



SAN FRANCISCO BAY  
BIRD OBSERVATORY



Western Snowy Plover Numbers, Nesting Success, Fledging Success and  
Avian Predator Surveys in the San Francisco Bay, 2008.



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**ABSTRACT**

Don Edwards San Francisco Bay National Wildlife Refuge (Refuge), the San Francisco Bay Bird Observatory (SFBBO), the California Department of Fish and Game (CDFG), the Hayward Area Recreational and Park District, and the East Bay Regional Parks District (EBRPD) forms the Western Snowy Plover Recovery Unit 3. The goal of this collaboration is the monitoring and management of the San Francisco Bay’s population of breeding Western Snowy Plovers (*Charadrius alexandrinus nivosus*). In 2008, we recorded Snowy Plover numbers, site use, nest success, fledging success and avian predator numbers throughout the Snowy Plover breeding season.

During the 2008 breeding season window survey of the Pacific coast (24 May– 7 June) we counted 133 adult Snowy Plovers in the Bay. In 2008, we monitored 118 Snowy Plover nests in the South San Francisco Bay (South Bay). On Refuge property, we monitored 27 nests in the Alviso salt pond complex (ponds A8, A12, and the Alviso Marina impoundment), pond A23 in the Warm Springs complex, and ponds R1, R3, R4, and RSF2 in the Ravenswood complex. Four of the six monitored nests in Alviso hatched (67%) and 2 were depredated (33%). We located 4 nests in Warm Springs pond A23. Three of the nests hatched (75%) and 1 was depredated (25%). We monitored 17 nests in the Ravenswood complex, 14 of which hatched (82%) and 3 were depredated (18%). The Mayfield estimate for daily nest survival was 0.58 for the entire South Bay.

This year we located more Snowy Plover nests at Eden Landing Ecological Reserve (Eden Landing, CDFG) (n = 90) than in previous years (n = 80 in 2007 and n = 70 in 2006). Of the 90 nests, 42 hatched (46.7%), 38 were depredated (42.2%), 5 were lost at hatching (5.6%), 3 were flooded (3%), 1 was abandoned (1%) and 1 had an unknown fate (1%).

Throughout the South Bay, we banded 83 chicks this breeding season. From visual observations, we determined that 24 chicks survived to fledging (28.9%) as of 30 September 2008.

The avian predator management program at Eden Landing continued in 2008. Avian predators of concern included Common Ravens (*Corvus corax*), Northern Harriers (*Circus cyaneus*) and California Gulls (*Larus californicus*) among others. Mammalian predators throughout the study area included feral cats (*Felis felis*), raccoons (*Procyon lotor*), skunks (*Mephitis mephitis*), and non-native red foxes (*Vulpes vulpes*).

The South Bay Salt Pond Restoration Project which encompasses much of the South Bay should continue to consider the habitat requirements of Western Snowy Plovers in the restoration planning process, including the need for large expanses of dry salt pond nesting substrate adjacent to foraging areas.

## INTRODUCTION AND BACKGROUND

The Pacific coast Snowy Plover population, the Western Snowy Plover (*Charadrius alexandrinus nivosus*), breeds along or near tidal water and is behaviorally distinct from the interior population (Funk 2007). The Western Snowy Plover population has declined in response to poor reproductive success, likely due to habitat loss, habitat alteration, human disturbance, and increasing predator populations (Page et al. 1991). In response to the population decline, the U.S. Fish and Wildlife Service listed the Western Snowy Plover as a threatened species in 1993 (USFWS 1993).

Western Snowy Plover Recovery Unit 3 consists of the San Francisco Bay and includes Napa, Alameda, Santa Clara and San Mateo counties (USFWS 2007). In 1992, the Don Edwards San Francisco Bay National Wildlife Refuge (Refuge) began monitoring Snowy Plovers on Refuge lands. The Refuge developed five goals for its Snowy Plover monitoring program: 1) identify areas used by Snowy Plovers for foraging, roosting and nesting, 2) estimate Snowy Plover numbers, including breeding pairs, 3) monitor nest success, 4) assess predation pressures on Snowy Plovers and 5) protect Snowy Plover breeding areas from predators and other disturbances. The Refuge joined with the California Department of Fish and Game (CDFG) in 2000 to monitor Snowy Plovers on its Eden Landing Ecological Reserve property (hereafter Eden Landing). The San Francisco Bay Bird Observatory (SFBBO) and the Refuge began a cooperative agreement to monitor suitable Snowy Plover habitat in the South Bay in 2003.

Increasing predator populations are impacting Snowy Plovers throughout their range (USFWS 2007). To assess this issue in the South Bay, SFBBO and Refuge biologists have conducted avian predator surveys in Snowy Plover nesting areas since 2003 to gauge the potential predator pressure on the nesting Snowy Plovers and to focus predator management activities. Avian predators include American Crows (*Corvus brachyrhynchos*), Common Ravens (*Corvus corax*; Page 1990), and Northern Harriers (*Circus cyaneus*; USFWS 2002) and California Gulls (*Larus californicus*). The South Bay population of California Gulls is increasing exponentially (Strong et al. 2004a). Gulls are opportunistic feeders, depredate shorebird nest and chicks in the South Bay, disturb ground-nesting birds, and may displace Snowy Plovers and other ground-nesting shorebirds in the salt ponds (Ackerman et al. 2006). Other avian predators of concern include Red-Tailed Hawk (*Buteo jamaicensis*), American Kestrel (*Falco sparverius*), Peregrine Falcon (*Falco peregrinus*), White-Tailed Kite (*Elanus leucurus*), and Loggerhead Shrike (*Lanius ludovicianus*).

In 1991, the Refuge and the U.S. Department of Agriculture – Wildlife Services (Wildlife Services) began a mammalian predator management program to remove predators of Snowy Plovers, California Clapper Rails (*Rallus longirostris obsoletus*), and salt marsh harvest mice (*Reithrodontomys reviventris*). In 2004, Wildlife Services began an avian predator management program at Eden Landing, with the goal of reducing the impact of avian predators on nesting Snowy Plovers (Strong et al. 2004b).

The Refuge, SFBBO, CDFG, and EBRPD continued monitoring Snowy Plovers and avian predators in 2008 to assess the status of the Bay’s Snowy Plover population and the predation pressures that Snowy Plovers face. This report summarizes the 2008 breeding season data, including Snowy Plover surveys, nest success, fledging success, avian predator surveys and predator management programs.

## **METHODS**

### **Study Area**

SFBBO and Refuge staff conducted Snowy Plover and predator surveys in the South San Francisco Bay salt ponds (Figure 1) and one site in the North Bay salt ponds (Figure 2). The South Bay, which includes the area just north of the San Mateo Bridge and extends to the extreme southern portion of the Bay, contains the majority of the Snowy Plover habitat in the Bay.

The Refuge includes approximately 30,000 acres of salt pond habitat, tidal marsh, mudflats and upland habitat in the South San Francisco Bay. In 2008, the Refuge lowered water levels in pond A12 in the Alviso complex for shorebird nesting and foraging habitat. For this study, we divided the Refuge into six geographic locations: Warm Springs, Alviso, Ravenswood, Coyote Hills, Dumbarton, and Mowry (Figure 3, Figure 4, Figure 5 ).

CDFG owns and operates Eden Landing (formally known as Baumberg), which includes approximately 5,500 acres of salt ponds, marsh and tidal habitat (Figure 6). Eden Landing is located just south of the San Mateo Bridge on the east side of the Bay and extends south to the Alameda County Flood Control Channel. Most of the salt ponds within the complex have water control structures that allow water management to enhance Snowy Plover nesting and foraging habitat. In 2008, CDFG managed pond E8A for nesting Snowy Plovers and managed the remaining ponds as seasonal wetlands that filled in the winter with rain water and dried during the spring and summer months. Plovers nested in both managed and seasonal ponds at Eden Landing.

CDFG owns and manages the Napa-Sonoma Marshes Wildlife Area and ponds 7 and 7a, are the only known Snowy Plover breeding ponds in the North Bay (Figure 2).

HARD owns the land directly north of Highway 92 which is co-managed by East Bay Regional Parks District. This area includes potential Snowy Plover foraging and nesting habitat in the Oliver Brother North ponds and Frank Dump West. The EBRPD manages an island constructed for California Least Terns (*Sternula antillarum brownii*) in the adjacent area which was used by nesting Snowy Plovers in 2008.

### **Adult and Nest Monitoring**

Snowy Plovers in the San Francisco Bay nest predominantly on the bottom of dry salt ponds. Plovers are site-faithful in choosing their nesting sites (Warriner et al. 1986); therefore, we monitor many of the same ponds every year. However, within pond complexes, water levels vary annually and seasonally, resulting in constantly changing foraging and nesting habitat. As conditions change, we monitor any additional areas that might provide suitable Snowy Plover habitat.

We divided the study ponds into two categories: focus ponds and monthly survey ponds. Volunteers and biologists surveyed all areas during the last weekend of every month, March to August with the exception of the Coyote Hills and Mowry ponds. These two areas were only surveyed during the window surveys due to a lack of nesting habitat. SFBBO and Refuge biologists and interns surveyed focus ponds once per week from 1 March 2008 to 30 September 2008.

We surveyed 16 Refuge ponds for Snowy Plovers, with eleven surveyed weekly as focus ponds (Table 1). We monitored 17 ponds at Eden Landing, with 11 weekly focus ponds and 6 monthly survey ponds (Table 2). SFBBO volunteers monitored the Napa-Sonoma Marshes Wildlife Area monthly (Table 2).

SFBBO staff monitored the EBRPD Least Tern island when EBRPD staff contacted them about the nesting Snowy Plovers. We did not conduct surveys on the property.

Volunteers, interns and biologists monitored the ponds by driving slowly on the levees surrounding the ponds and stopping approximately every 0.3 miles to scan for Snowy Plovers. We surveyed ponds from inside vehicles to lessen disturbance, and limited walking surveys to areas impassible by vehicles. During each survey, we recorded the numbers and behavior of adult Snowy Plovers, identified the sex of each Snowy Plover based on plumage characteristics (Page 1991), and marked its approximate location on a geo-referenced map. Also, if appropriate, we recorded the number of nests, the number of chicks in each pond, and their color-band combinations if the Snowy Plovers were banded.

If we observed behavior indicating a Snowy Plover was incubating a nest, we monitored the Snowy Plover's behavior for 10 minutes. If we determined that a bird was most likely incubating a nest, SFBBO and Refuge biologists walked out to the location of the nest. If we located an active nest, we recorded its location with a GPS unit (Garmin® GPS

60). During the monthly volunteer surveys, volunteers did not search for potential nests, but instead marked the location on maps and described nearby landmarks. Later, SFBBO and Refuge staff searched for the potential nests. Volunteers did not approach nests or walk out onto ponds.

We based the window survey data on a complete survey of the South Bay, completed over the last week of May. The methods for the window survey are the same as described above.

### **Reproductive Success**

We monitored nests weekly until we determined the fate of the nest, either from hatching, depredation, flooding, abandonment or unknown fate. We assigned each nest an individual nest number using the pond names followed by a sequential number (e.g. E8A-1, E8A-2, E8A-3, etc.). On each visit, we recorded the nest status and, if the nest was still active, if the adult was incubating and the number of eggs or chicks in the nest. We also floated the eggs (Hays and LeCroy 1971) to estimate egg age. We placed individual eggs in a container of room temperature water and recorded the angle of the egg (the long axis of the egg relative to a horizontal line) and the maximum diameter of exposed egg (Hays and LeCroy 1971). 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 hatch date for all monitored nests.

To determine nest fate, we used the estimated hatch date and searched the nest scrape. When there were no longer eggs in the scrape, we searched the scrape for small eggshell fragments that indicated the nest hatched (Mabee 1997). If we did not find eggshell fragments, we looked for other signs of depredation such as dried yolk and disturbance in and around the scrape. If the eggs disappeared more than one week before the estimated hatch date and we failed to find eggshell fragments, we assumed the nest was depredated. If we found eggs in the nest for more than a week after the estimated hatch date and did not see adults in the area or signs of incubation, we recorded the nest as abandoned. If we observed chicks hatching or wet chicks in the nest, we recorded that date as the hatch date. If we found egg shell fragments, we assumed the chicks hatched (Mabee 1997), and we assigned the estimated hatch date as the actual hatch date. When nests are visited on the hatch date and it is unclear if the nest was depredated as eggs or as newly hatched chicks, we classified the nests as lost at hatch. We collected abandoned eggs and transferred eggs to U.S. Geological Survey (USGS) staff for use in a contaminants analysis study.

## Chick color banding

In 2008, SFBBO and Refuge biologists banded Snowy Plover chicks to study Snowy Plover movements within the salt ponds and to estimate fledging success for the South Bay. To band chicks, biologists checked nests daily, starting three days before the estimated hatch date. Because of the vast area of the salt ponds and the precocial nature of Snowy Plover chicks, it was crucial that we arrived at the nests when the chicks had just hatched, but had not yet left the scrape. We gave each chick a unique four-color combination so we could tell individuals apart. Each combination consisted of three darvic color bands and one silver U.S. Fish and Wildlife Service band we wrapped in auto pin-striping tape to make up the fourth color in the combination (K. Neuman, pers. comm.). We placed 2 bands on each leg of a chick.

To estimate chick survival and follow movements, we surveyed ponds and areas with banded chicks every 2-3 days. We recorded if we saw the chick and marked the chick's approximate location on a map.

## Avian Predator Surveys

SFBBO and Refuge biologists and interns conducted weekly avian predator surveys on focus ponds and volunteers conducted monthly avian predator surveys at our monthly ponds. We defined avian predators as any species that could potentially prey on a Snowy Plover nest, chick or adult and included: Common Ravens, American Crows, Northern Harriers, American Kestrels, Peregrine Falcons, Merlins (*Falco columbarius*), Red-Tailed Hawks, White-Tailed Kites, Golden Eagles (*Aquila chrysaetos*), Great Blue Herons (*Ardea herodias*), Great Egrets (*Ardea alba*), Snowy Egrets (*Egretta thula*), Loggerhead Shrikes, and Burrowing Owls (*Athene cunicularia*).

We conducted avian predator surveys by driving slowly on the levees surrounding the ponds and stopping every 0.3 miles to survey for predators. We recorded the species present, number of individuals, their behavior and marked their approximate location on a map. In addition, we recorded any predator nests in the area and attempted to determine the fate of those nests. We calculated the number of predators seen per week dividing the total number of individuals seen in each area by the number of surveys conducted and averaged this data to compare predators among Snowy Plover survey locations.

## Predator Management

The Refuge supervised and directed the predator management program and Wildlife Services provided predatory removal services. Wildlife Services removed targeted mammalian predators were removed from Refuge and CDFG property, focusing their

efforts on Snowy Plover breeding areas. Mammalian predators managed by this program include red fox (*Vulpes vulpes*), feral cats (*Felis felis*), skunks (*Mephitis mephitis*), and raccoons (*Procyon lotor*). At Eden Landing, the avian predator management program targeted individual Common Ravens, American Crows and Northern Harriers observed hunting on Snowy Plover nesting ponds. Wildlife Services, in conjunction with Pacific Gas and Electric (PG&E), facilitated the removal of avian predator nests on electrical transmission towers near Snowy Plover nesting ponds.

## Data Analysis

For the purposes of data analysis, we defined a survey as one complete survey of a single pond. We calculated the mean number of Snowy Plovers seen per area (total number of Snowy Plovers seen over the season in an area divided by the number of surveys completed) and reported the standard error for each area.

We measured nest success, hatching success, fledging success and Mayfield hatching success in the South Bay Snowy Plover population. Nest success is the percentage of total nests that hatched at least one egg. Hatching success is the percentage of eggs hatched per total eggs laid. Fledging success is the percentage of chicks fledged per chicks banded. Mayfield hatching success is the estimated proportion of nests in which eggs hatch ( $P = [1 - Nu/E]^h$ , where  $Nu$  = number of unsuccessful clutches,  $E$  = total exposure-days and  $h$  = clutch ages at hatching (Mayfield 1961).

We calculated nest density in the ponds by dividing the number of nests in each pond by the acreage.

The number of predators seen was calculated by area, as most predators have a larger territory than one pond (Strong et al 2004).

## RESULTS

### Overall Plover Numbers

During the 2008 breeding season window survey of the Pacific coast, we recorded 133 Snowy Plovers in the San Francisco Bay. We consistently observed the highest numbers of Snowy Plovers at Eden Landing, however the numbers of Snowy Plovers in individual ponds varied greatly (Figure 7). We found the highest number of Snowy Plovers on pond E8A, which CDFG managed as Snowy Plover nesting and foraging habitat. We also regularly observed Snowy Plovers on Refuge ponds A8, A22, A23, R1 and the impoundment area next to New Chicago Marsh in Alviso (Figure 8).

We observed the highest number of Snowy Plover nests at E8A ( $n = 45$ ), E12 ( $n = 13$ ), E14 ( $n = 13$ ) and R1 ( $n = 13$ ; Table 5).

We located the most chicks (both banded and unbanded) during the week of 26 May 2008, when we found 19 chicks within the South Bay (Appendix 1).

### *Refuge*

The Ravenswood ponds and Alviso ponds had the highest numbers of Snowy Plovers on the Refuge with the mean number of Snowy Plovers/week of 19.65 and 13.67, respectively (Table 3). The majority of the Snowy Plovers at Ravenswood were on pond R1 (mean of 14.8) (Appendix 2). We observed Snowy Plovers in the Alviso impoundment area as well as foraging in the western section on New Chicago Marsh in Alviso. We also observed Snowy Plovers on Warm Springs ponds A22 and A23, but never in large numbers (mean: 4.6 on A22 and 3.7 on A23; Table 3).

### *Eden Landing*

Eden Landing had the highest number of Snowy Plovers all season with an average of 102 Snowy Plovers/week (Table 3). We observed Snowy Plovers on ponds E11, E16B, E12, E14, E8, E8X, E8A, E6, E6A, E6B and E4C (Appendix 3). Throughout the season, pond E8A had the highest number of consistent use, with a mean of 53.6 adults/week (Appendix 2). The ponds with the next highest use were E12 and E14, with the mean numbers of 16.1 and 15.3, respectively.

### *Napa*

In 2008, volunteers observed Snowy Plovers on ponds 7 and 7a in the Napa-Sonoma Marshes Wildlife Area. The mean number of Snowy Plovers on pond 7a was 3.0 and the mean number on pond 7 was 17.2 (Table 3). The mean number of Snowy Plovers on pond 7 was high because a flock of 74 birds was observed during the last weekend of August. These birds were probably from the coast and were not present during the entire breeding season.

## **Reproductive Success**

### *Refuge*

We monitored 27 nests on Refuge property: 13 nests on R1, 1 nest on R3, 1 nest on R4, 2 nests on RSF2, 3 nests on A8, 1 nest on A12, 2 nests in the impoundment area and 4 nests on A23 (Table 5). Four of the 6 monitored nests in Alviso hatched (67%) and 2 were depredated (33%; Table 5). We monitored 17 nests in the Ravenswood complex. Fourteen of the nests (82%) hatched and 3 of the nests (18%) were depredated. We located 4 nests in Warm Springs pond A23. Three of the nests hatched (75%) and 1 was depredated (25%). We also observed at least 3 other broods at Warm Springs from nests that had not been monitored. Of the 85 eggs we found on Refuge property, 62 (73%) hatched (Table 4).

One Snowy Plover nest was successful on pond A12, draw down specifically for American Avocet (*Recurvirostra americana*) and Forster's Tern (*Sterna forsteri*) nesting in 2008. A second nest was apparently attempted at pond A12 but abandoned or pushed out: one Snowy Plover egg was collected from an avocet nest by USGS during their mercury investigations on the pond (C. Eagles-Smith, pers. comm.)

### *Eden Landing*

We monitored 90 nests in eight ponds at Eden Landing. Of these nests, 42 hatched (46.7%), 38 were depredated (42.2%), 1 was abandoned (1%), 3 were flooded (3%), 1 had an unknown fate (1%) and 5 were lost at hatching (5.6%; Table 5). Of the 264 eggs we found at Eden Landing, 115 (44%) hatched (Table 4). Pond E8A had the highest numbers of Snowy Plover nests ( $n = 46$ ). Out of these nests, 46.7% of the nests were depredated and 33.3% hatched. Pond E12 and E14 both had 13 nests with 8 nests hatching on both ponds (61% on each pond; Table 5). Of the 264 eggs monitored at Eden Landing, 177 hatched (51%, Table 4).

Skunks were responsible for the depredation of 4 Snowy Plover nests in E8A, as we observed their tracks leading up to depredated nests. We do not know which predators were responsible for other depredated nests as there were no tracks or other signs around the scrapes. A high tide event flooded 3 nests in pond E8A. The nest with the unknown fate was also in E8A and possibly flooded during the same tidal event (we could not access the nest after the flooding). In addition to the nests that we found on E8A, it is likely that there were at least 8 more successful nests on that pond because several times we observed chicks of ages that did not correspond to those of monitored nests.

Five of the nests were classified as "lost at hatch" because the nest appeared to have hatched; however there were no chicks present on the hatch morning. We observed blood in the scrape at four of these nests.

### *Hayward Shoreline*

There was one Snowy Plover nest on the East Bay Regional Park's island constructed for nesting Least Terns. The nest had three eggs, all which hatched (100%; Table 5).

## *South Bay Overall*

We monitored 118 nests this season in the entire study area. Sixty-four hatched, 44 were depredated, 1 was abandoned, 3 flooded, 1 had an unknown fate and 5 were lost at hatching (Table 5).

### **Mayfield Estimates**

We observed 3283.5 nest exposure days. Fifty-four nests were lost to depredation, abandonment or flooding. Therefore, mortality was  $54/3283.5$  or 0.016. Survival was calculated as  $1 - 0.016$  or 0.984. The probability that a nest survived the 33 days between nest initiation and hatching was  $0.984^{33}$  or 0.58.

### **Nest Density and Breeding Chronology**

The pond with the highest nest density was pond E8A (0.18 nests per acre; Table 7). Nest densities for all ponds are listed in Table 6 and Table 7.

The peak nest initiation week in the South Bay was 28 April with 13 nests initiated (Figure 9). This season we had small four peaks in the number of initiated nests. The first peak was in the beginning of the season when 9 nests were initiated during the week of 24 March. The second peak was during the week of 28 April with 13 nests initiated. The last two peaks were the week of 9 June with 12 nests initiated and 30 June and 7 July, with nine nests initiated both weeks.

### **Chick Fledging Rates**

In 2008, SFBBO and Refuge biologists banded 83 Snowy Plover chicks and 24 chicks fledged (28.9% fledge rate). The fledge rate was 26.9% at Eden Landing, 50% at Alviso, 0% at Warm Springs, 0% at Ravenswood and 100% at Hayward Shoreline (Table 8). A higher percentage of chicks banded in July and August successfully fledged than those banded in April, May and June (Table 9).

### **Banded Bird Re-sightings**

We observed five Snowy Plovers that were banded outside of the San Francisco Bay. On 10 March, 15 April and throughout the month of July, we observed PR:GY at Eden Landing. This female was banded in Salinas in 2003 and nested on pond E8A early in the season and on E8 in July. On 12 June, we observed RY:GO at Eden Landing, which hatched at Ford Ord in 2007. On 28 June, we saw RO:YR in Alviso. This bird was banded during the Cosco Bucas Oil Spill cleanup. We observed OB:RY in September at Eden

Landing. This bird was banded at Marina State Beach in 2007. In mid September, we observed WR:GO at Eden Landing. This female was banded at Salinas State Beach in 2003 (F. Bidstrup, pers comm.).

On 24 October, a bird banded at Eden Landing in July was observed in Santa Cruz on Seabright Beach by PRBO Conservation Science staff (J. Erbes, pers comm.).

## **Avian Predators**

### *Refuge*

The most common avian predators we observed in Alviso were California Gulls (Table 10). Approximately 26,366 California Gulls nested in the colony on pond A6 (SFBBO, unpublished data). Other predators in the complex were Common Ravens, Great and Snowy Egrets, Peregrine Falcons and Red-Tailed Hawks (Table 10). Northern Harriers nested this year in Alviso Slough.

The most commonly seen predators at Warm Springs were California Gulls and unidentified gulls (Table 10). Throughout the season we also observed large numbers of Common Ravens in and around ponds A22 and A23 with as many as 54 counted in one survey (average per survey was 13.8; Table 10). Ravens nested in the PG&E towers to the north of pond A22. There was also a constant stream of gulls traveling to and from the Newby Island Landfill to the Tri-Cities Landfill. Ponds A22 and A23 are located in between these landfills. These ponds are also located in close proximity to the Mowry California Gull colony which supported 14,158 nesting gulls (SFBBO, unpublished data).

The most common predator we observed at the Dumbarton ponds were unidentified gulls, followed by California Gulls and Common Ravens (Table 10).

Wildlife Services did not conduct any avian predator management on Refuge property.

### *Eden Landing*

The most commonly observed avian predators at Eden Landing in 2008 were unidentified and California gulls (Table 10). We also observed Northern Harriers, Red-Tailed Hawks, Common Ravens, Great and Snowy Egrets and Great Blue Herons (Table 10). Eden Landing is just north of the Coyote Hills California Gull colony where 4,952 gulls nested this year (SFBBO, unpub. data). There were large numbers of gulls roosting on the southern portion on pond E3C and the north side of pond E6A. We noticed a large increase in the number of gulls on pond E8A during the beginning of June.

We frequently observed Northern Harriers hunting pond E8A, E8, E14 and along North Creek and Old Alameda Creek. We did not locate any harrier nests this season nor did we locate any Red-Tailed Hawk nests. We commonly saw the Red-Tailed Hawk perched in the power poles along Old Alameda Creek and along the east side of E12. We consistently observed White-Tailed Kites along Mt. Eden Creek and a pair of American Kestrels on the power lines near E12.

Great Blue Herons nested again this season on the old hunting blind on E6B, referred to as the “heron house”. This structure is slowly collapsing and only supported six nests this season. The herons responded by nesting on the hunting blinds on pond E9.

California Least Terns (*Sternula antillarum brownie*) nested again on pond E8A in early June. We observed an increase California Gulls in this pond in late May and early June. We observed a total of two Least Tern nests and both were depredated within a week. We recorded our first Snowy Plover lost at hatch nest during the last week in May, and 3 in the first week of June. All the lost at hatch nests had blood in the nest cups and there were no other signs of predators in the area.

### *Napa*

The predators most frequently seen by our volunteers at the Napa-Sonoma Marsh Wildlife Area were gulls, including Ring-Billed, California and unidentified gulls (Table 10).

### *Direct Avian Depredation*

We did not observe any direct avian depredation events in 2008.

### *Mammalian Predators*

Wildlife Services conducted the mammalian predator management program in Snowy Plover breeding areas. This included daytime scouting and nighttime spotlighting surveys. SFBBO volunteers and staff did not conduct mammalian predator surveys; however we did record any mammals we observed during surveys at the Refuge or Eden Landing.

A feral cat feeding station was set up outside the Veasy Street gate to Eden Landing and we regularly saw cats there and inside the reserve. We also observed a black and white cat by the Eden Landing Road gate. We observed grey foxes by E12 and Mt. Eden Creek. We observed a skunk near E8A and skunk tracks around the pond bottom.

## **Public Access**

On Refuge property, public access allowed near Snowy Plover nesting areas is limited. However, in Alviso, the levees surrounding A12, A13 and the impoundment area, the northern levee by Warm Springs pond A22, the levees around some of the Dumbarton ponds, the loop trail around Ravenswood ponds R1 and R2, and the north and east levees around RSF2 were all open to the public. Currently at Eden Landing, there is no public access. However an extension of the Bay Trail will open in the winter of 2008-2009. This trail will not border any Snowy Plover breeding ponds.

## **DISCUSSION**

### **Plover Numbers**

It is difficult to estimate the exact number of breeding Snowy Plovers in the San Francisco Bay because adult Snowy Plovers are not color banded and surveys of areas take several days to complete. A rough estimate of the number of breeding Snowy Plovers is 133 birds, based on a complete survey done during the breeding window survey conducted the last week in May.

In 2008, we observed higher numbers of Snowy Plovers at Alviso, Ravenswood and Warm Springs than in 2007. The mean number of Snowy Plovers decreased slightly at Eden Landing from 2007. We also observed few avian predators at the Ravenswood ponds, which may have increased Snowy Plover use.

A small number of Snowy Plovers used the salt ponds in the North Bay, at the Napa-Sonoma Marsh Wildlife Area, and volunteers saw up to three broods of Snowy Plovers and chicks. They also found a very large flock of 74 Snowy Plovers roosting on ponds 7 and 7a during the last week in August. It is likely these Snowy Plovers breed elsewhere and use the Napa ponds during migration or to over-winter.

### **Reproductive Success**

We found more Snowy Plover nests in the South Bay in 2008 (118 nests) than in 2007 or 2006 (89 and 81, respectively). However, this increase may be due to increased survey efforts, rather than an actual increase in the number of nests.

Although nest success in the South Bay increased slightly from 49.4% in 2007 to 54% in 2008, nest success from 2006 – 2008 was much lower than nest success in 2004 and 2005 (83.6% and 84%, respectively; Figure 10). Because depredation events usually leave no sign at the nest other than missing eggs, we have no way to positively identify

predators. However, this year, we found skunk tracks leading up to four depredated nests. This was the first year we documented skunk depredation in the South Bay; Meckstroth and Miles (2005) reported them as the most common nest predators removed by Wildlife Services in the South Bay.

Additionally, this year we classified five nests as “lost at hatch” because we were unable to determine if nests were depredated as eggs or chicks (G. Page, pers. comm.). We monitored nests daily for four days prior to hatching. The morning that these nests hatched, we found no chicks in the area and blood in the scrape of four of the five nests.

In 2008, Snowy Plovers nested in more areas on the Refuge than they have in previous years as water management may play a role in increasing numbers of nesting Snowy Plovers. In A12, managers drew down the water level to provide nesting habitat for shorebirds and a pair of Snowy Plovers successfully nested on an island on the south western edge of the pond. This management was also successful in creating nesting habitat for approximately 300 American Avocets and approximately 40 Forster Terns. However, California Gulls depredated a large number of these nests toward the end of the nesting season (USGS, unpub. data).

We monitored four nests in Warm Springs’ pond A23. We also observed Snowy Plovers foraging and roosting in pond A22, however the large amount of vegetation growing in the western portion may limit Snowy Plovers nesting on the pond. Both ponds were fairly dry from the beginning of the season, and thousands of gulls roosted on the levee separating the ponds. Gulls may be attracted to this area because of the proximity of Warm Springs to two landfills (Newby Island and Tri-Cities). We also observed gulls consistently flying over Warm Springs, likely in transit between the two landfills, and large numbers of Common Ravens. Tri-Cities Landfill is due to close in the next few years, which may decrease the amount of gulls roosting in the ponds and flying over Warm Springs.

At Eden Landing, Snowy Plovers nested on eight ponds, and most nests were on E8A. We observed Snowy Plovers intensively using pond E8A for foraging throughout the season. CDFG managed this pond to have water in the borrow ditches and maintained water in parts of the flat pond bottom throughout the season. This management scheme provided the mosaic of dry and wet habitat that Snowy Plovers seem to prefer for nesting and foraging as pond E8A had the highest nest density of any pond in the South Bay in 2008.

Snowy Plovers also nested in pond E16B this season. Although 7 of 8 nests on the pond hatched (87.5%), we never observed chicks on the pond, and we did not observe Snowy Plovers on the pond after the last nest hatched. The edges of the borrow ditch on pond E16B are very steep and do not provide foraging habitat. If this pond is to support higher numbers of Snowy Plovers in the future, the water level should be higher in the borrow ditch or interior channels should be added to enhance foraging habitat.

Mid- season, Snowy Plovers nested in the dry dredge lock in the north side of pond E6. We monitored two nests and both were depredated. Plovers stopped using the pond after the nests were depredated.

This season CDFG maintained high water levels in E6A, E6B and E8 early in the season because of construction activities. New water control structures were added in the northwest corner of E6B and between E6B and E6A. These structures will give managers greater control over water levels in the ponds. The high water levels limited the amount of habitat available to Snowy Plovers in the beginning of the season, but once construction was completed the ponds started to dry, Snowy Plovers nested on E8 and E6B in very small numbers.

Late season nesting habitat is important to Snowy Plovers because of their extended breeding season. Similar to the two previous breeding seasons, pond E12 dried throughout the season and provided nesting habitat starting in June. This year, Snowy Plovers mainly nested on the pond bottom, rather than the raised, linear berms running throughout the pond. Pond E12 also served as an important roosting area for Snowy Plovers at the end of the season. For the past three breeding seasons, E12 dried in the middle of the breeding season and hosted the majority of the late season nesting habitat.

This season there were at least three Snowy Plover nests in the North Bay, at CDFG's Napa-Sonoma Marshes Wildlife Area. Karen Taylor, CDFG biologist, found two broods of chicks in June (K. Taylor, pers. comm.) and SFBBO volunteers observed a male with a chick a month later.

In 2008, SFBBO and the Refuge banded chicks in the South Bay for the first time since 2001. Our overall South Bay fledge rate of 28.9% is lower than what PRBO Conservation Science has reported in Monterey Bay from 1997 through 2007 (Page, pers. comm.). However, with only one year of data we cannot state if this low fledge rate is typical of the South Bay.

At Eden Landing, pond E12 had the highest fledge rate. We did not observe as many predators around E12 as compared to other ponds such as E8A, which is bordered by Old Alameda Creek, North Creek and Whale's Tail Marsh. The E12 chicks may have also benefited from hatching later in the season. Throughout Eden Landing, chicks that were banded in July and August had the best fledging rate for the season. This improvement in fledging success may be due to additional predator food sources in the ponds in July and August because of the returning shorebirds.

In Alviso, we banded six chicks, three from the A12 nest and three from a nest in the impoundment. Both broods moved from their nesting locations within days of hatching. A few days after the chicks hatched from the A12 nest, we observed the male and one

chick in the Alviso impoundment nearly a half-mile away. The three chicks from the impoundment nest fledged after the male moved them to dry pan area of New Chicago Marsh adjacent to the impoundment. The chicks may have benefited from the additional cover that the vegetation in New Chicago Marsh provided. Ackerman et al. (2006) found that Black-Necked Stilt and American Avocet chicks were less likely to be depredated if they were in habitats with more emergent vegetation, such as marshes, than in more open habitats such as salt ponds.

We banded 5 chicks from the 2 nests on RSF2 and none of the 5 chicks banded on RSF2 are known to have fledged. The number of Snowy Plovers we observed in RSF2 decreased throughout the season and we stopped seeing them in the pond by the middle of July. RSF2 dried almost completely throughout the season and may not have provided good foraging habitat later in the season. We did not band the R1 and R4 chicks due to lack of personnel for re-sightings. In addition, pond R4 as well as R3 are very difficult to survey due to the topography within it; many lumps of gypsum make it difficult to see anything hiding in the pond. The borrow ditches in the R1-R4 ponds are very steep sided and therefore do not provide ideal foraging habitat for Snowy Plovers. Ponds R1-R4 may serve as an ecological trap by attracting Snowy Plovers to what seems like good foraging habitat but as the pond dries the steep borrow ditches may decrease fledging rates. In order to enhance Snowy Plover foraging and nesting habitat, the water levels should be managed in R1-R4 to maintain higher water levels throughout the season.

The pair of Snowy Plovers that nested on the Least Tern island that EBRPD created fledged their three chicks. EBRPD has an active predator management program for the colony of Least Terns, which also benefited the Snowy Plovers. In addition, Snowy Plovers in other areas are known to benefit from the intense predator response of terns (Nguyen et al. 2006).

### **Restoration and Snowy Plover Nesting Success**

The majority of the South Bay's Snowy Plover nesting habitat is located within the footprint of the South Bay Salt Pond Restoration Project (the Project). The Project aims to restore large areas of former salt ponds to a mix of tidal habitats. The Project will manage other former salt ponds as Snowy Plover nesting habitat or as waterbird habitat during migration and winter. The Project has agreed to aim to support 125 breeding pairs within the project area. The Project should work carefully to maintain enough nesting habitat to support the existing population of Snowy Plovers. The Project is expected to begin construction of Phase One restoration projects in 2009. Managers should leave enough nesting habitat available in the adjacent ponds during the construction period, or provide alternative habitat in other areas utilized by Snowy Plovers.

In order to help the Project reach its goal of 125 breeding pairs, in winter 2008/2009 SFBBO is starting a habitat enhancement project on ponds currently managed for Snowy Plovers at Eden Landing or have the potential to be managed in the future.

Enhancements will include removing all potential raptor perches that exist on the ponds and surrounding levees to reduce predator pressure on adults and chicks. We will add oyster shells to the pond bottoms to provide better camouflage for nesting plovers. Large oyster shells may also provide some shade and predator protection for small plover chicks. SFBBO and the Refuge will continue to monitor Snowy Plovers in the 2009 breeding season to evaluate the effectiveness of the habitat enhancements.

Ponds managed for Snowy Plovers should be located in numerous parts of the Bay and locations should vary yearly. This may help reduce predation levels and may prevent individual predators from “learning” the locations of Snowy Plover nesting ponds.

Plovers in the San Francisco Bay seem to prefer nesting in dry salt ponds on large, open salt pan areas located near foraging habitat. Two Snowy Plovers nested on islands this season, however it is unknown how many pairs the created islands in ponds A16, RSF2 and E12/13 will support. Therefore, dry salt pan habitat may need to be actively managed and maintained in the future as primary nesting habitat.

Another goal of the Project is to increase the public access to certain areas. Research has shown that the Snowy Plovers in the South Bay are very sensitive to recreational disturbance (Robinson 2008); therefore public access may need to be limited or prohibited on trails adjacent to Snowy Plover nesting ponds during the breeding season (March-August). Additionally, fencing or barriers may limit pedestrians from entering sensitive nesting areas and reduce human disturbance.

### **Avian Predators**

Northern Harriers continue to be one of our main avian predators of concern. Although we did not witness any direct predation events in 2008, we often observed harriers hunting Snowy Plover nesting ponds and the surrounding levees. Harriers were frequently hunting E8A, E8X, E8, North Creek and along Old Alameda Creek, where they have nested in the past. We observed harriers depredate a nest and a chick in 2007.

The restoration of marsh habitat in the future will increase the potential Northern Harrier nesting habitat in the South Bay. An increase of the local Northern Harrier population may result in higher predation pressure on salt pond nesting shorebirds.

California Gull colonies in the South Bay continue to grow (SFBBO, unpub. data). Three of the largest colonies (Alviso A6 colony, Mowry M4/M5 colony and the Coyote Hills colony) are close to Snowy Plover nesting areas. Gulls are opportunistic feeders and have been known to depredate shorebird eggs and chicks in the South Bay (Ackerman et

al. 2006). This year we saw more gulls using the ponds at Eden Landing for foraging and roosting. There was a large group of gulls roosting along the northern side of E6A for a large portion of the season. There was also a large influx of gulls on E8A during the middle of the breeding season.

Common Ravens were seen in many of the Snowy Plover nesting areas. Raven nests were constructed on the PG&E towers north of A22 and E10. Although we did not witness any direct predation events, we did observe large numbers of ravens, especially at Warm Springs. There, the ravens are likely feeding at the landfills and then roosting in the pond and pasture area between the landfills.

### **Effects of Avian Predator Distance and Behavior on Snowy Plovers: A Pilot Study**

A pilot study done on the effects of avian predator distance and behavior on Snowy Plovers in the salt ponds indicates that Snowy Plovers respond differently to various predators (Christy 2008). Snowy Plover response to Northern Harriers was to run away 100% of the time, whether the harrier was 20 m or greater than 200 m from a Snowy Plover nest. American Kestrel, Peregrine Falcon and White-Tailed Kite caused nesting Snowy Plovers to crouch but not run.

Gulls were recorded at distances varying from 10m to 200m from the nest. The closer a gull was to the nest the higher the chances the gull had of eliciting a response (alert, crouch, or run) from the Snowy Plover. There was no significant difference in response from hunting or in-transit gulls. Previous research conducted by Page et al (1985) showed that gulls elicited no response from plovers in an area where gulls were not known to depredate plovers, and plovers ran or crouched in areas where gulls were known to depredate plovers.

## **RECOMMENDATIONS**

### **Research Recommendations**

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

1. Continue banding and tracking of Snowy Plover chicks (and begin with adults) to examine how they use the managed and seasonal ponds throughout the breeding season as well as their general movements and habitat use. Banding birds gives us data on Snowy Plover survival rates and fledging success. This is vital information to know if we are going to reach our recovery goal of 500 birds in Recovery Unit 3, with 250 birds to be supported in the Project area.
2. Habitat enhancement studies determining the effectiveness of adding oyster shells to pond bottoms to increase Snowy Plover nest densities and nest success.

3. Plover foraging habitat use (borrow ditches, open channel, muted tidal, shallow pools, dry substrate) and invertebrate availability within the salt ponds.
4. Experimental designs to determine whether Snowy Plovers in the Bay will nest on islands constructed as part of the Project. Monitor islands for Snowy Plovers that have already been constructed, such as the Least Tern island at Hayward Shoreline.
5. Further studies on Northern Harrier territory size and habitat use.
6. Research on the effectiveness of the avian predator management on increasing Snowy Plover nest success.
7. Studies of the water levels and Snowy Plover use of ponds, and water management techniques to improve habitat quality for Snowy Plovers.
8. Nest site density and carrying capacity within the salt pond habitat.
9. Further research should be conducted into the potential impacts of disturbance from trail use at Eden Landing and RSF2.

### **Monitoring Recommendations**

1. The Western Snowy Plover monitoring program should continue into the future. Monitoring the South Bay population will be increasingly important as the amount of habitat is reduced due to Project activities. We want to ensure that the population numbers do not decrease as restoration activities occur.
2. The Snowy Plover nest monitoring program should continue, including floating the eggs to estimate incubation stage, nest initiation dates and hatching dates.
3. Plover chicks and adults should be banded to determine chick survival, fledging rates and movement. Banded chicks should be re-sighted every few days to track their movements. Banding the chicks will be our only way to know if we can meet the recovery goal of 1.0 chick fledged per male.
4. Plover habitat should be located early in the breeding season and then additional potential seasonal nesting habitat should be scouted for throughout the season. The most likely Snowy Plover habitat will be determined by historical use, water levels, rainfall and other variables within the ponds. Assuming water levels in 2009 will be comparable to 2008, the following ponds should be monitored weekly for Snowy Plover use: A12, E6B, E8, E8A, E8X, E11, E12, E14, E16B, and the Ravenswood ponds.
5. Snowy Plover monitoring surveys should be conducted in the early morning or late afternoon when lighting is best for looking for Snowy Plovers.
6. More volunteers should be recruited and trained this winter to survey all potential Snowy Plover nesting areas throughout the season.
7. The SFBBO, along with CDFG and the Refuge should develop a Snowy Plover outreach program in areas adjacent to Snowy Plover breeding habitats. Some of these areas will be open to the public within the next few years and actions should be taken now to educate the public on Snowy Plover conservation issues.

8. The SFBBO, along with CDFG and the Refuge, should design interpretive panels to be placed in areas open to the public to educate people on Snowy Plover habitat needs and conservation issues.

### **Management Recommendations**

1. Management should continue to meet Snowy Plover habitat requirements by: a) providing areas of drying salt ponds with nearby high salinity foraging habitat, b) manage ponds in several areas around the South Bay for Snowy Plovers to reduce the potential impacts from predation, flooding, or disease, c) varying the locations of Snowy Plover ponds should from year to year to reduce predation rates.
2. The predator management program should continue in 2009 in the South Bay. This should include removing mammalian and avian predators, predator nests, and when necessary, adults. Avian predator management should be added to Refuge lands.
3. Removal of man-made structures that could serve as potential predator perches should be undertaken. This includes old unused hunting blinds, telephone poles and other stakes and posts around the ponds. This is especially important in ponds that may be used more heavily in the future, such as E6B and E8.
4. Pond E6A and A22 should be flooded to kill off vegetation that is growing on the pond bottoms. The increasing vegetation could be discouraging the Snowy Plovers from using these ponds.
5. Pond E11 has fissures throughout the mid section of the pond. Some of these cracks are over half a meter deep and could be a hazard for Snowy Plover chicks. Filling of these cracks or scraping the pond surface may be necessary if this pond is to be managed for Snowy Plover nesting in the future. In the interim, the pond should be flooded to prevent Snowy Plover nesting.
6. If the Ravenswood ponds are to support more Snowy Plovers in the future, the water level should be higher in order to keep water in the borrow ditches and the interior channels. This will create better foraging habitat and hopefully increase the numbers of Snowy Plovers using the complex.
7. Managers and biologists should continue to work with PG&E to remove predator nests from the towers. Tower design modifications should be researched to discourage ravens and Red-Tailed Hawks from nesting in the towers near Snowy Plover habitat.
8. The feral cat feeding station by the Eden Landing Veasy Street gate should be removed. This encourages feral cats near Eden Landing as well as other predators including raccoons, skunks and rats.
9. More effort should be put into enforcement of regulations and area closures of Snowy Plover breeding habitat to minimize disturbance from humans. This will become progressively more important as additional areas are open to the public as part of the Project.

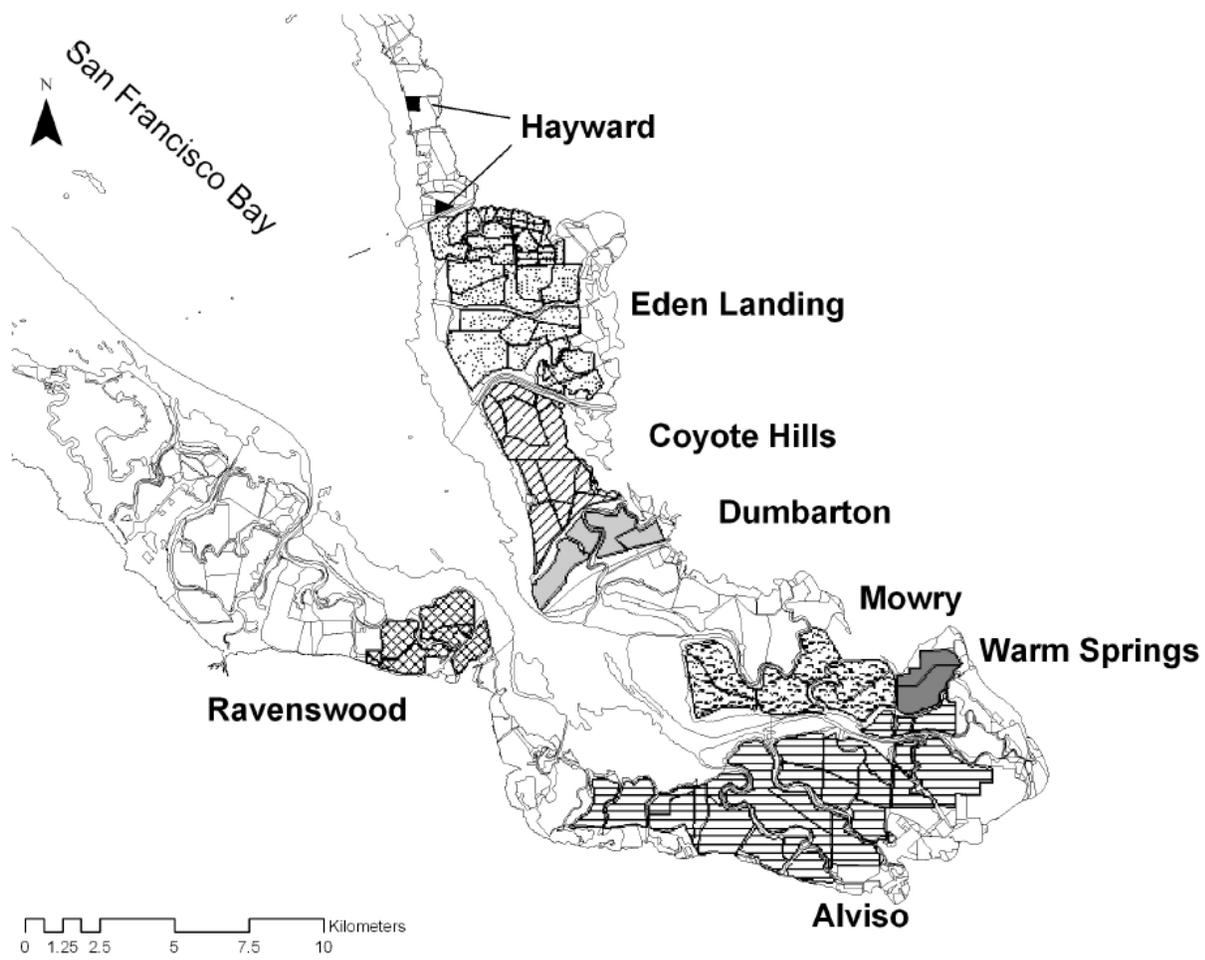
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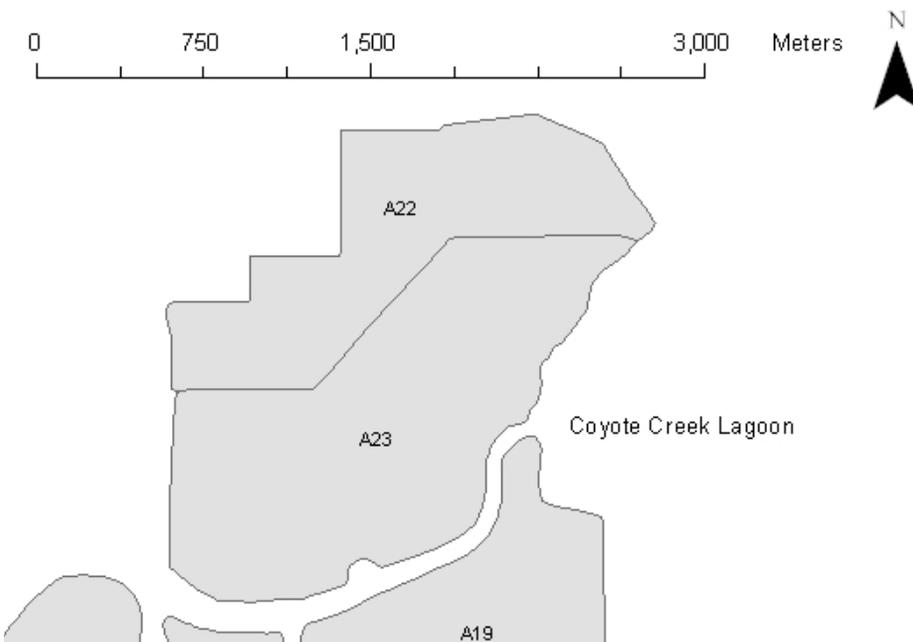
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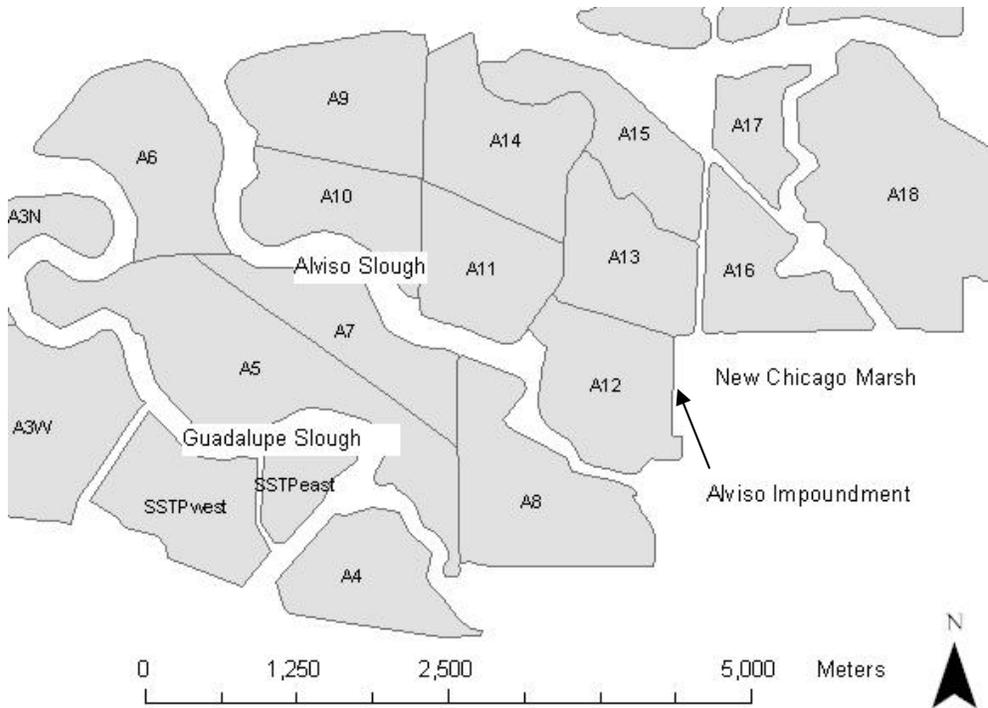
**Figure 1.** The Don Edwards San Francisco Bay National Wildlife Refuge, CDFG’s Eden Landing, and Hayward Area Recreation District lands in the South San Francisco Bay.



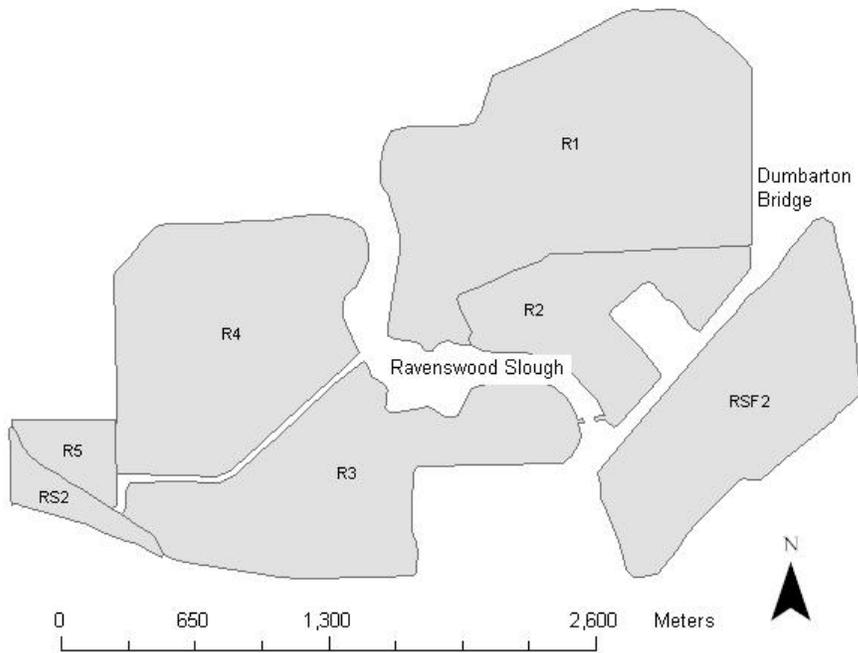
**Figure 2.** Salt ponds located in the Napa Sonoma Marsh Wildlife Area, near Napa, North San Francisco Bay.



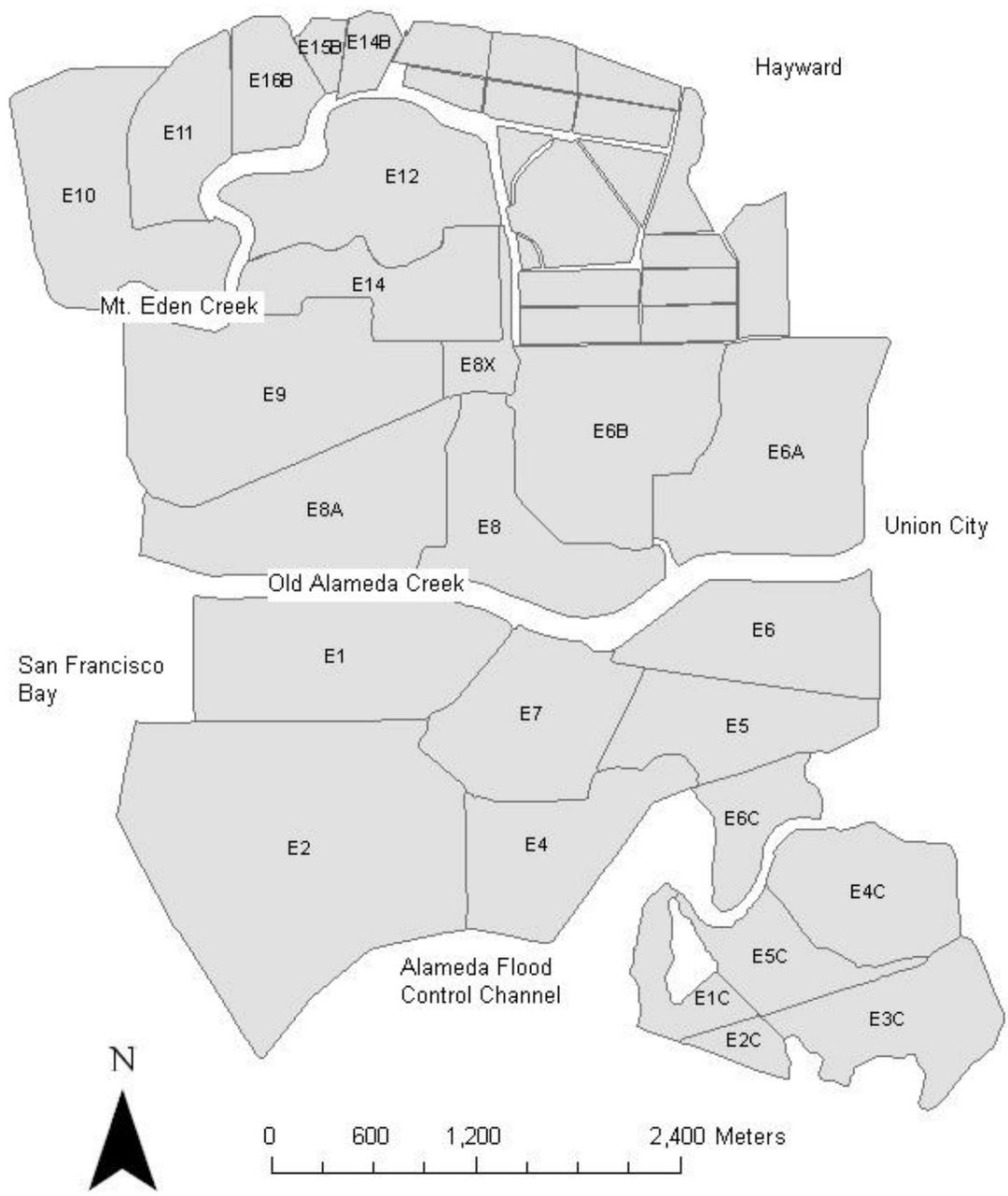
**Figure 3.** Salt ponds located in the Warm Springs area, near Fremont, South San Francisco Bay.



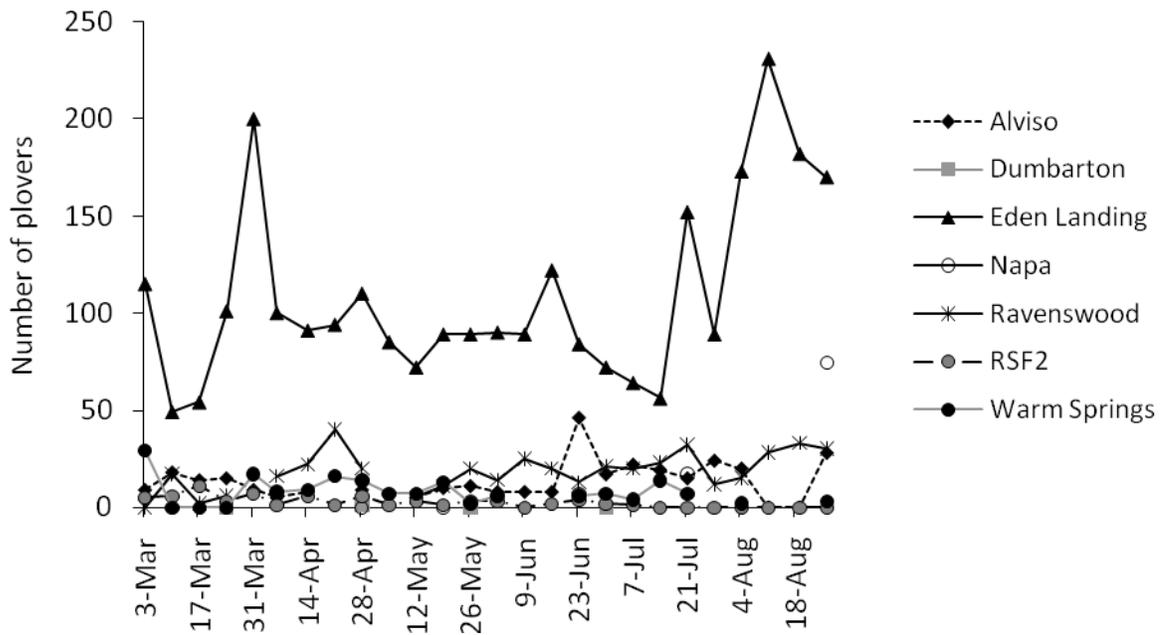
**Figure 4.** Salt ponds in the Alviso complex, at the southern end of the South San Francisco Bay.



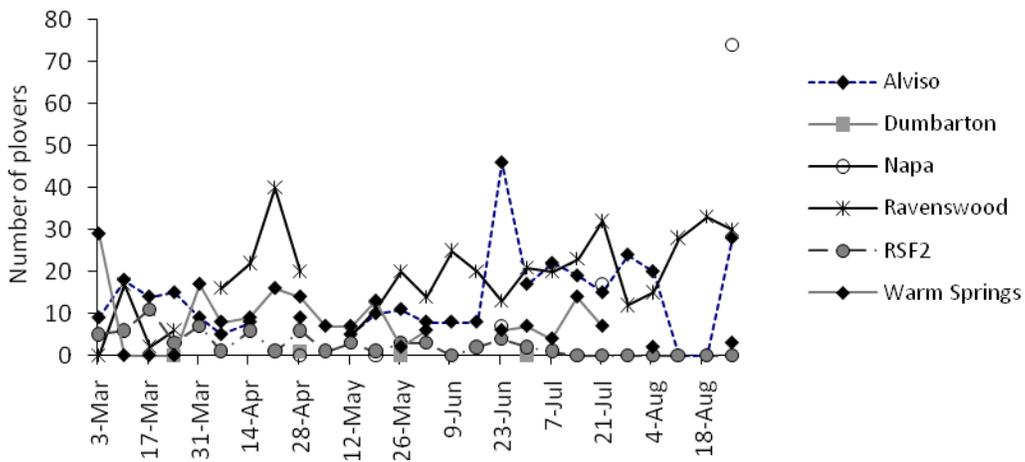
**Figure 5.** Salt ponds in the Ravenswood complex, at the west end of the Dumbarton Bridge, South San Francisco Bay.



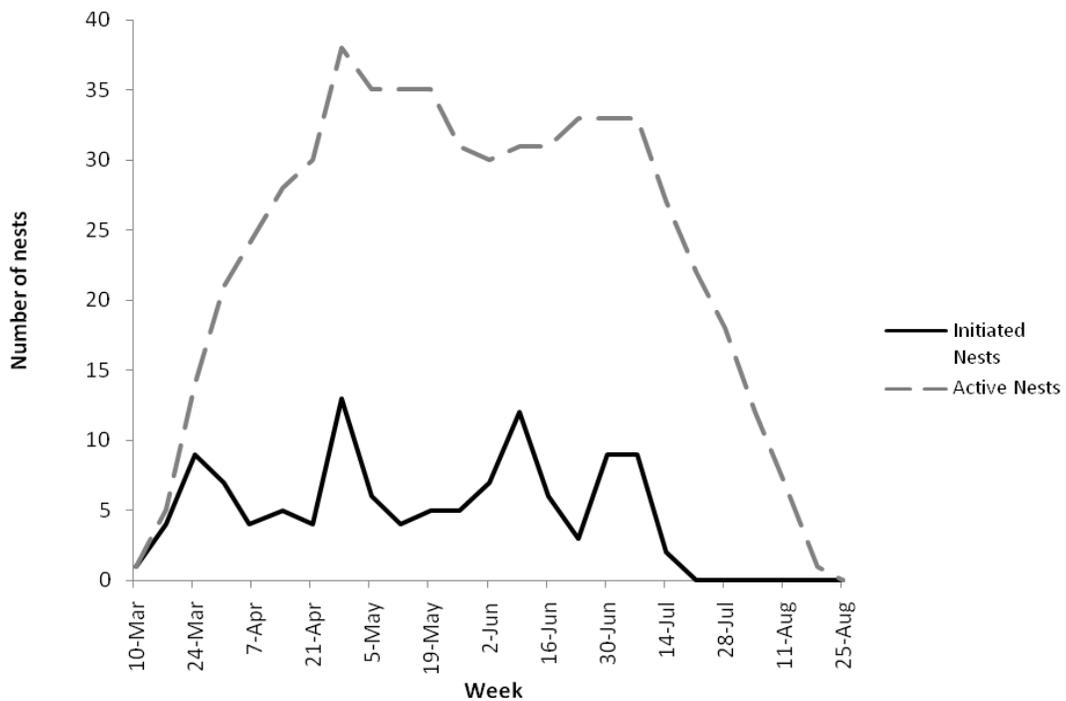
**Figure 6.** Salt ponds in the Eden Landing Ecological Reserve Complex, near Hayward, South San Francisco Bay.



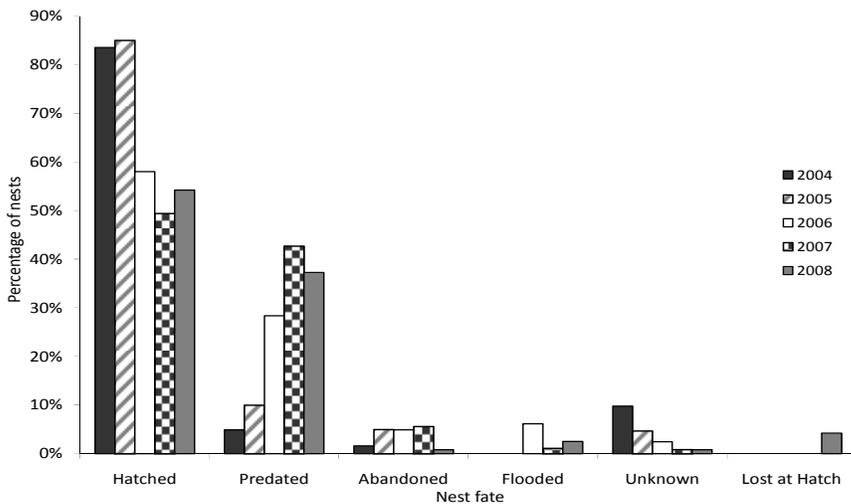
**Figure 7.** Weekly count of adult Snowy Plovers by week and area, San Francisco Bay, 2008.



**Figure 8.** Weekly count of adult Snowy Plovers by week and area, San Francisco Bay, 2008, excluding Eden Landing.



**Figure 9.** The weekly number of initiated and active Snowy Plover nests in the South San Francisco Bay, 2008.



**Figure 10.** Annual Snowy Plover nest fates in the South San Francisco Bay, 2004-2008.

**Table 1.** Ponds surveyed within the Don Edwards National Wildlife Refuge, South San Francisco Bay, 2008. Asterisk denotes focus ponds.

Location	Ponds
Alviso	A5, A6, A7, A8*, A12*, A13*, Impoundment
Dumbarton	N1, N2, N3, PP1
Ravenswood	R1*, R2*, R3, R4, R5, RSF2*
Warm Springs	A22*, A23*

**Table 2.** Ponds surveyed on California Department of Fish and Game property, San Francisco Bay, 2008. Asterisk denotes focus ponds.

Location	Ponds
Eden Landing Ecological Reserve	E6*, E6A*, E6B*, E8*, E8A*, E8X*, E11*, E12*, E14*, E15B, E16B*, E1C, E2C, E3C, E4C, E5C, E6C
Napa-Sonoma Marsh	7, 7a

**Table 3.** Summary statistics of Snowy Plovers numbers by area San Francisco Bay, 2008.

Location	Statistic	Males	Females	Unknown Adults	All Adults	Juveniles	Chicks
Alviso	Mean (n=24)	3.58	2.54	7.54	13.67	0.21	0.63
Dumbarton	Mean (n=4)	0.25	0.00	0.00	0.25	0.00	0.00
Eden Landing	Mean (n=26)	21.96	16.31	70.31	108.58	1.65	6.65
Napa	Mean (n=4)	1.60	2.20	15.80	19.60	0.60	0.20
Ravenswood	Mean (n=26)	5.12	4.50	10.04	19.65	0.69	2.00
Warm Springs	Mean (n=21)	3.24	2.00	2.90	8.14	0.52	2.38
Alviso	Std Error	0.88	0.53	1.63	2.03	0.10	0.25
Dumbarton	Std Error	0.25	0.00	0.00	0.25	0.00	0.00
Eden Landing	Std Error	1.79	1.63	8.54	9.32	0.39	1.30
Napa	Std Error	0.98	1.56	14.58	13.95	0.43	0.00
Ravenswood	Std Error	0.84	0.64	1.00	1.89	0.23	0.52
Warm Springs	Std Error	0.67	0.40	0.98	1.54	0.20	0.47

**Table 4.** Snowy Plover individual eggs hatching rate by pond the South San Francisco Bay, 2008.

Location	Number of Eggs	Eggs Hatched	% Hatched	Total nests
Refuge				
Alviso				
A8	9	3	33%	3
A12	3	3	100%	1
Impoundment	6	6	100%	2
Ravenswood				
R1	40	31	78%	13
R3	3	0	0%	1
R4	3	2	67%	1
RSF2	6	6	100%	2
Warm Springs				
A23	12	8	67%	4
<b>Refuge Total</b>	<b>82</b>	<b>59</b>	<b>72%</b>	<b>27</b>
Eden landing				
B6B	3	3	100%	1
B8	21	9	43%	7
B8A	132	40	30%	45
B8X	3	0	0%	1
B12	36	23	64%	13
B14	39	24	62%	13
B16B	24	16	67%	8
B6	6	0	0%	2
<b>Eden Landing Total</b>	<b>264</b>	<b>115</b>	<b>44%</b>	<b>90</b>
Hayward	3	3	100%	1
<b>Total South Bay</b>	<b>349</b>	<b>177</b>	<b>51%</b>	<b>118</b>

**Table 5.** Snowy Plover nest fates by pond in the South San Francisco Bay, 2008.

Location	Hatched	Predated	Abandoned	Flooded	Unknown	Lost at Hatch	Total nests
Alviso							
A8	1	2					3
A12	1						1
Impoundment	2						2
Eden Landing							
B6B	1						1
B8	3	4					7
B8A	15	21		3	1	5	45
B8X		1					1
B12	8	4	1				13
B14	8	5					13
B16B	7	1					8
B6		2					2
Ravenswood							
R1	11	2					13
R3		1					1
R4	1						1
RSF2	2						2
Warm Springs							
A23	3	1					4
Hayward	1						1
Total South Bay	64	44	1	3	1	5	118

**Table 6.** Snowy Plover nest densities (nests/acre) by pond on Refuge property in the South San Francisco Bay, 2008.

Refuge							
Nests per acre	A8	R1	R3	R4	RSF2	A12	A23
	0.007	0.029	0.004	0.003	0.008	0.003	0.009

**Table 7.** Snowy Plover nest densities (nests/acre) by pond at Eden Landing in the South San Francisco Bay, 2008.

Eden Landing								
Nests per acre	E6B	E8	E8A	E8X	E12	E14	E16B	E6
	0.004	0.039	0.176	0.033	0.056	0.083	0.098	0.011

**Table 8.** Number of chicks banded, chicks fledged and percent fledged per pond in the South San Francisco Bay, 2008.

	Chicks Banded	Chicks Fledged	Percent Fledged
<b>Alviso</b>			
A12	3	0	0.0%
Impoundment	3	3	100.0%
Total	6	3	50.0%
<b>Eden Landing</b>			
E8A	21	5	23.8%
E12	15	8	53.3%
E14	13	4	30.8%
E16B	10	0	0.0%
E8	5	1	20.0%
E6B	2	0	0.0%
E8X	1	0	0.0%
Total	67	18	26.9%
<b>Hayward</b>			
Least Tern Island	3	3	100.0%
<b>Ravenswood</b>			
RSF2	5	0	0.0%
<b>Warm Springs</b>			
A23	2	0	0.0%
<b>All Areas</b>	<b>83</b>	<b>24</b>	<b>28.9%</b>

**Table 9.** Numbers of chicks banded, chicks fledged and percent fledged per month for the South San Francisco Bay, 2008.

	Chicks Banded	Chicks Fledged	Percent Fledged
April	9	0	0.0%
May	30	3	10.0%
June	11	3	27.3%
July	16	11	68.8%
August	17	7	41.2%

**Table 10.** Mean predators per survey in each area in the South San Francisco Bay, 2008.  
We did not include the Alviso California Gull colony in our estimates.

		Alviso	Dumbarton	Eden Landing	Napa	Ravenswood	Warm Springs
Predators Of Concern	Northern Harrier	0.53	0.25	0.71	0.25	0.24	0.35
	Common Raven	2.91	0.75	0.21	0.75	0.95	13.83
	Peregrine Falcon	0.20		0.14		0.22	0.17
	American Crow	0.09	1	0.05		1.30	1.22
	White-Tailed Kite	0.02		0.15		0.19	
	American Kestrel			0.18			0.13
	Red-Tailed Hawk	0.49	0.25	1.12	0.25	0.37	0.78
	California Gull	190.31	12.25	6.55	4.5	0.86	88.26
	Other Gull	199.51	44.25	48.75	5	50.97	333.00
Other Predators	Ring-Billed Gull	1.78			8.25	0.00	
	Western Gull	0.04		0.81		0.02	1.30
	Black-Crowned Night Heron	0.89		1.01	0.5		0.04
	Great Blue Heron	0.98		2.65	0.5	0.21	
	Snowy Egret	3.29	0.5	6.25	3.25	1.83	0.04
	Great Egret	3.27		5.53	2.25	0.30	0.09
	Loggerhead Shrike			0.01			
	Golden Eagle			0.01			0.09
	Number of Surveys	45.00	4	91.00	4	63.00	23.00

APPENDIX A. The number of chicks seen per week in the South San Francisco Bay, 2008.

	A12	A13	A22	A23	A8	R1	R3	R4	RSF2	E11	E12	E14	E16B	E6	E6B	E8	E8A	E8X	7A (Napa)	Total
3-Mar			0		0	0			0	0	0	0	0	0	0	0	0	0		0
10-Mar			0		0	0			0	0	0	0	0	0	0	0	0	0		0
17-Mar	0		0		0	0			0	0	0	0	0	0	0	0	0	0		0
24-Mar	0		0		0	0			0	0	0	0	0	0	0	0	0	0		0
31-Mar	0	0	0		0				0	0	0	0	0	0	0	0	0	0		0
6-Apr	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
14-Apr			0			0	0	0	0	0	0	0	0	0	0	0	0	0		0
21-Apr	3	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0		3
28-Apr	1		0	2		0	1	0	0	0	0	0	0	0	0	0	3	0	0	7
5-May	0	0	1		0				0	0	0	1	1	0			7	0		10
12-May	0	0	0	1	0	0			0	0	0	2	0	0	0	0	4	0		7
19-May	0	0	3		0	1			1	0	0	3	0	0	0	0	7	0	0	15
26-May	0	0	1	1	1	0	0	0	0	0	0	3	0	0			13	0		19
2-Jun	0	0	1	1	0	0	0	1	0	1	2	3	0	0	0	0	8	0		17
9-Jun	0	0			0	0	0	0	0	0	2	0	0	1	0	0	3	0		6
16-Jun	0				0	0			0	0	0	0	0	0	0	0	2	0		2
23-Jun			1		1	1			0	0	0	0	0	1	0	1	2	1	0	8
30-Jun			2	1	0	2			1	0	0	1	0	1	0	0	2	0		10
7-Jul	0	0	2		0	2			0	0	1	0	0	0	0	0	0	0		5
14-Jul	0	0	2	2	0	2	0	0	0	0	4	0	0	0	0	0	0	0		10
21-Jul	0	0	1	1	0	4			0	0	2	1	0	0	0	0	2	0	1	12
28-Jul	0	0			1	3	0	1	0	0	1	0	0	0	0	0	4	0		10
4-Aug	0		1	1		3			0	0	4	0	0	0	1	1	2	0		13
11-Aug	0	0				2			0	0	3	0	0	0	0	0	2	1		8
19-Aug					0	2			0	0	1	0	0	0	2	0	2	1		8
26-Aug					0	0			0	0	0	0	0	0	1	0	2	0	0	3
Mean	0.21	0.00	0.75	1.25	0.14	0.92	0.11	0.2	0.08	0.04	0.77	0.54	0.04	0.12	0.17	0.08	2.60	0.13	0.20	6.65
SE	0.16	0.00	0.20	0.16	0.07	0.25	0.11	0.1	0.05	0.04	0.25	0.20	0.04	0.06	0.10	0.06	0.64	0.07	0.20	1.116

**APPENDIX B: Number of adult plovers seen per week on Refuge property.**

Week	Alviso											
	A8	A12	A13	Impoundment	A22	A23	N2	R1	R2	R3	R4	RSF2
3-Mar	9				29	0		0				5
10-Mar	18				0	0		17				6
17-Mar	14				0	0		0	2			11
24-Mar	15	0			0	0	0	6	0			3
31-Mar	9	0			0	17						7
6-Apr	5	0	0		1	7		12	0	2	2	1
14-Apr	6	2	0		3	6		4	0	17	1	6
21-Apr					10	6		18	12	6	4	1
28-Apr	6	1	2		7	7	1	9	6	2	3	6
5-May					5	2						1
12-May												
19-May	4	1	0		0	7		5	0			3
26-May	10	0	0		13	0		11	0			1
2-Jun	10	1	0		1	1	0	13	0	6	1	3
9-Jun	8	0	0		1	5		5	0	6	3	3
16-Jun	8	0	0					12	0	3	10	0
23-Jun	8	0	0					20	0			2
30-Jun	40	4		2	6			13	0			4
7-Jul	17				4	1	0	21	0			2
14-Jul	20			2	4			20	0			1
21-Jul	17	0	0	2	9	5		20	0	0	3	0
28-Jul	15	0	0	0	3	4		32	0			0
4-Aug	24	0	0	0				12	0	0	0	0
11-Aug	4-Aug	20	0	0	0	1	1	15	0			0
19-Aug	11-Aug		0					28	0			0
26-Aug	19-Aug	0	0	0				33	0			0
	26-Aug	28				3		30	0			0
Mean	14.14	0.50	0.14	0.86	4.85	3.79	0.25	14.83	0.91	4.67	3.00	2.54
SE	1.85	0.25	0.14	0.40	1.53	0.96	0.25	1.94	0.60	1.74	0.97	0.56

**APPENDIX C. Number of adult plovers seen per week on CDFG property (Eden Landing and Napa-Sonoma Marsh Wildlife Area)**

Week	E11	E12	E14	E15B	E16B	E3C	E4C	E5C	E6	E6A	E6B	E8	E8A	E8X	7 (Napa)	7A (Napa)
3-Mar	0	0	13	0	6	0	0	0		0	0	3	93	0		
10-Mar	0	0	9	0	0	0	0	0		0	0	5	35	0		
17-Mar	0	0	20	0	0	0	0	0		0	0	6	28	0		
24-Mar	0	0	48	0	2	5	0	0		0	0	0	46	0		
31-Mar	3	0	74	0	8	0	0	0		0	0	1	114	0		
6-Apr	8	0	30		11	0	1			0	0	0	50			
14-Apr	5	0	21		7	0	7	0	0	1	0	25	24			
21-Apr	0	18	22	0	2					1	0	3	48	0		
28-Apr	0	2	31	1	11	0	3	0		5	0	3	54	0	0	0
5-May	5	4	33	0	14								29	0		
12-May	2	11	25	1	3					0	0	6	24	0		
19-May	0	25	17	0	7					0	0	4	36	0	0	0
26-May	0	16	9	0	2	0	0	0	4				58	0		
2-Jun	1	15	6	0	1				0	0	15	17	35	0		
9-Jun	0	24	5	0	0	0	0	3	3	0	2	8	44	0		
16-Jun	1	20	0	0	0				3	0	8	13	77	0		
23-Jun	0	30	3	0	0				8	0	10	10	22	1	3	4
30-Jun	30	19	4	0	0				2	0	3	2	12	0		
7-Jul	4	23	2	0	0				2	0	5	4	24	0		
14-Jul	2	35	1	0	0				2	0	13	3				
21-Jul	0	33	12	0	0					0	18	0	89	0	9	8
28-Jul	0	15	6	0	0	0	0	2	0	0	8	1	57	0		
4-Aug	0	19	0	0	0	0	0	0		0	24	1	129	0		
11-Aug	0	24	5	0	0				0	0	23	2	176	1		
19-Aug	0	37	1	0	0				0	0	132	4	7	1		
26-Aug	0	49	0	0	0				0	0	90	0	31	0		74
Mean	2.35	16.12	15.27	0.08	2.85	0.42	0.92	0.45	1.85	0.29	14.63	5.04	53.68	0.13	3.00	17.20
SE	1.18	2.73	3.40	0.06	0.83	0.42	0.61	0.31	0.65	0.21	6.38	1.23	7.98	0.07	2.12	14.28