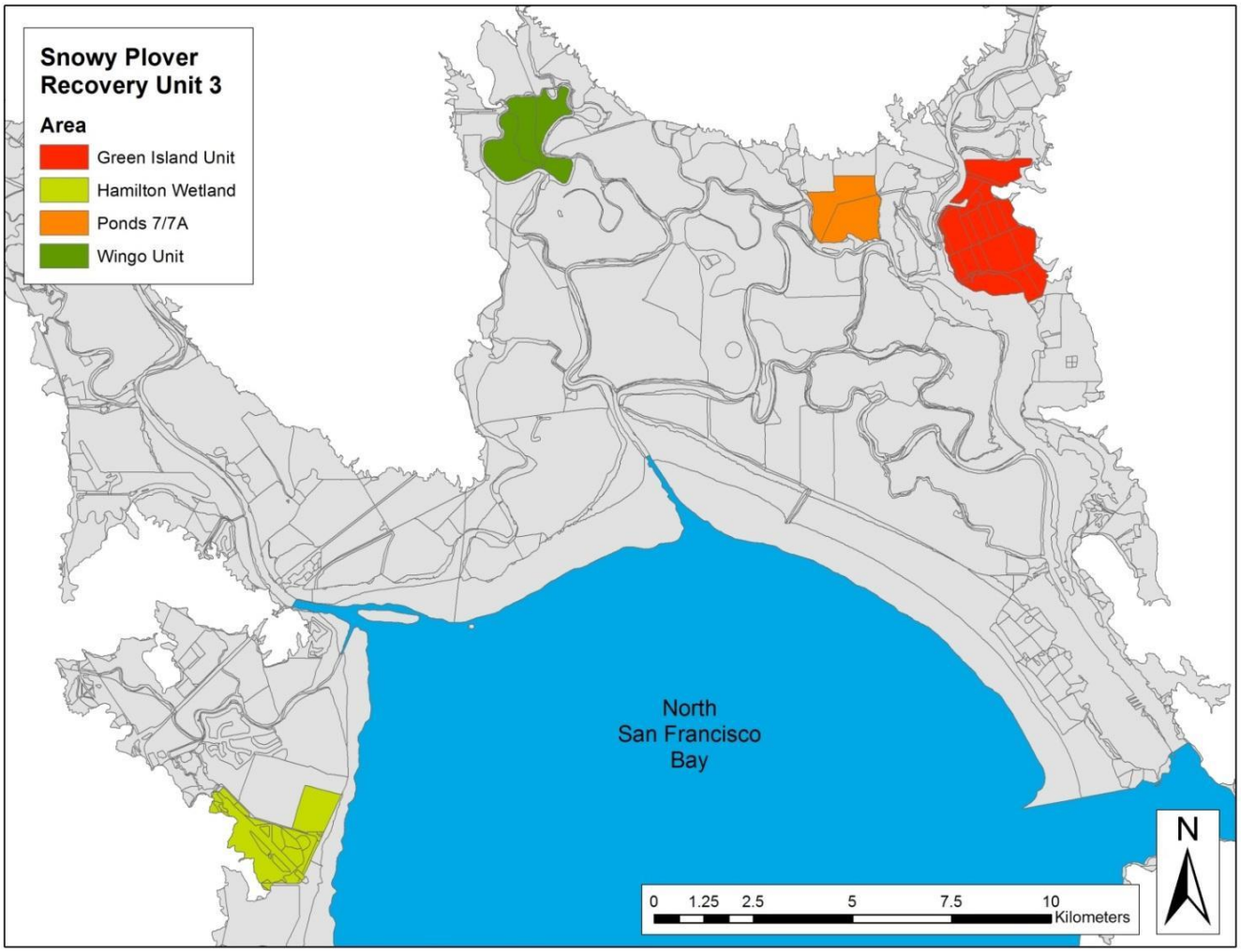

Figure 2. Snowy Plover breeding areas in the CDFW's Napa-Sonoma Marshes Wildlife Area: the Wingo Unit, ponds 7/7a, and the nesting islands at the Green Island Unit (formerly called the Napa Plant Site); Coastal Conservancy's Hamilton Wetlands, North San Francisco Bay, California.

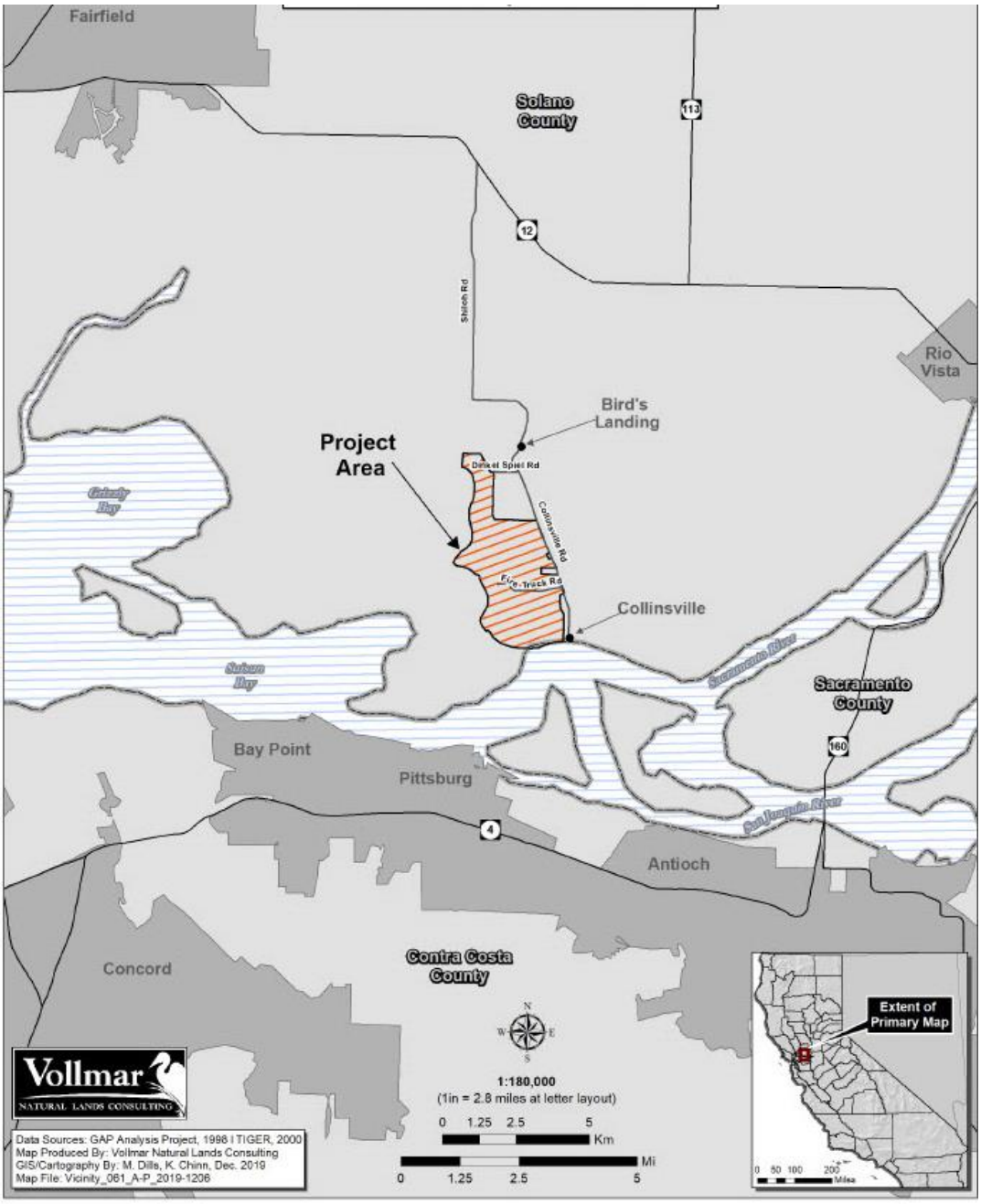

Figure 3. Snowy Plover breeding habitat at Montezuma Wetlands, located in Solano County, CA adjacent to Suisun Bay and the Sacramento/San Juaquin River Delta. Montezuma Wetlands is a private wetland restoration site. Image used courtesy of Vollmar Consulting.

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 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, Hayward, California. See Figure 1 for location of Eden Landing Ecological Reserve within South San Francisco Bay.

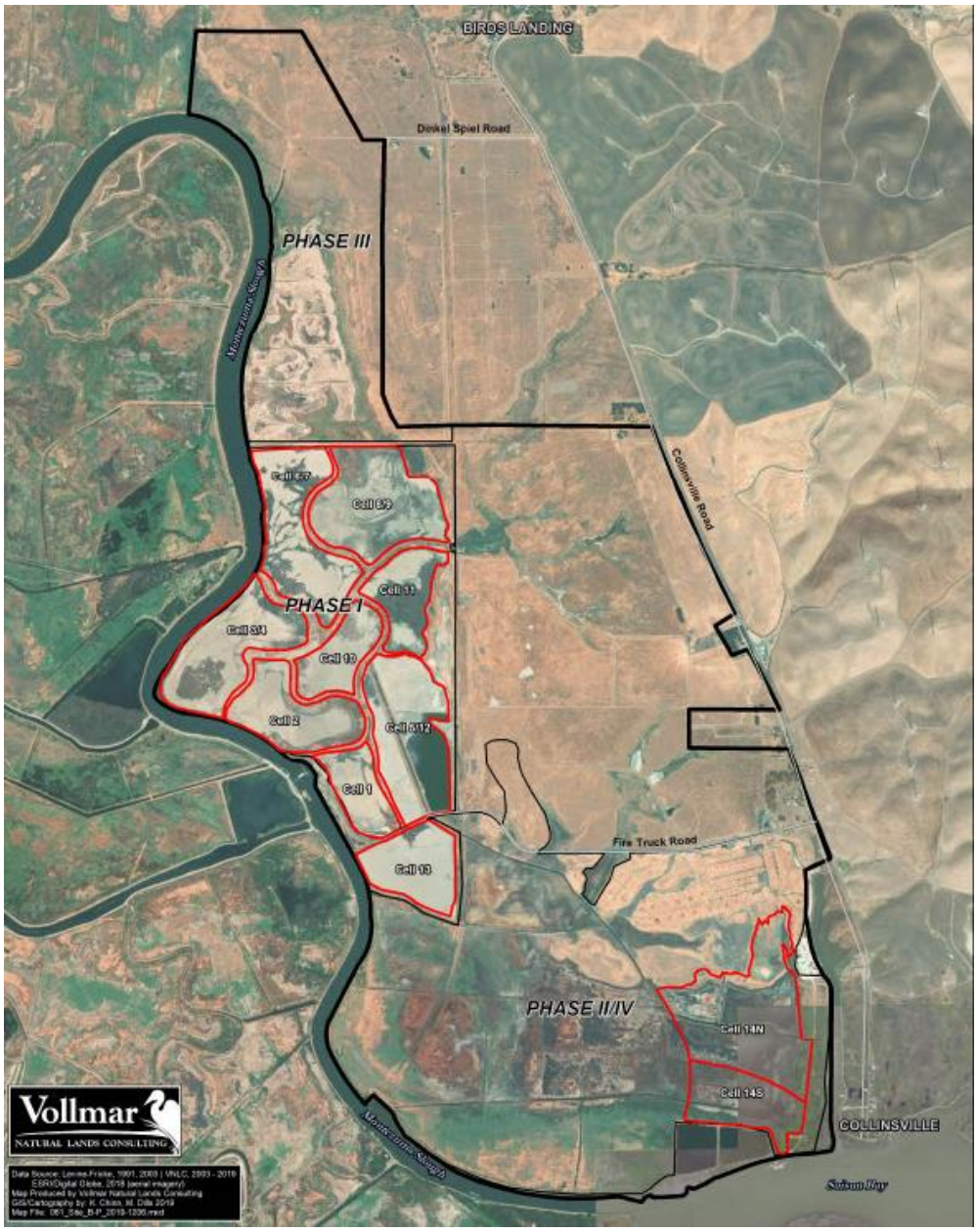

Figure 8. Close-up of Montezuma Wetlands Project Site, Solano County, CA. Image used courtesy of Vollmar Consulting.

Figure 9. Close-up of Hamilton Wetlands, Novato, CA. The northern seasonal wetlands, which may remain suitable for Snowy Plover breeding, are outlined in red.

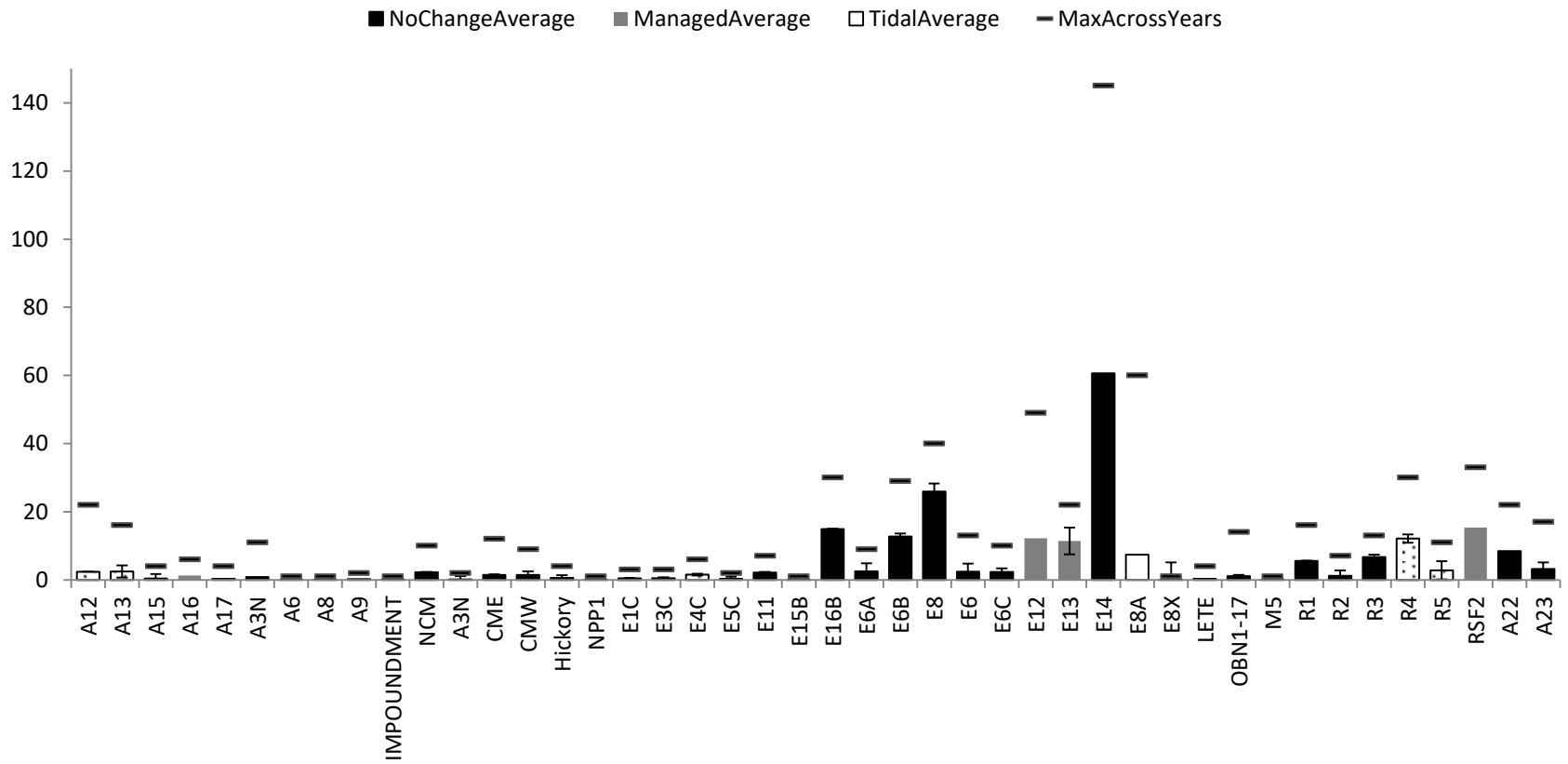

Figure 10. Average number of Snowy Plover nests initiated by pond in South SF Bay, CA from 2009-2020. Data are shown as mean + 1SD. The purpose of this figure is to illustrate which ponds have supported Snowy Plover nesting activity in recent years, and of these, which ponds were/are included in restoration 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 Phase II, 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 Phase 1/2 actions, 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 Wildlands Inc. property (Newark Slough Mitigation Bank, termed Hickory in this report). See Figure 1 for location of Dumbarton within South San Francisco Bay.

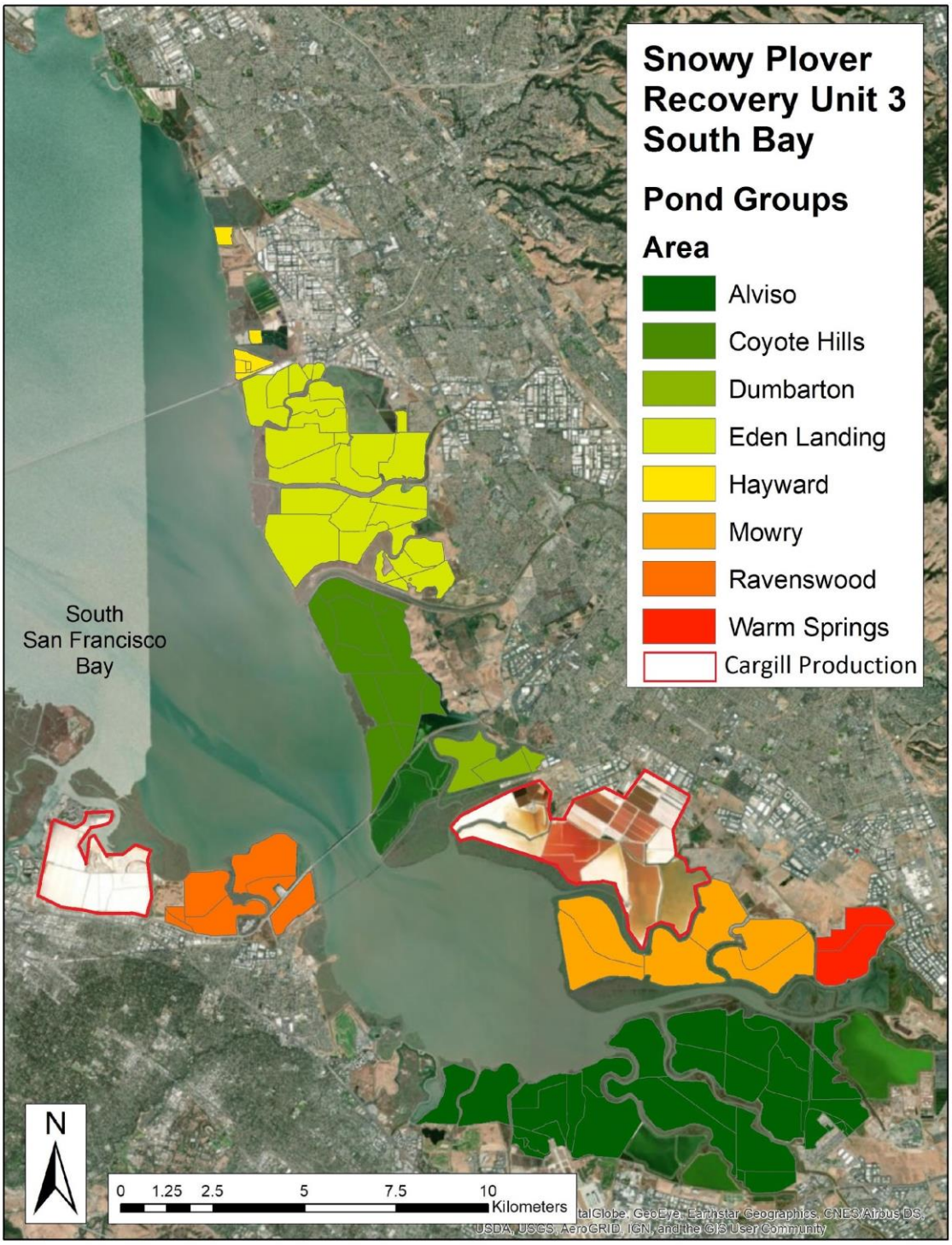

Figure 13. Cargill salt production ponds in relation to other pond groups, South San Francisco Bay, CA. The Redwood City plant is located west of the Ravenswood ponds, while the Newark plant is located north of the Mowry ponds.

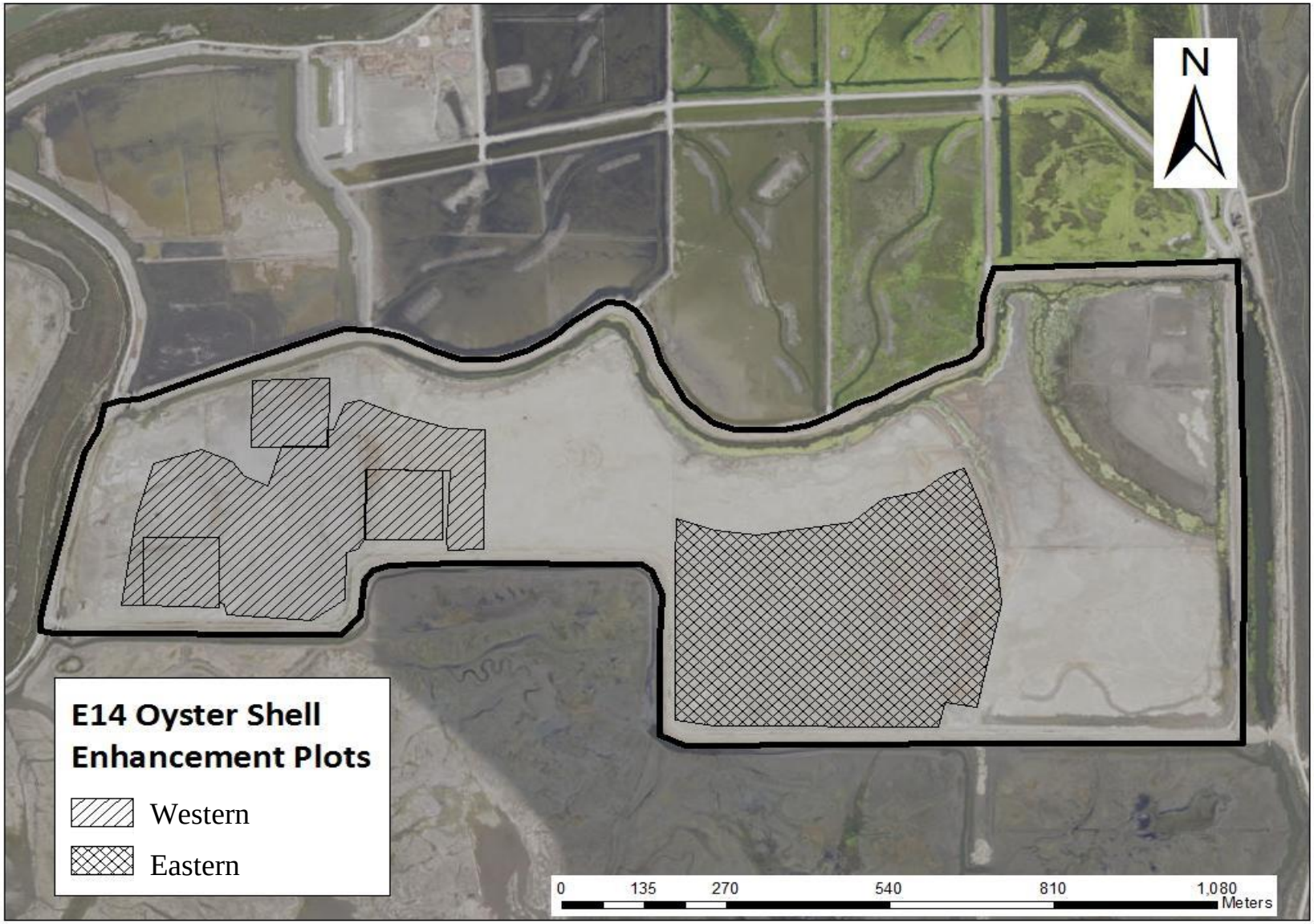

Figure 14. Oyster shell enhancement plots at Pond E14, Eden Landing Ecological Reserve, Hayward, CA.

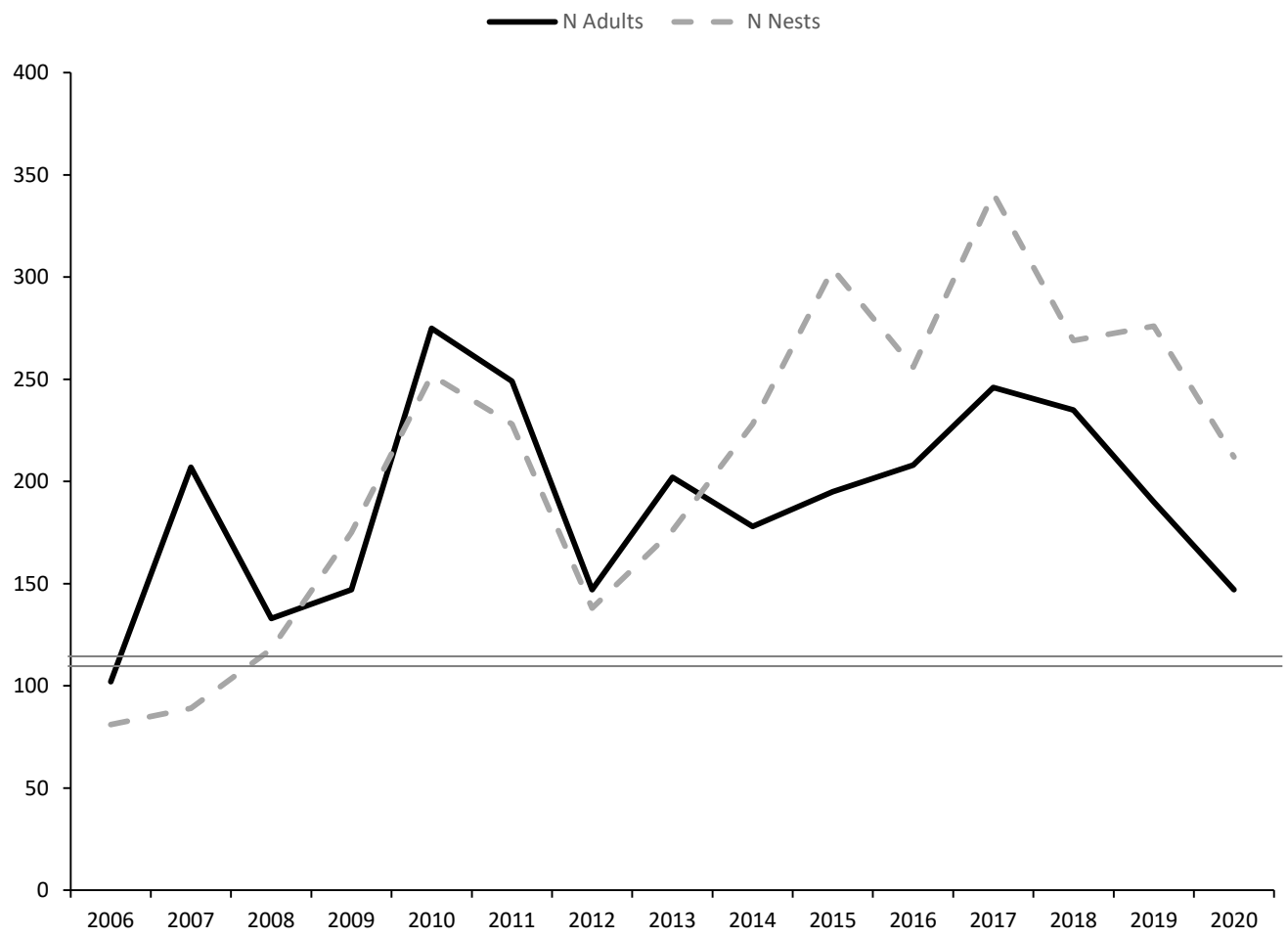

Figure 15. The total number of Snowy Plover adults counted during the breeding window survey and the total number of Snowy Plover nests counted during the season in all regularly monitored Recovery Unit 3 (RU3) areas, San Francisco Bay, from 2006-2020. The double line indicates the South Bay Salt Pond 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.

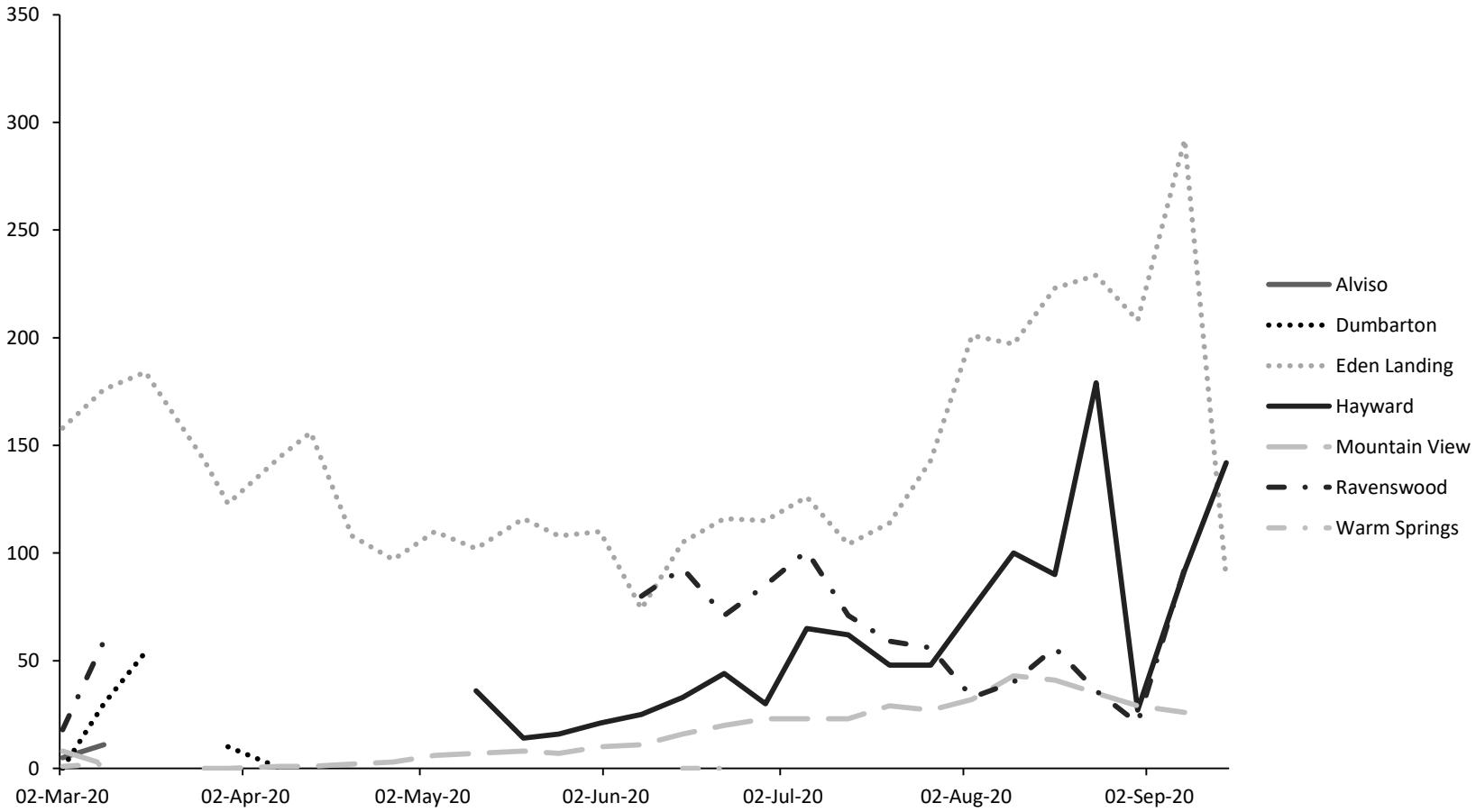

Figure 16. Weekly counts of adult Snowy Plovers by week and area, South San Francisco Bay, California, 2020. Data presented here for all locations monitored where Snowy Plovers were observed. Note the high number of Snowy Plovers observed in April and September are presumed to be migrating and not breeding in the San Francisco Bay. Note that due to COVID-19 pandemic restrictions, Alviso and Warm Springs were not surveyed after the week of March 16, Ravenswood was not surveyed between the weeks of March 16 and June 1, and surveys did not begin at Hayward Shoreline until the week of May 11.

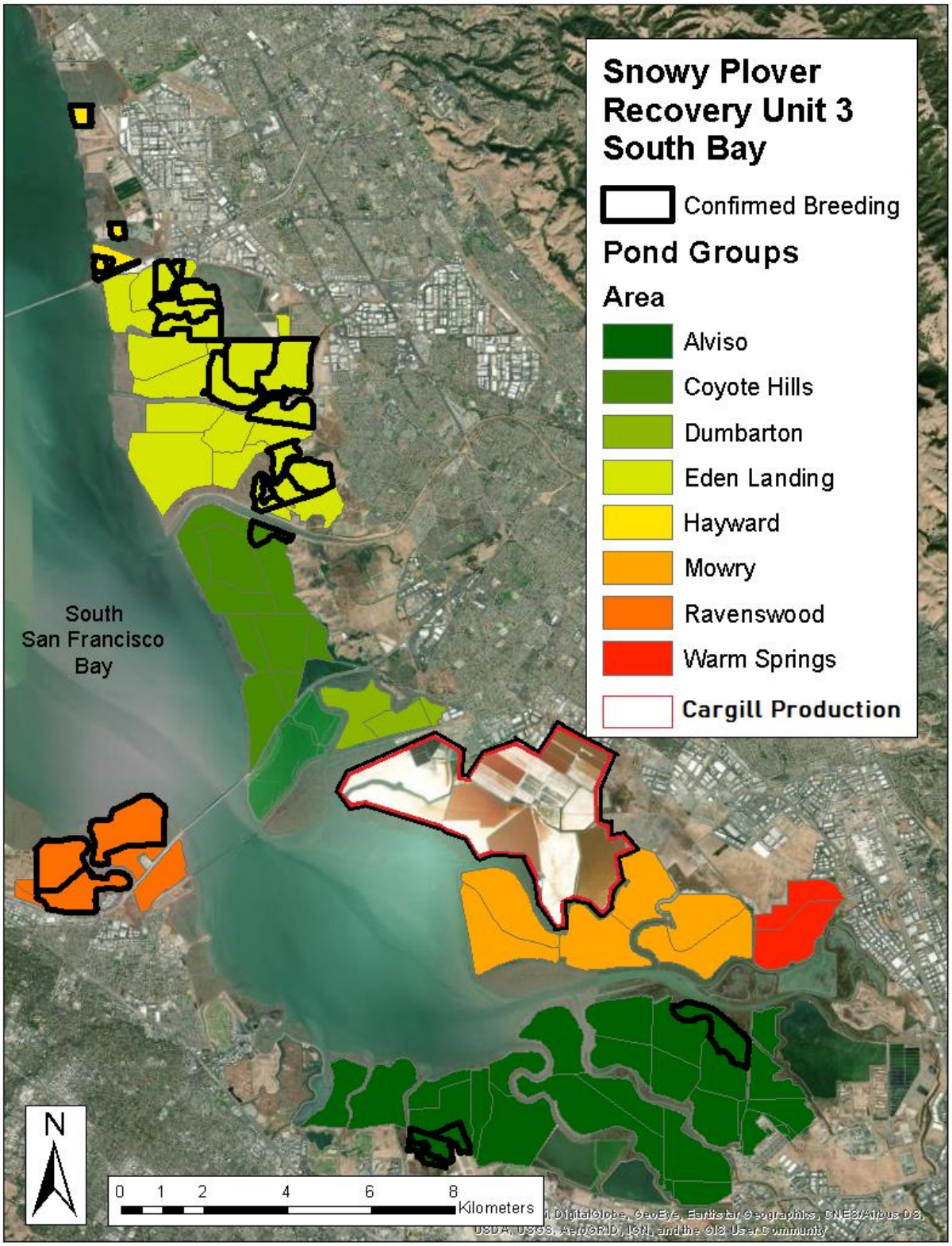

Figure 17. Areas (black outline) with documented Snowy Plover nesting activity during the 2020 breeding season, South San Francisco Bay, California.

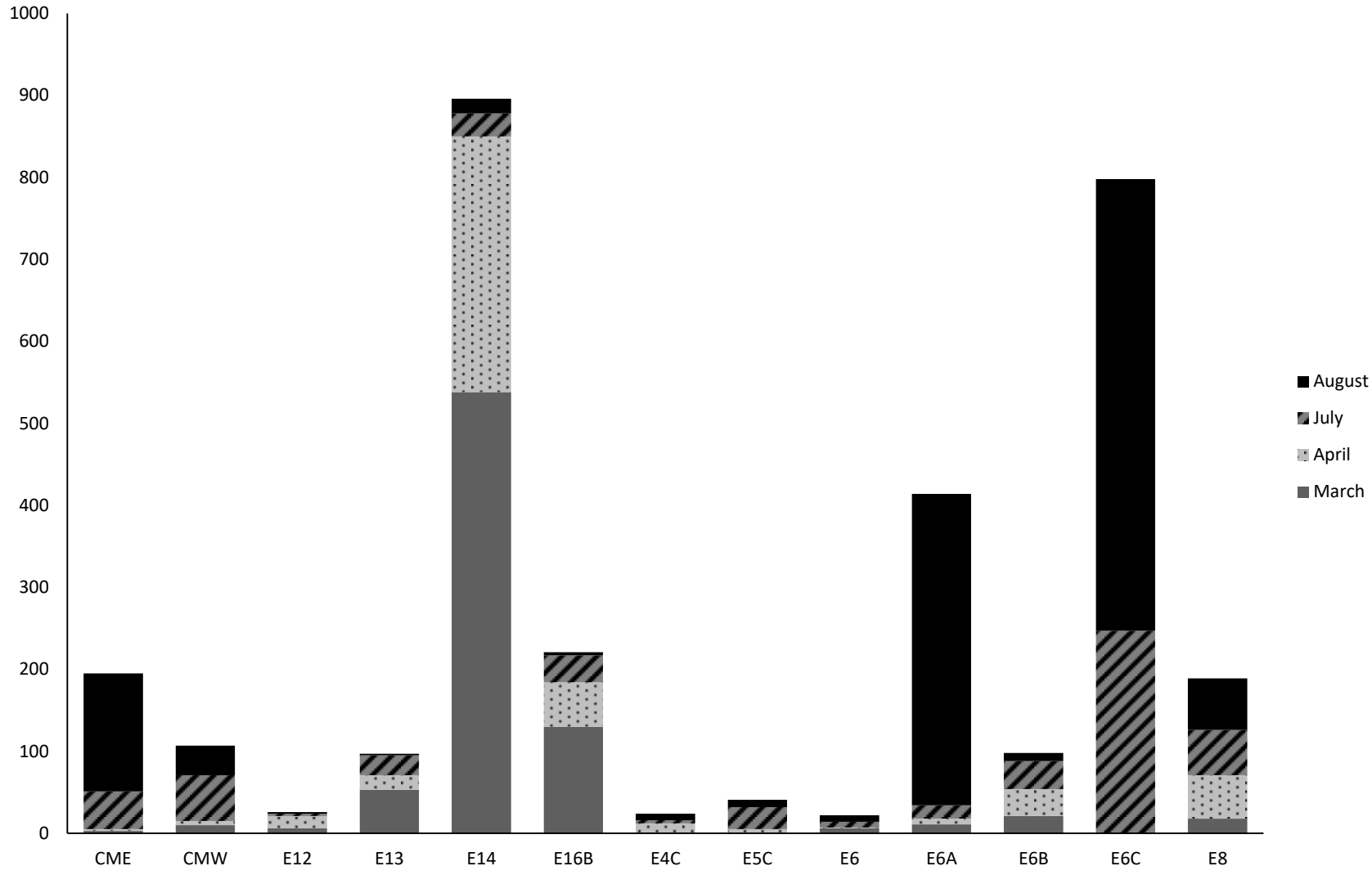

Figure 18. Sum of adult plovers observed during surveys at select ponds during March, April, July and August, 2020. The purpose of this figure is to show that ponds are used by Snowy Plovers in varying intensity during the beginning and end of the breeding season.

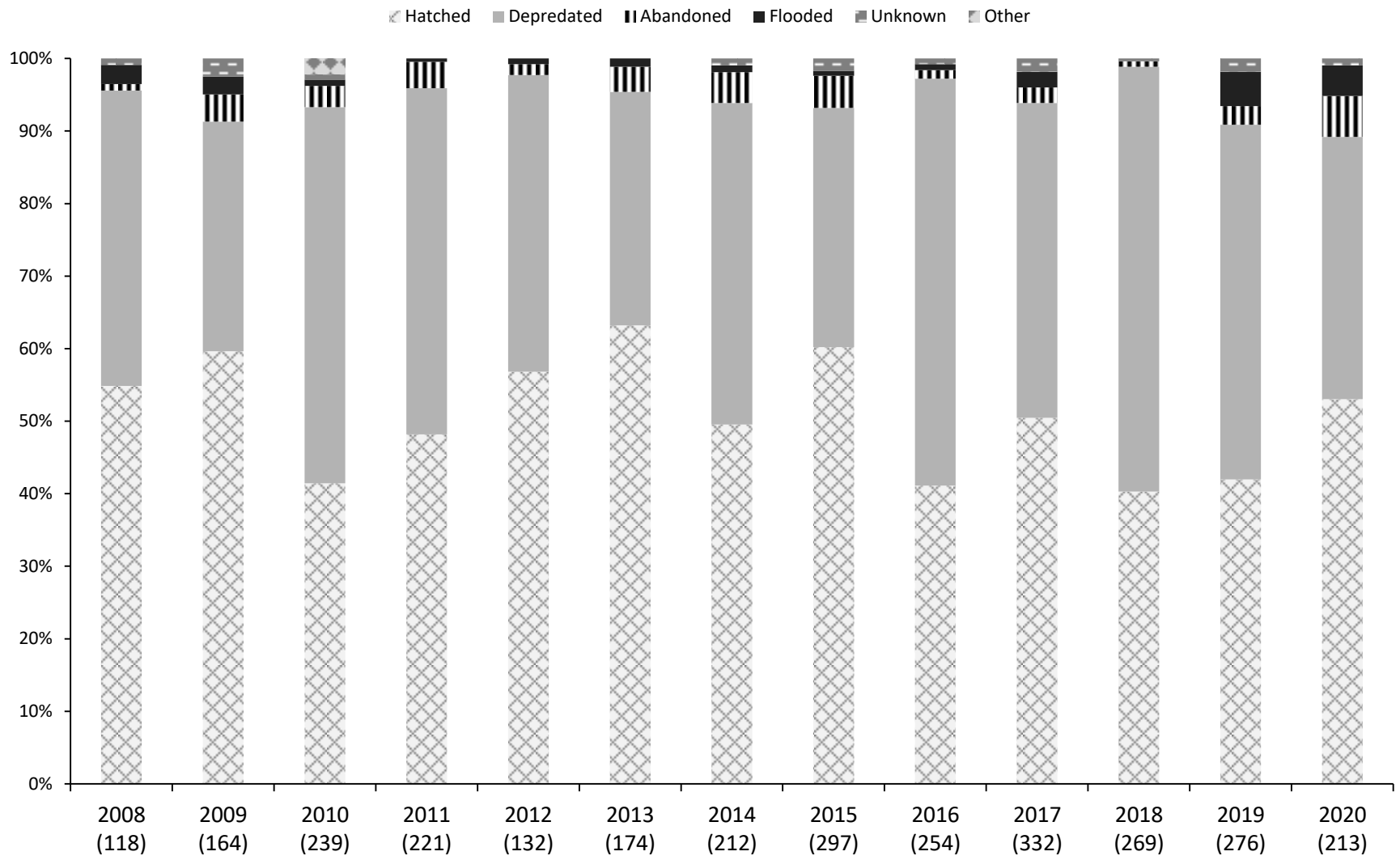

Figure 19. Annual apparent Snowy Plover nest fates in the South San Francisco Bay, California, 2008-2020. The number of nests monitored is indicated in parentheses beneath the year.

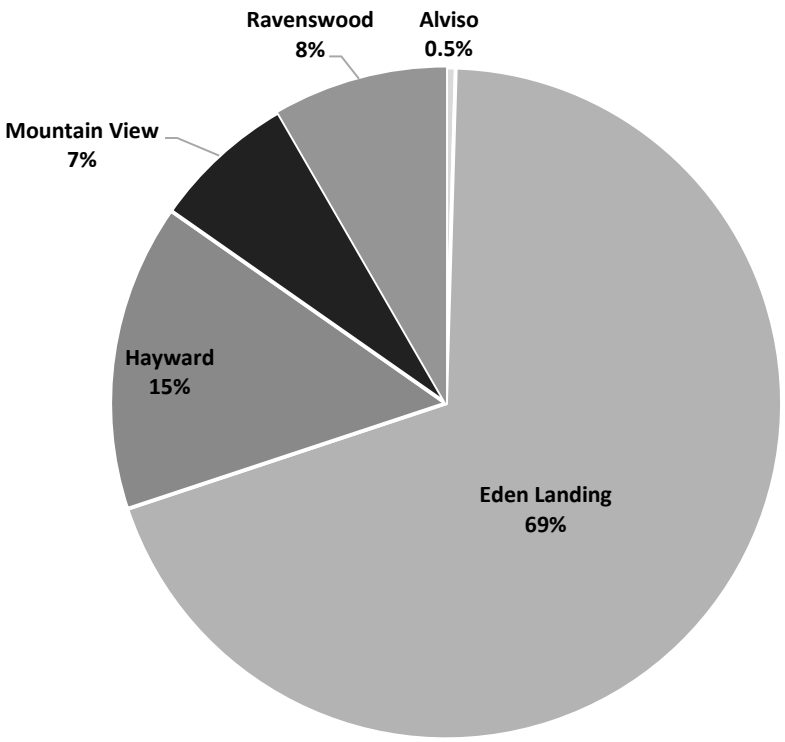

Figure 20. The proportion of Snowy Plover nests found in each pond complex in the South San Francisco Bay, California, 2020. Note that due to COVID-19 pandemic restrictions, Alviso and Warm Springs were not surveyed after the week of March 16, Ravenswood was not surveyed between the weeks of March 16 and June 1, and surveys did not begin at Hayward Shoreline until the week of May 11.

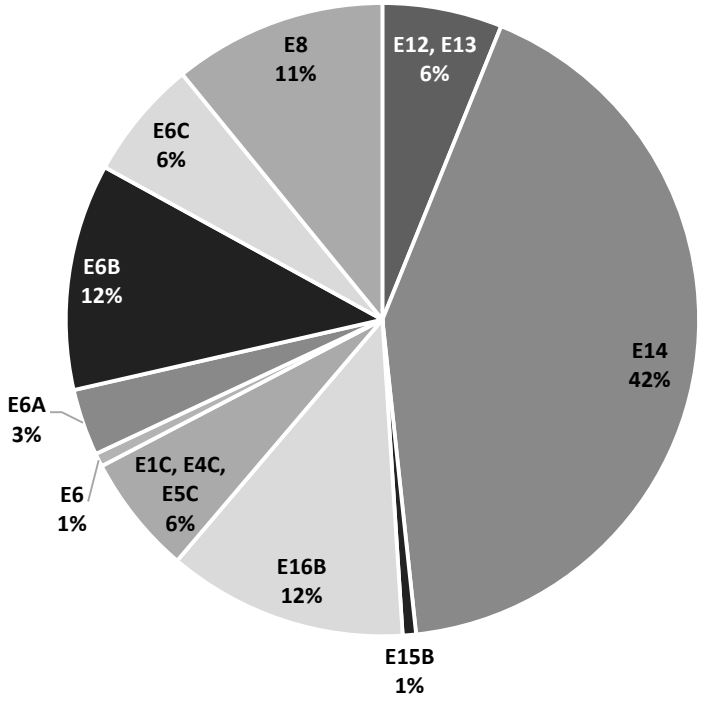

Figure 21. The proportion of Snowy Plover nests found in each Eden Landing pond within the Eden Landing Ecological Reserve, Hayward, California, 2020. Note that 42% of Eden Landing nests were found in pond E14.

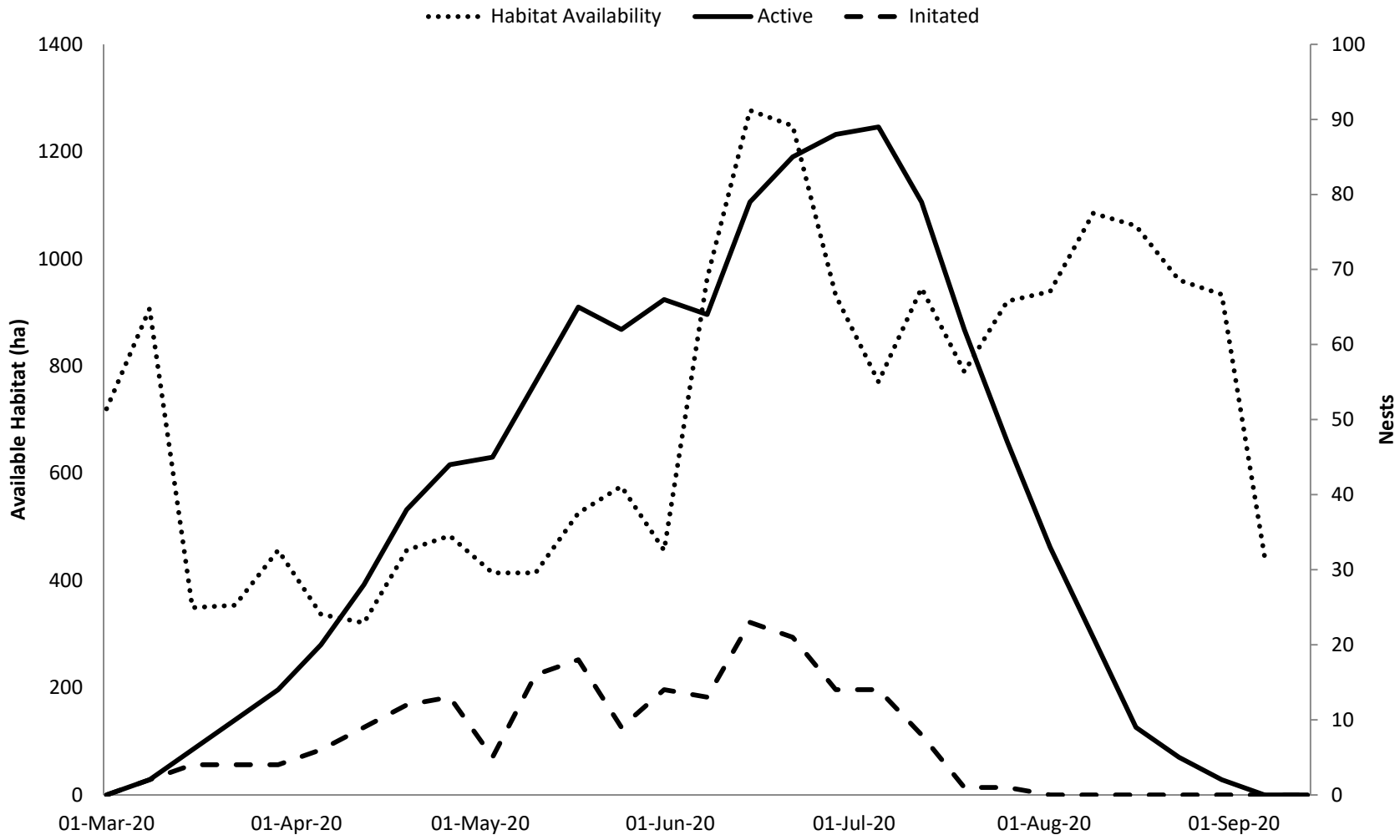

Figure 22. The weekly number of initiated and active Snowy Plover nests and estimated habitat availability in the South San Francisco Bay, California, 2020.

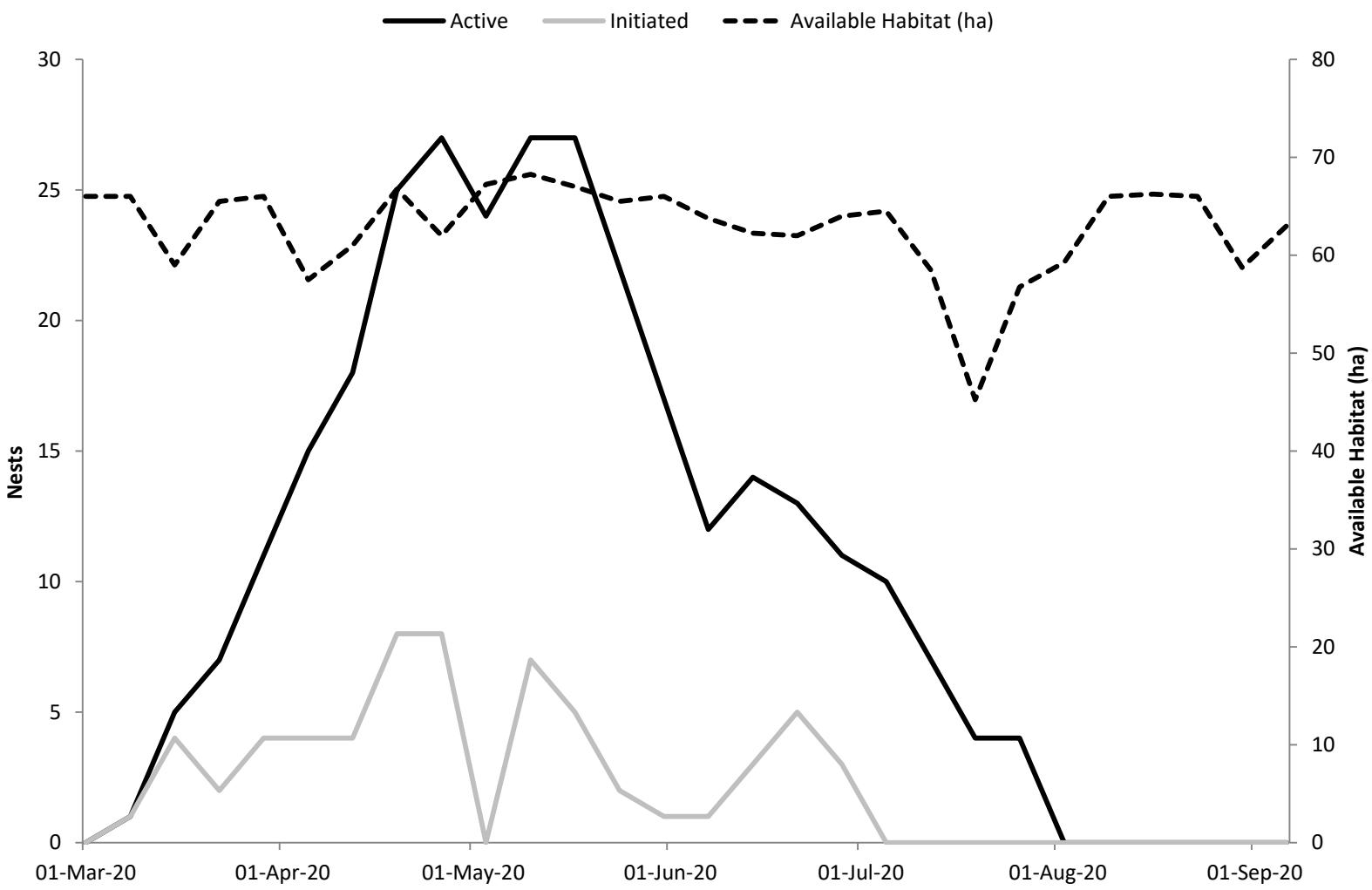

Figure 23. Active and initiated Snowy Plover nests at pond E14, Eden Landing Ecological Reserve during the 2020 breeding season.

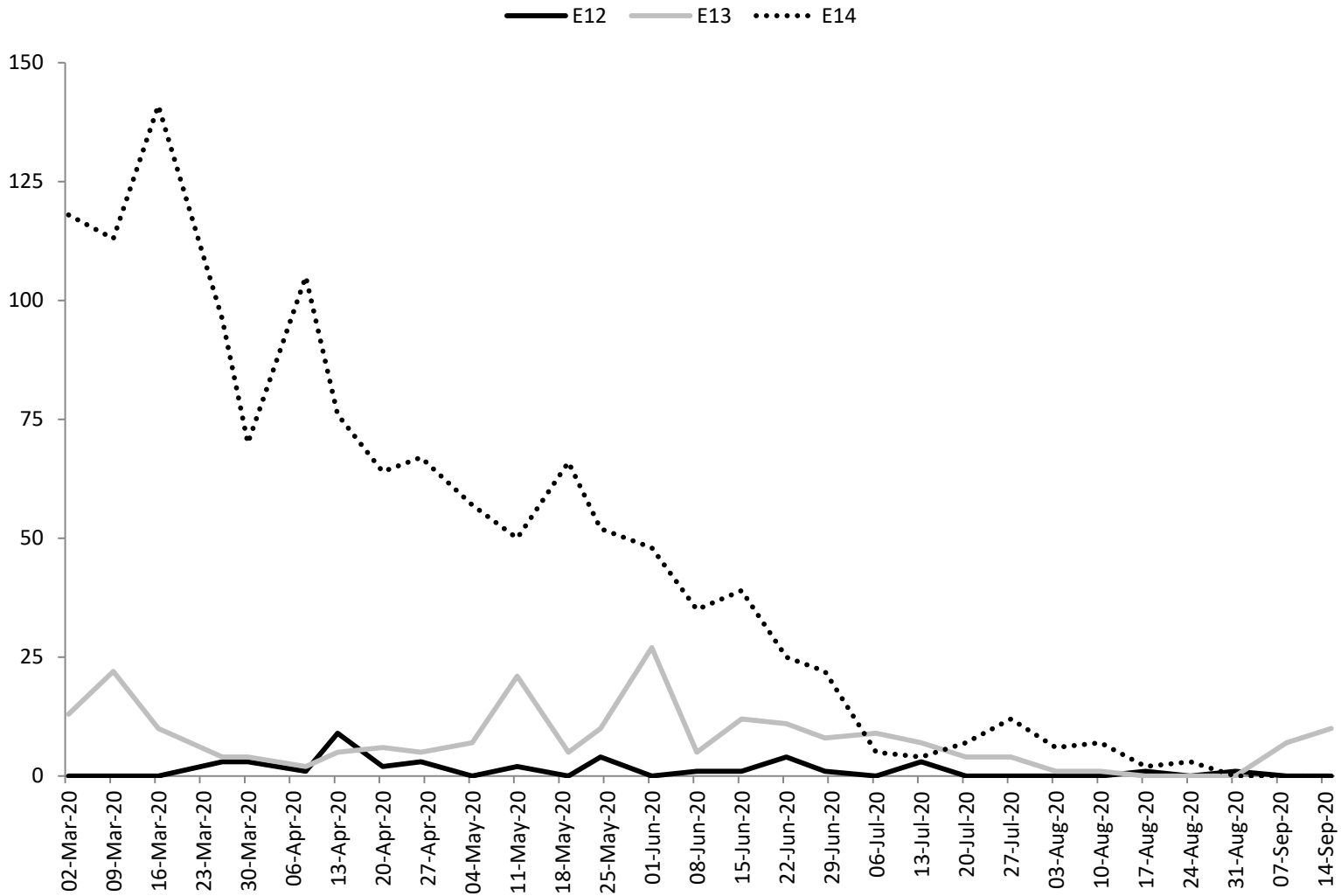

Figure 24. Number of Snowy Plover adults observed from March 2-September 15, 2020, at Ponds E12-14, Eden Landing.

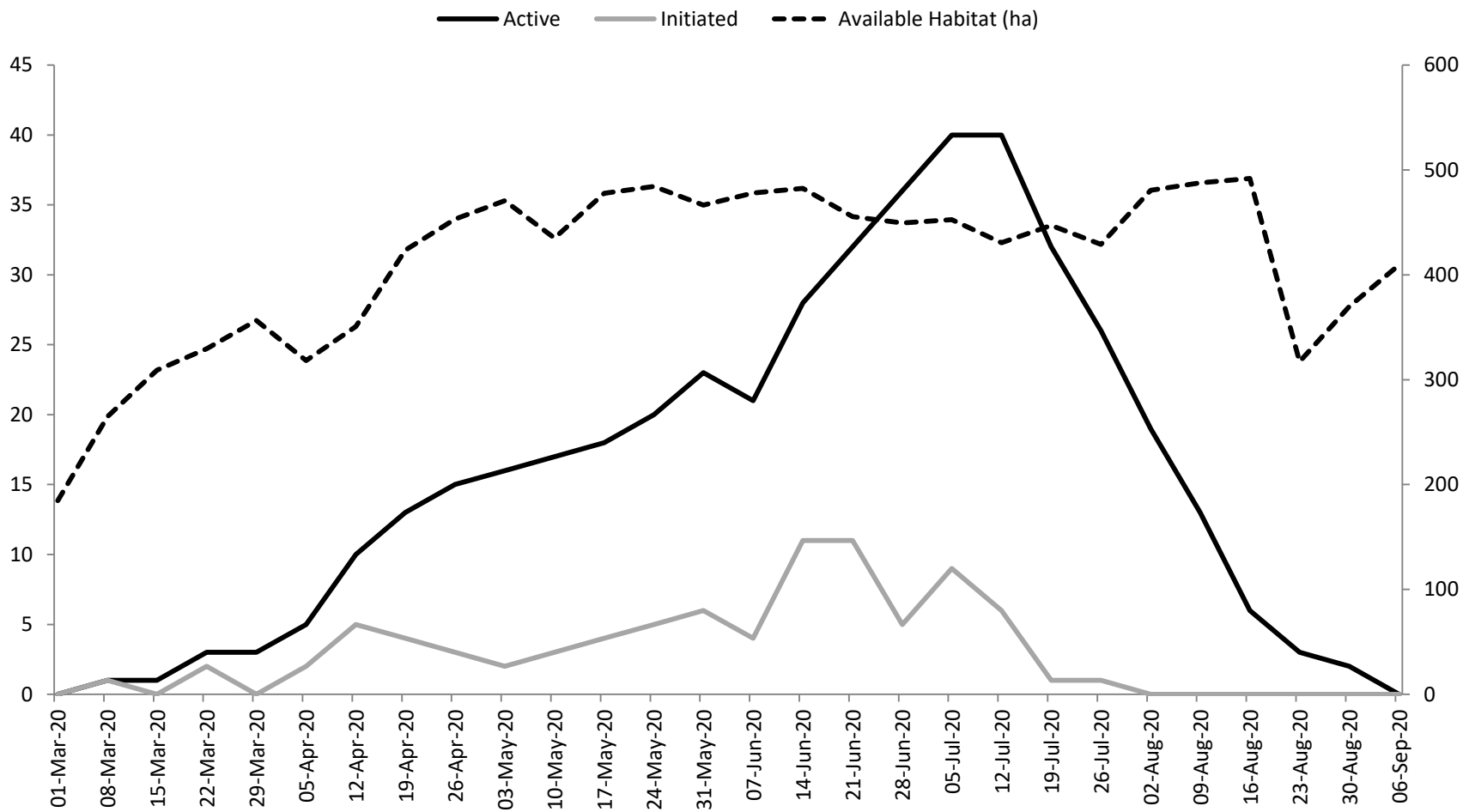

Figure 25. Active and initiated Snowy Plover nests at all ponds in Eden Landing Ecological Reserve, excluding E14, during the 2020 breeding season

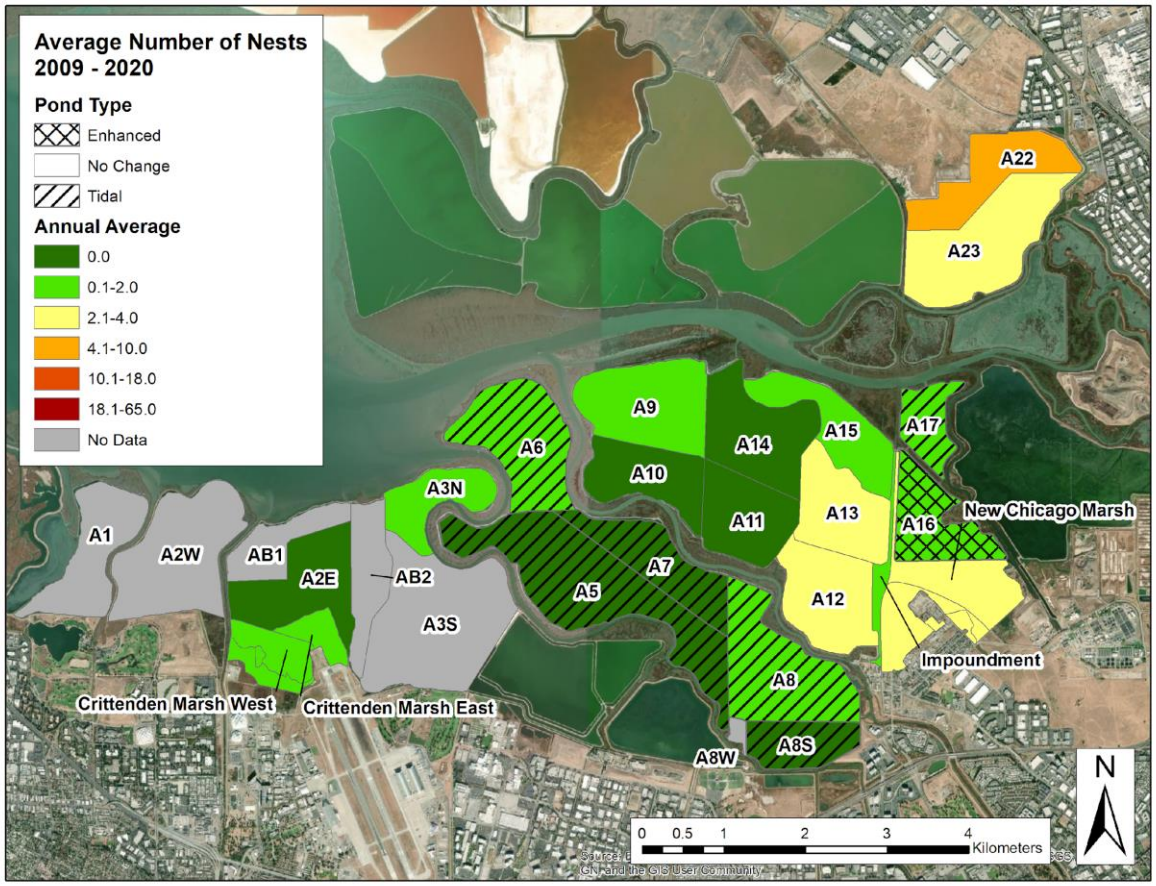

Figure 26. Average number of Snowy Plover nests initiated by pond in the Alviso Complex, South San Francisco Bay, California from 2009-2020. The purpose of this figure is to illustrate which ponds have supported Snowy Plover nesting activity in recent years, and of these, which ponds were included in Phase 1 actions of the South Bay Salt Pond Restoration Project. Diagonal lines denote ponds that have been returned to tidal (or muted tidal) influence, hatch lines denote ponds that were enhanced for multiple species, and solid colors denote ponds that were not directly affected by Phase 1 actions. 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.

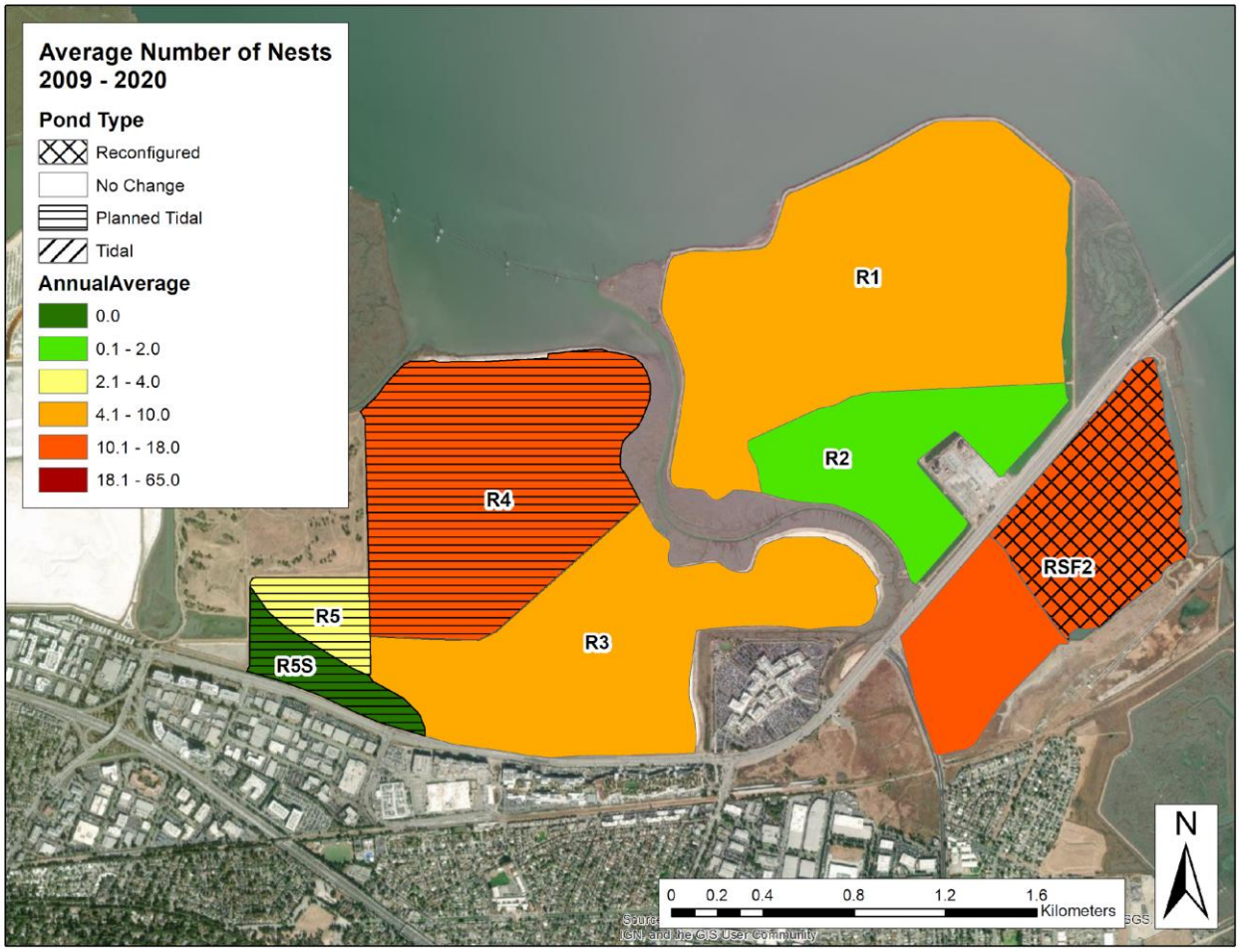

Figure 27. Average number of Snowy Plover nests initiated by pond in the Ravenswood Complex, South San Francisco Bay, California from 2009-2020. The purpose of this figure is to illustrate which ponds have supported Snowy Plover nesting activity in recent years, and of these, which ponds are included in Phase 2 restoration plans of the South Bay Salt Pond Restoration Project. Crossed hatch lines denote ponds that have been enhanced for multiple species (including snowy plovers) and the amount of habitat available to Snowy Plovers is reduced compared to recent years, 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.

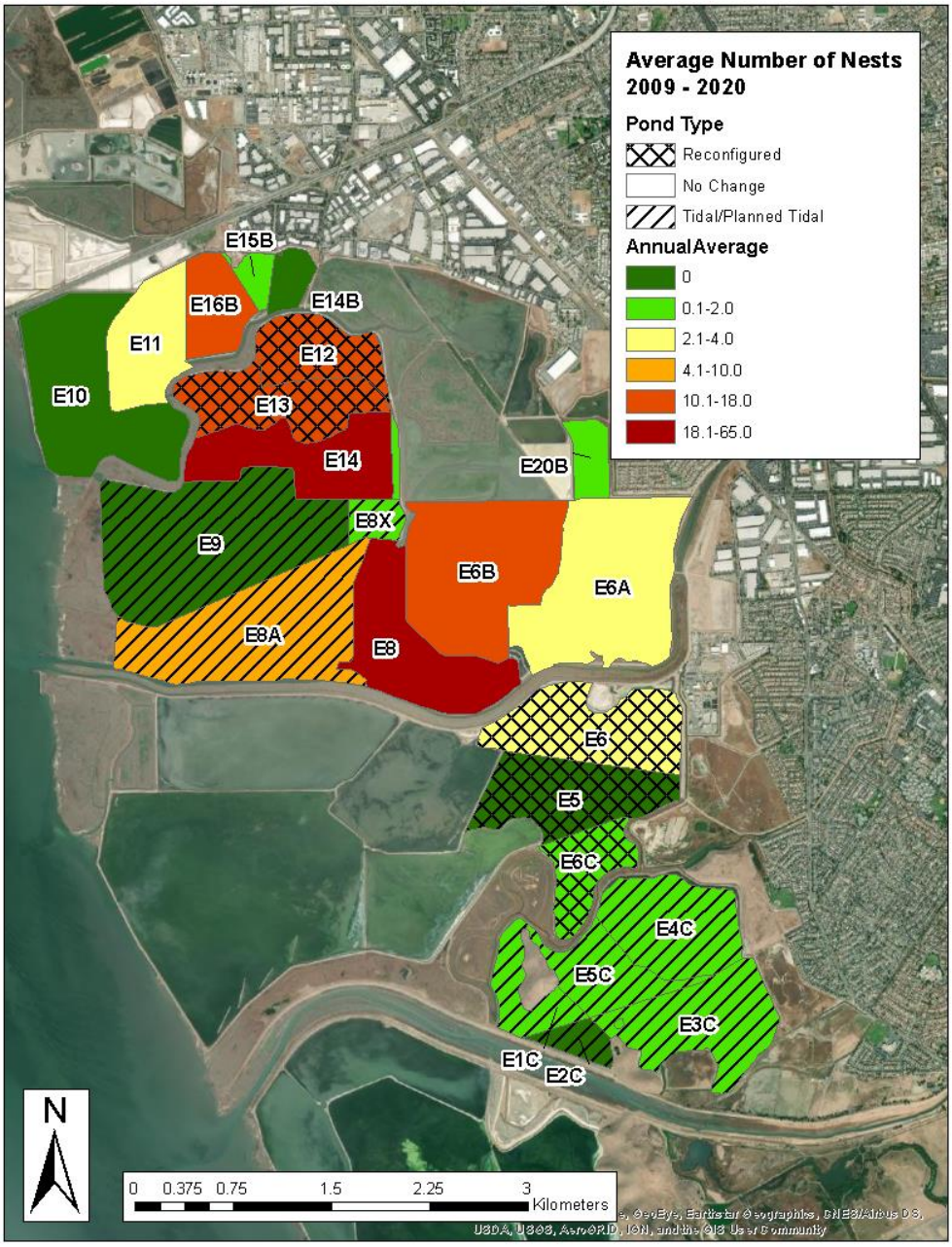

Figure 28. Average number of Snowy Plover nests initiated by pond in the Eden Landing Ecological Reserve, South San Francisco Bay, California from 2009-2020. The purpose of this figure is to illustrate which ponds have supported Snowy Plover nesting activity in recent years, and of these, which ponds were included in Phase 1 actions of the South Bay Salt Pond Restoration Project. Diagonal lines denote ponds that have been 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 Phase 2 actions. 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, 2005-2020. Note that in 2020, due to the Covid-19 pandemic an incomplete survey that did not include Refuge Lands was conducted.

REGION	SITE	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Alameda	Eden Landing	91	84	162	94	88	184	185	82	97	94	76	120	144	142	117	115
	Coyote Hills	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0
	Crown Beach	-	-	-	-	-	-	-	-	-	0	0	0	-	-	-	-
	Dumbarton	0	0	2	0	0	0	0	0	0	0	0	0	2	7	2	-
	Hayward	0	0	0	1	4	12	8	9	32	7	2	4	0	7	12	19
	Warm Springs	23	7	0	3	14	27	17	3	1	11	24	14	2	20	7	-
Marin	Hamilton Wetlands	-	-	-	-	-	-	-	-	-	-	-	0	-	0	0	2
Napa	Napa	0			0	12	10	1	0	3	10	10	0	-	2	2	-
San Mateo	Ravenswood	3	3	23	24	21	42	27	33	59	45	68	42	76	51	48	-
Santa Clara	Alviso	7	8	20	11	8	0	11	20	10	0	1	21	19	4	1	-
	Mountain View	-	-	-	-	-	-	-	-	-	11	0	0	0	2	0	8
North Bay Delta	Montezuma Wetlands	-	-	-	-	-	-	-	-	-	-	14	6	3	0	0	3
Total Unit 3		**124**	**102**	**207**	**133**	**147**	**275**	**249**	**147**	**202**	**178**	**195**	**208**	**246**	**235**	**190**	**147**

Table 2. Snowy Plover nest fates by pond in the South San Francisco Bay, California, 2020.

Location	Hatched	Depredated	Abandoned	Flooded	Failed to Hatch	Unknown	**Total Nests Monitored**	**Detected as Brood**	**Total Nests**
Alviso									
A15	0	0	0	0	0	1	**1**	0	**1**
Cargill Production									
Newark	0	0	0	0	0	0	0	1	1
Redwood City	0	0	0	0	0	0	0	0	0
Coyote Hills									
Patterson Pond	0	0	0	0	0	0	0	2	2
Hayward									
FDW	15	3	0	0	0	0	**18**	0	**18**
LETE	2	1	0	0	0	0	**3**	0	**3**
OBN1	0	0	0	0	0	0	**0**	1	**1**
OBN3	1	0	0	0	0	0	**1**	0	**1**
OBN4	1	1	0	0	0	0	**2**	1	**3**
OBN5	2	3	0	0	0	0	**5**	0	**5**
OBN6	1	0	0	0	0	1	**2**	0	**2**
OBN9	0	1	0	0	0	0	**1**	0	**1**
Eden Landing									
E6A	3	2	0	0	0	0	**5**	2	**7**
E6B	7	10	0	0	0	0	**17**	1	**18**
E8	10	6	0	0	0	0	**16**	1	**17**
E12	0	2	0	0	0	0	**2**	0	**2**
E13	4	3	0	0	0	0	**7**	0	**7**
E14	25	27	8	2	0	0	**62**	2	**64**
E15B	0	1	0	0	0	0	**1**	2	**3**
E16B	8	8	0	2	0	0	**18**	1	**19**
E1C	1	0	0	0	0	0	**1**	0	**1**

E4C	3	1	1	1	0	0	**6**	0	**6**
E5C	2	0	0	0	0	0	**2**	0	**2**
E6C	2	1	0	6	0	0	**9**	0	**9**
E6	1	0	0	0	0	0	**1**	0	**1**
Mountain View									
CME	5	1	0	0	0	0	**6**	0	**6**
CMW	5	4	0	0	0	0	**9**	0	**9**
Ravenswood									
R1	7	1	0	0	0	0	**8**	1	**9**
R3	3	0	0	0	0	0	**3**	3	**6**
R4	5	1	1	0	0	0	**7**	9	**16**
Total South Bay	**113**	**77**	12	9	0	2	**213**	27	**240**
Montezuma Wet.	2	2	0	0	0	0	**4**	0	**4**
Napa-Sonoma Marsh Wildlife Area	0	0	0	0	0	0	**0**	0	**0**
Total North Bay	**2**	**2**	**0**	**0**	**0**	0	**4**	0	**4**
RU3 Total	**115**	**79**	**12**	**9**	**0**	**2**	**217**	**27**	**244**

Table 3. Undetected successful nests inferred by the presence of unaccounted for broods on ponds in the South San Francisco Bay, California, 2020.

Pond	# Nests
Cargill Newark Prod.	1
E14	2
E15B	2
E16B	1
E6A	2
E6B	1
E8	1
OBN1	1
OBN4	1
Patterson Pond	2
R1	1
R3	3
R4	9
Total	**27**

Table 4. Apparent fledging success (all sites combined) of Snowy Plover chicks in the South San Francisco Bay, California, 2008-2020. 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
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 5. Apparent fledging success of Snowy Plover chicks by pond and chicks fledged per male in the South San Francisco Bay, California, 2020. 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
E14	27	5	19%	11	0.45

E16B	6	1	17%	2	0.5
E13	1	1	100%	1	1
E8	6	1	17%	3	0.33
E6A	3	1	33%	1	1
E6B	11	2	18%	4	0.5
E4C	7	3	43%	3	1
E5C	2	0	0%	1	0
R3	5	0	0%	2	0
R4	7	1	14%	3	0.33
FDW	5	3	60%	2	1.5
CMW,CME	5	5	100%	2	2.5
Total	**85**	**23**	**27%**	**35**	**0.66**

Table 6. Adult Snowy Plover banding attempts at ponds E13, E14, and E6B, Eden Landing, Hayward, California, 2020.

Date	Pond	Sex	Band Combo	Note
5/2/2020	E14	Male	ak:wb	Did not return to nest for several hours after banding, eggs taken to Monterey County SPCA where hatched and raised, released at Eden Landing on 6/11/20
5/19/2020	E14	Male	kk:gx	Would not cross mats, unable to re-capture Previously banded, missing 2nd band on right, believed to be kk:gy
6/11/2020	E6B	Male Female	wn:yy ak:rr	Both adults trapped at nest, banded and released before banding chicks. Biologists confirmed both adults returned to chicks within 15 minutes after banders out of sight.
7/7/2020	E13	Female	yv:rw	Banded as chick at E14 in 2016, violet tape reported missing by 12/27/16. Re-taped violet band in 2020.

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

Table 7. Snowy Plover color band combinations deployed in 2020.

ak:ab	ak:pg	gk:aw	gk:rr	ka:rg	kk:gw	ko:wg	on:yg	wn:yg	Yv:yg[1]
ak:ag	ak:pr	gk:ay	gk:wy	ka:rr	kk:ob	ko:wy	wn:aw	wn:yg	
ak:ar	ak:pw	gk:bb	gk:xx	ka:wg	kk:og	on:ag	wn:gg	wn:yy	
ak:br	ak:rb	gk:br	gk:yg	ka:wg	kk:pb	on:bg	wn:gr	yv:bg	
ak:gb	ak:rr	gk:gb	gk:yr	ka:yg	kk:wb	on:bw	wn:gw	yv:bw	
ak:gg	ak:wb	gk:gw	ka:bw	ka:yy	ko:ag	on:by	wn:ob	yv:gg	
ak:gr	ak:yb	gk:ob	ka:gw	kk:ar	ko:aw	on:gb	wn:ow	yv:ob	

ak:ob	ak:yr	gk:og	ka:ob	kk:aw	ko:bg	on:ob	wn:pw	Yv:og[1]
ak:ow	gk:ab	gk:pb	ka:or	kk:bw	ko:by	on:ry	wn:rg	yv:pb
ak:pb	gk:ag	gk:rb	ka:py	kk:by	ko:gg	on:wr	wn:wy	Yv:wb[1]

a = aqua, b = blue, g = green, k = black, n = brown, o =orange, p = pink, r = red, v = violet, w = white, x =no band
[1]Banded by Point Blue Conservation Science with service band above the tibiotarsal joint

Table 8. 2020 Return rates of 2019 banded fledges and all birds banded before 2019 in the South San Francisco Bay, California, 2020.

Category	Observed in 2019	Observed in 2020	Return Rate
Banded and fledged in 2019	19	8	42%
Banded before 2019	36	24	66%

Table 9. SFBBO Snowy Plover color band combinations from prior years observed in Recovery Unit 3, 2020

ak:bw	gk:py	ka:rb	kk:or	ko:gb	rk:yy	yv:gw
ak:oy	gk:yb	ka:ry	kk:wg	ko:gy	wn:ay	yv:rw
ak:ry	ka:ag	kk:ab	kk:wy	ko:or	wn:or	
gk:or	ka:bb	kk:by	ko:ab	on:gw	wn:pr	
gk:pg	ka:oy	kk:gy	ko:ay	rk:og	yv:ar	

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

Table 10. The average number of predators observed per survey (in parentheses) at the Ravenswood Complex, South San Francisco Bay, California, March-September 2020. Note, weekly surveys at RSF2 stopped in the third week of March. Weekly surveys in R1-RS5 stopped in the third week of March and resumed in the second week of June.

Predator Species	**R1 (16)**	**R2 (16)**	**R3 (16)**	**R4 (16)**	**R5 (16)**	**RS5 (16)**	**RSF2 (2)**
Snowy Egret	10.438	0.125	0	0	0	0.062	33.5
Unidentified Gull	0.25	18.438	0	0.188	0	0	20.5
California Gull	4.312	7.938	0.062	0	0	0.062	0.5
Great Egret	8.25	0	0	0	0	0	1.5
Common Raven	0.125	0	1.938	1	0.312	0.625	0.5
American Crow	0	0	3.875	0.062	0.312	0.188	0
Great Blue Heron	2.688	0	0.062	0	0	0	1.5
Ring-billed Gull	0.125	0.125	0	0	0	0	3.5
Western Gull	0	0	0	0	0	0	1.5
White-tailed Kite	0.062	0	0.25	0.062	0	0	0.5
Black-crowned Night-Heron	0.25	0	0	0	0	0	0
Northern Harrier	0.062	0	0	0.188	0	0	0
American Kestrel	0	0	0.062	0.062	0.062	0	0
Peregrine Falcon	0	0.125	0	0.062	0	0	0
Red-tailed Hawk	0	0.062	0.125	0	0	0	0

Skunk	0	0	0	0.062	0	0.062	0
Burrowing Owl	0	0	0	0.062	0	0	0
Herring Gull	0.062	0	0	0	0	0	0

Table 11. The average number of predators observed per survey at Mountain View Ponds, South San Francisco Bay, California, March-September 2020.

Predator Species	**A2E (2)**	**CME (27)**	**CMW (27)**
California Gull	562.5	27.926	10.889
Snowy Egret	12.5	1.037	23.259
Great Egret	4.5	0.333	7.037
Common Raven	0	0.111	0.704
Great Blue Heron	0.5	0.037	0.148
Unidentified Gull	0	0.259	0.074
Northern Harrier	0	0.037	0.259
American Crow	0	0	0.259
Red-tailed Hawk	0	0.074	0.111
Merlin	0	0	0.037

Table 12. The average number of predators observed per survey in South Eden Landing Ecological Reserve, Hayward, California, March-September 2020.

Predator Species	**E1C (28)**	**E2C (28)**	**E3C (28)**	**E4C (28)**	**E5C (28)**	**E6 (27)**	**E6C (16)**
Unidentified Gull	0.071	3.571	59.464	5.107	37.214	12.37	0.438
California Gull	0.143	0.036	16.821	0.571	23.25	50.481	0.125
Snowy Egret	0.036	0.143	11.143	0	0	6.852	0.188
Great Egret	0.107	0.036	2.571	0	0	2.815	0.125
Ring-billed Gull	0.929	0.214	0	0	0	0	0
Mew Gull	0.214	0	0	0	0	0.889	0
Great Blue Heron	0	0.071	0.107	0	0	0.333	0.062
Common Raven	0.357	0.036	0	0	0	0	0.125
White-tailed Kite	0.036	0	0	0.071	0.036	0.037	0.312
Northern Harrier	0	0	0	0.036	0.036	0.037	0.25
Red-tailed Hawk	0.071	0	0.071	0.107	0	0.037	0.062
Black-crowned Night-Heron	0.036	0	0	0	0	0.296	0
Peregrine Falcon	0	0	0.036	0.036	0	0	0.125
Herring Gull	0	0	0	0	0	0.185	0
American Crow	0.071	0	0	0.071	0	0	0
Burrowing Owl	0.071	0	0	0	0	0	0
Barn Owl	0	0	0	0	0	0.037	0
Loggerhead Shrike	0	0	0	0	0	0.037	0
Western Gull	0	0	0	0	0	0.037	0

Table 13. The average number of predators observed per survey at the Whale's Tail loop, Eden Landing Ecological Reserve, Hayward, California, March-September 2020.

Predator Species	E12 (29)	E13 (29)	E14 (29)	E8XN (29)
Unidentified Gull	13.138	45.586	3.207	0
California Gull	17.724	16.414	10.103	0.069
Snowy Egret	1.483	4.31	0.483	0.552
Great Egret	1.69	2.931	0.862	0.483
Ring-billed Gull	5.483	0.069	0.069	0
Northern Harrier	0.069	0.172	1.138	0.034
Peregrine Falcon	0	0	0.862	0.034
Great Blue Heron	0.276	0.276	0.103	0.207
Western Gull	0.207	0.379	0	0
Common Raven	0	0	0.517	0
White-tailed Kite	0	0.034	0.345	0.103
Merlin	0	0.034	0.241	0
Black-crowned Night-Heron	0.034	0.172	0.069	0
Red-tailed Hawk	0.034	0	0.138	0
Iceland Gull	0.103	0.034	0	0
American Crow	0.103	0	0	0
Short-eared Owl	0	0	0.069	0
Bald Eagle	0.034	0	0	0

Table 14. The average number of predators observed per survey at the Old Alameda Creek Loops, Eden Landing Ecological Reserve, Hayward, California, March-September 2020.

Predator Name	E20B (29)	E6A (29)	E6B (29)	E8 (29)
California Gull	0	39.586	5	0.069
Snowy Egret	0	24.276	1.552	3.345
Unidentified Gull	0	23.517	0.172	0.517
Great Egret	0	8.517	2.31	1.552
Great Blue Heron	0	0.759	0.379	0.379
Peregrine Falcon	0.069	0.655	0.379	0.138
Red-tailed Hawk	0.138	0.655	0.138	0.103
Northern Harrier	0	0.241	0.207	0.345
Ring-billed Gull	0	0.103	0.621	0.034
White-tailed Kite	0.069	0.069	0.034	0.241
Herring Gull	0	0.138	0.034	0.069
Black-crowned Night-Heron	0.034	0.138	0.034	0
Common Raven	0.034	0	0	0.069
Bald Eagle	0.034	0.034	0	0.034
Western Gull	0	0.069	0	0
American Kestrel	0	0.034	0	0.034
Feral Cat	0	0.034	0	0

Table 15. The average number of predators observed per survey at the Mount Eden Creek Loop, Eden Landing Ecological Reserve, Hayward, California, March-September 2020.

Predator Name	E10 (25)	E11 (26)	E14B (28)	E15B (28)	E16B (28)
California Gull	25.92	29.385	1.857	0.25	0.321
Unidentified Gull	29.16	7.577	2.714	0.036	0.214
Snowy Egret	6.88	13.154	1.893	0.036	0.214
Great Egret	1.48	3.769	0.071	0	0.25
White-tailed Kite	0.36	0.038	0	0	0.571
Great Blue Heron	0.4	0.269	0.036	0	0
Herring Gull	0.6	0	0	0	0
Ring-billed Gull	0.24	0.231	0.071	0	0
Black-crowned Night-Heron	0.24	0.077	0	0	0.036
Peregrine Falcon	0.16	0.038	0	0	0.143
Western Gull	0.24	0	0	0	0
Northern Harrier	0.08	0.077	0	0	0.071
American Crow	0	0.077	0.036	0.071	0
Common Raven	0	0	0.071	0.071	0
Cooper's Hawk	0	0	0	0.036	0
Iceland Gull	0	0	0.036	0	0
Red-tailed Hawk	0	0	0	0	0.036

Table 16. The average number of predators observed per survey at Franks Dump West and Oliver Brothers North Ponds, Hayward Regional Shoreline, Hayward, California, May-September 2020.

PredatorName	FDW (18)	OBN1-17 (19)*
Common Raven	0.111	0.904
American Crow	0.889	0
California Gull	0.667	0
Snowy Egret	0.389	0.053
Northern Harrier	0.222	0.105
Red-tailed Hawk	0.167	0
Unidentified Gull	0	0.167
Red Fox	0	0.164
Western Gull	0.111	0
Peregrine Falcon	0.056	0

*OBN ponds with zero observed predators: OBN 1-2, OBN 6-8, OBN 11, OBN 14-17

Table 17. Predators and pedestrians recorded by trail cameras placed at pond access points at select pond in Eden Landing Ecological Reserve, Hayward, California, 2020.

Species	Date	Time	Pond	Description
Coyote	4/27/2020	21:40	E16B	Looked at camera from afar, walked away
Coyote	4/29/2020	5:15	E16B	Ran by camera, around until 6:02AM, appeared to be hunting
Coyote	5/2/2020	0:34	E14	Ran by camera

Pedestrian	5/7/2020	19:58	E12	Walked by camera
Common Raven	5/7/2020	17:46	E14	Walked around area for approximately 30 mins
Common Raven	5/7/2020	9:21	E8	Flew by camera
Coyote	5/14/2020	4:13	E14	Approached camera, potentially interested, around for approximately 4 minutes
Dog	5/14/2020	18:02	E12	Off leash, ran in front of camera
Common Raven	5/15/2020	12:21	E14	Walked around in front of camera, potentially interested in
Coyote	5/16/2020	5:25	E16B	Ran by camera
Great Egret	5/18/2020	13:21	E14	Walked in front of camera, appeared headed towards Western shell plot
Human, Dog	5/24/2020	19:26	E14	Three pedestrians and one dog walked by camera, picked up, put back down
Common Raven	5/27/2020	12:00	E14	Two ravens walked around levee, eventually pushed camera over
Coyote	6/16/2020	17:15	E16B	In front of camera
Human	6/27/2020	20:41	E14	Two trespassers running on pond
Coyote	6/27/2020	21:08	E16B	In front of camera
Northern Harrier	7/1/2020	21:45	E12	Male perched on levee
Coyote	7/1/2020	22:53	E16B	In front of camera
Coyote	7/2/2020	22:20	E16B	In front of camera
Human	7/2/2020	20:56	E12	Two trespassers walked on levee past camera
Human	7/4/2020	14:13	E8	Trespasser rode motorcycle on pond, back wheel caught on camera

Table 18. 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

[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 19. Snowy Plover nests at pond E14 by treatment type, Eden Landing Ecological Reserve, Hayward, California, 2020.

Treatment	n	Hatched	%Hatched	%Depredated	%Abandoned
Western	19	8	42	58	0
Eastern	27	12	44	41	15
Control	16	5	31	40	16

Table 20. Chi-square analyses for nest habitat type selection

	χ2	***df***	***p-value***
2020	25.28	2	3.234e-06

Table 21. Daily nest survival (DSR) outputs for all plover nests in pond E14 in Eden Landing Ecological Reserve, Hayward, California in 2020. 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		2.5438	0.1761	2.1987	2.8888	0.9272	0.9272
Distance to Levee*		0.0071	0.0033	0.0007	0.0136	0.9224	0.9224
Nest Age		0.0278	0.0296	-0.0303	0.0859	0.5657	0.9883
Time		-0.0065	0.0058	-0.0178	0.0049	0.9551	0.8894
Time by Treatment	Time * Western	-0.8194	1.0653	-2.9074	1.2686	0.9299	0.9320
	Time * Eastern	-0.0016	0.0140	-0.0291	0.0260	0.9671	0.8971
	Time * Non	-0.0148	0.0135	-0.0412	0.0116	0.9765	0.7449

Table 22. Summary of logistic regression models of E14 nest fate tested and associated Akaike information criterion (AIC). The purpose of this table is to explain the decision making process for the model that was selected.

Model	AIC
Adj. Fate ~ Near_Dist *NumNbr_100m * Day. Initiation.Adj*Adj.Treatment2	65.589
Adj. Fate ~ NumNbr_100m * Day. Initiation.Adj	53.946
Adj. Fate ~ NumNbr_100m	49.948
Adj. Fate ~ Day. Initiation.Adj	50.039
Adj. Fate ~ Near_Dist	50.012
Adj.Fate ~ Adj.Treatment2	49.92

Table 23. Summary of logistic regression values of Snowy Plover nest fate by habitat treatment (shelled or unshelled) in Pond E14, Eden Landing Ecological Reserve, Hayward,California, 2020.

Coefficients	Estimate	SE	z value	Pr(>|z|)
(Intercept)	0.5108	0.6228	0.820	0.412
Adj.Treatment2	-0.2595	0.7514	-0.345	0.730

Table 24. Ponds surveyed weekly in the South San Francisco Bay, 2020.

Location	Ponds
Eden Landing	E1C-6C, E6, E6A, E6B, E8, E8XN, E10-14, E14B-E16B, E20B
Crittenden Marsh	CME, CMW
Ravenswood[1]	R1-5S, RSF2
Hayward Shoreline[2]	OBN 1-17, FDW
Alviso[3]	A9-16, NCM
Dumbarton[3]	NPP1, Hickory
Warm Springs[3]	A22-23

[1]Surveyed March 2-10, June 8-September 18
[2]Surveyed May 10-September18
[3]Surveyed March 2-10

Table 25. Ponds in Recovery Unit 3 surveyed less frequently or by other organizations

Location	Land Owner	Ponds
Alameda Creek Trail, Coyote Hills[1]	ACFCD	Patterson Pond
Least Tern Island[2]	HARD	Island 5
Napa-Sonoma Marshes Wildlife Area[3]	CDFW	7/7A, Green Island Unit, Wingo Unit
Hamilton Wetlands[4]	SCC	North Seasonal Wetland
Montezuma Wetlands[5]	Private	Montezuma Wetlands

[1]Surveyed monthly
[2]Surveyed weekly by EBRPD
[3]Surveyed in varying amounts by CDFW
[4]Surveyed during window surveys by Avocet Research Associates
[5]Surveyed opportunistically during Least Tern surveys

Table 26. Docent survey results at Eden Landing Ecological Reserve, Hayward, California, 2020.

Date	Location	Public Contacts	Group Size	Type	Info. Shared	Nature of Contact
1/23/20	E12-14	0	N/A	N/A	N/A	N/A
6/28/20	E12-14	0	N/A	N/A	N/A	N/A
7/27/20	E12-14	0	N/A	N/A	N/A	N/A

Table 27. 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 28. 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 29. Snowy Plover averaged apparent nest densities (nest/ha) by pond at all locations surveyed throughout the season in the South San Francisco Bay, 2020, excluding OBN ponds. We calculated nest densities (nest/ha) in each pond every week using data from habitat availability surveys; weekly densities were then averaged. By using the actual available nesting habitat rather than the total area of each pond potentially available for nesting, we are able to calculate more accurate nesting densities within ponds as water levels changed throughout the season.

Pond	Location	Average Nests/Ha
All	All	0.10
FDW	Hayward	0.70
E13[1]	Eden Landing	0.26
CMW	Crittenden Marsh	0.18
E14	Eden Landing	0.17
E12[1]	Eden Landing	0.11
E16B	Eden Landing	0.11
E6C	Eden Landing	0.10
CME	Crittenden Marsh	0.06
E5C	Eden Landing	0.04
E6	Eden Landing	0.04
E6B	Eden Landing	0.04
E8	Eden Landing	0.04
E4C	Eden Landing	0.03
R1	Ravenswood	0.03
E6A	Eden Landing	0.02
R4	Ravenswood	0.02
E15B	Eden Landing	0.01
E1C	Eden Landing	0.01
R3	Ravenswood	0.01

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