SAN FRANCISCO BAY
BIRD OBSERVATORY

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SERVICE
DEPARTMENT OF THE INTERIOR

Western Snowy Plover Numbers, Nesting Success, and Avian Predator Surveys in the San Francisco Bay, 2007.

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ABSTRACT

The 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 Department (HARD) and the East Bay Regional Parks District (EBRPD) formed snowy plover Recovery Unit 3. The goal of this collaboration was to monitor and manage the South San Francisco Bay's population of breeding western snowy plovers (*Charadrius alexandrinus nivosus*). In 2007, we recorded snowy plover numbers, nesting success, site use and avian predator numbers during the breeding season.

During the 2007 breeding season window survey of the Pacific coast (May 24 through June 7) we counted 207 adult plovers in the Bay, 7.43% of the total number of plovers (1537) counted on the Pacific Coast. This compared to 4.99% (72/1444) in 2003, 5.93% (113/1904) in 2004, 7.38% (124/1680) in 2005 and 5.28% (99/1874) in 2006. During our weekly surveys the total number of adult plovers recorded varied between 111 and 233, using totals from the two most comprehensive surveys (week starting June 24 and July 22 respectively).

We located a total of 89 nests within the study area. Within Refuge property, we located nine nests, on ponds A8, R1, R3 and RSF2. There were two nests on A8, both of which hatched (100%). Of the seven nests found on Ravenswood ponds, four hatched (57%), one was depredated (14%) and two were abandoned (29%). More plover nests were located in Ravenswood (n=7) than in recent years.

This year more plover nests were found at Eden Landing (n=80) compared to 2006 (n=70). Of the 80 nests we located at Eden Landing, 38 hatched (47%), 37 were depredated (46%), 3 were abandoned (4%), one was flooded (1%) and one had an unknown fate (1%).

At Eden Landing, the avian predator management program was continued. Avian predators of concern include common ravens, northern harriers, and California gulls among others. We observed three incidents of direct predation of plovers and plover nests this season: a common raven consumed a nest and northern harriers ate a chick and a nest. Mammalian predators targeted throughout the study area included feral cats, raccoons, skunks, and non-native red foxes.

This is the second year that CDFG managed ponds for plovers at Eden Landing. Water levels were drawn down in the managed ponds in February to create dry areas for plover nesting habitat while still maintaining some shallow flooded areas for migratory shorebird foraging. Due to minimal winter rainfall this year, many of the seasonal ponds were also dry at the beginning of the breeding season, providing additional early season nesting habitat. Plovers used both managed and seasonal ponds extensively.

The South Bay Salt Pond Restoration Project should continue to consider the habitat requirements of 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 population of the western snowy plover (*Charadrius alexandrinus nivosus*) was listed as a federally threatened species on March 5, 1993 (USFWS 1993). The Pacific coast population is thought to be distinct from the interior population and consists of the plovers breeding along or near tidal waters, including the San Francisco Bay salt ponds. The western snowy plover population has been in decline because of poor reproductive success due to habitat loss and degradation, human disturbance and increasing predator populations (Page et al. 1991).

In 2007, the United States Fish and Wildlife service finalized a western snowy plover recovery plan. This plan divided the coastal population into six recovery units. Recovery Unit 3 consists of the San Francisco Bay, including Napa, Alameda, Santa Clara and San Mateo counties. In 1992, the Don Edwards San Francisco Bay National Wildlife Refuge (Refuge) started monitoring snowy plovers on Refuge lands. The Refuge has five goals for their snowy plover monitoring and management program: 1) identify areas used by plovers for foraging, nesting and roosting, 2) estimate plover numbers, including breeding pairs, 3) evaluate nest success, 4) assess predation pressures on snowy plovers, 5) and protect snowy plover breeding areas from predators and other disturbances. The monitoring program was extended in 2000 to the California Department of Fish and Game's Eden Landing Ecological Reserve (CDFG, Eden Landing) due to the high numbers of plovers nesting at the site. Hayward Area Recreational District (HARD) and East Bay Regional Parks District (EBRPD) started monitoring their Hayward Shoreline property. The San Francisco Bay Bird Observatory (SFBBO) and the Refuge began a cooperative agreement monitoring suitable plover habitat in the South Bay in 2003 and have continued to work with the other partner agencies.

The Refuge and the U.S. Department of Agriculture – Wildlife Services (Wildlife Services) began a mammalian predator management program in 1991. This program targets predators of snowy plovers, the salt marsh harvest mouse (*Reithrodontomys reviventris*), and the California clapper rail (*Rallus longirostris obsoletus*). Mammals managed by this program include red fox (*Vulpes vulpes*), feral cats (*Felis felis*), skunks (*Mephitis mephitis*), and raccoons (*Procyon lotor*).

Snowy plovers in the San Francisco Bay are increasingly impacted by avian predators. The common raven (*Corvus corax*) population is increasing in the Bay Area and in other areas of California, partly due to increased food availability in urbanized areas (Boarman and Heinrich 1999). Common ravens are known to predate snowy plover eggs and chicks (Page 1990). Another avian predator of concern is the northern harrier (*Circus cyaneus*). Northern harriers nest in marshes and upland habitat adjacent to snowy plover ponds. Harriers were believed to be the main plover predator in the Salinas River National Wildlife Refuge in 1999 to 2001 (USFWS 2002). With the South Bay Salt Pond

Restoration Project plan to restore thousands of acres of salt ponds to tidal habitat, the population of harriers in the South Bay is expected to increase.

The South Bay's California gull (*Larus californicus*) population is growing exponentially. Gulls predate shorebird nests and chicks and may disturb nesting birds. They also have the potential to displace plovers and other ground-nesting birds from their nesting habitat within the salt ponds and on the levees (Ackerman et al. 2006).

Other avian predators of concern include American crow (*Corvus brachyrhnchos*), red-tailed hawk (*Buteo jamaicensis*), American kestrel (*Falco sparverius*), peregrine falcon (*Falco peregrinus*), white-tailed kite (*Elanus leucurus*), and loggerhead shrike (*Lanius ludovicianus*).

To reduce the impact of avian predators on snowy plovers at Eden Landing, CDFG directed Wildlife Services to begin conducting avian predator management in 2004. The effort was originally focused on reducing predation from crows and ravens. In 2006, management of northern harriers was initiated in response to high levels of plover nest predation. Currently, the avian predator management program focuses on reducing plover depredation from these three avian species that have been identified as the top plover predators at the site. Removal of avian predators takes place on CDFG property only.

In 2007, the Refuge, SFBBO, CDFG, HARD and EBRPD continued monitoring snowy plovers and avian predators in order to gain more information on the South Bay's snowy plover population and the predation pressure the plovers face. This report is a summary of the 2007 breeding season data, including the snowy plover surveys, nest monitoring, avian predator surveys and mammalian predator management programs. We also provide management recommendations for the South Bay Salt Pond Restoration Project.

STUDY AREA

We conducted snowy plover and predator surveys in the South San Francisco Bay salt ponds, where the majority of the Bay's plover nesting habitat exists. This area starts just north of the San Mateo Bridge and extends south to the extreme southern portion of the Bay (Figure 1). In the Napa ponds in the North Bay, the pond water management regime provides only a small amount of potential plover nesting habitat. No plovers were observed in this pond system during one visit in June.

Eden Landing, formally known as Baumberg, is managed by the CDFG and consists of 5,500 acres of salt ponds, marsh and tidal habitat. Eden Landing encompasses the area adjacent to the Bay from south of the San Mateo Bridge on the east side of the Bay, to the Alameda Flood Control Channel. Many of the salt ponds within Eden Landing have water control structures that allow management to enhance snowy plover nesting and foraging opportunities. In 2007, the two ponds that were managed for plovers were B8A and B14. Other ponds are managed as seasonal wetlands, filling with winter rains and drying during the warmer spring and summer months. Plovers nest in both managed and

seasonal ponds within Eden Landing. In 2007, we had additional personnel and were able to monitor all of the Eden Landing ponds weekly (Figures 2 and 3).

The Refuge encompasses approximately 30,000 acres of salt pond habitat, tidal marsh, mudflats and upland habitat in the South San Francisco Bay. In 2007, none of the Refuge ponds were specifically managed to provide snowy plover nesting and foraging habitat. For this study we divided the Refuge into six geographic areas: Alviso, Coyote Hills, Dumbarton, Mowry, Ravenswood and Warm Springs (Figure 1). Warm Springs (Figure 4), Alviso pond A8 (Figure 5), and parts of Ravenswood (Figure 6) were monitored weekly. We monitored the Dumbarton ponds, New Chicago Marsh and the impoundment in Alviso and the remainder of the Ravenswood ponds monthly. Coyote Hills was visited once during the breeding season window survey. We did not survey the Mowry ponds this year because we determined that there was no suitable plover habitat in that area due to current pond management.

Hayward Area Recreational Department owns the land directly north of Highway 92, which is co-managed by East Bay Regional Parks District. This area includes potential snowy plover nesting and foraging habitat in the Oliver Brothers North ponds OBN1-OBN17 and Frank Dump West. These ponds are currently managed as seasonal wetlands. Our volunteers surveyed the area monthly throughout the breeding season.

Figure 1: The Don Edwards San Francisco Bay National Wildlife Refuge, CDFG's Eden Landing, and HARD Hayward lands in the South San Francisco Bay.

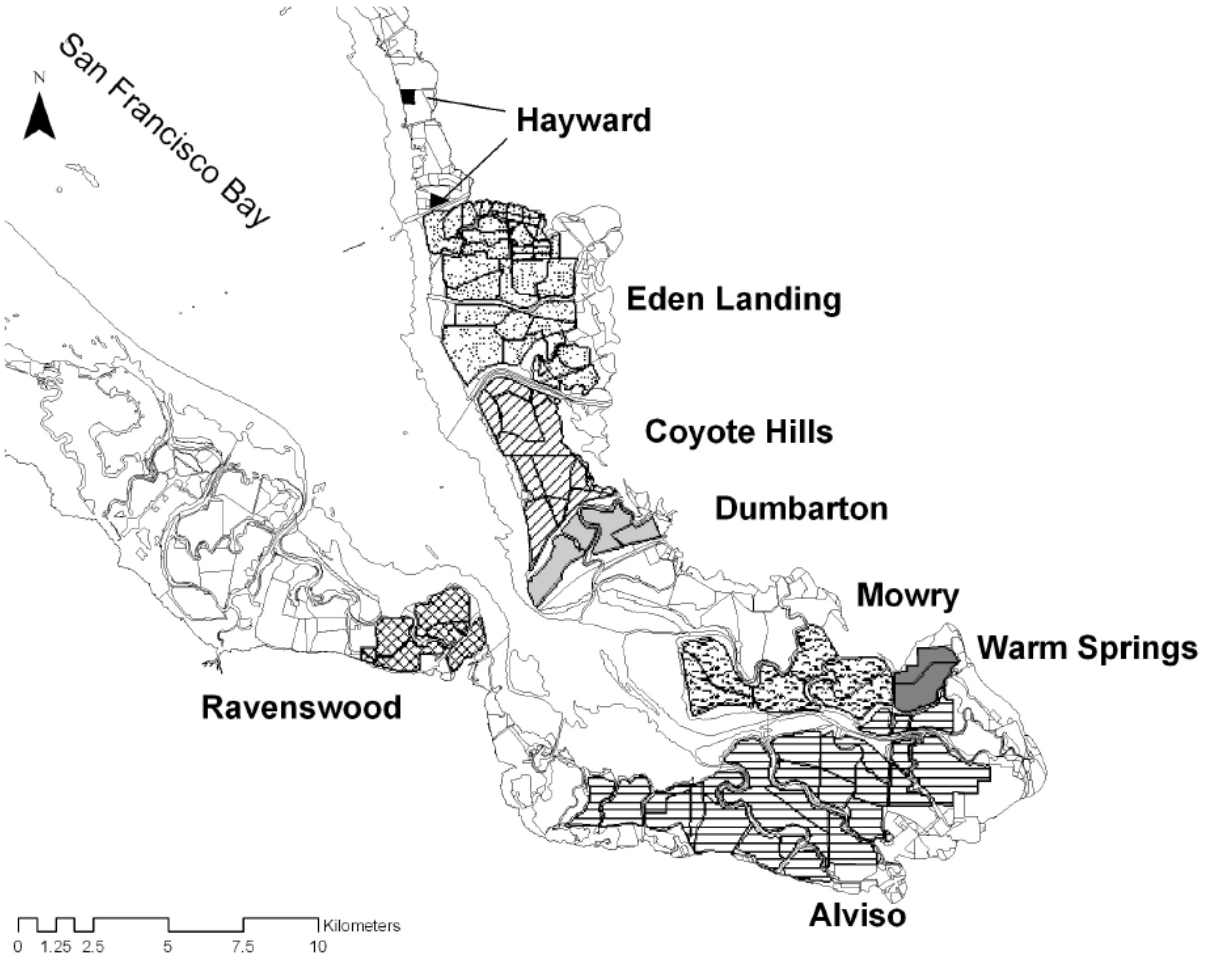


Figure 2: Salt ponds located in the northern part of Eden Landing, south of Highway 92 and north of Old Alameda Creek.

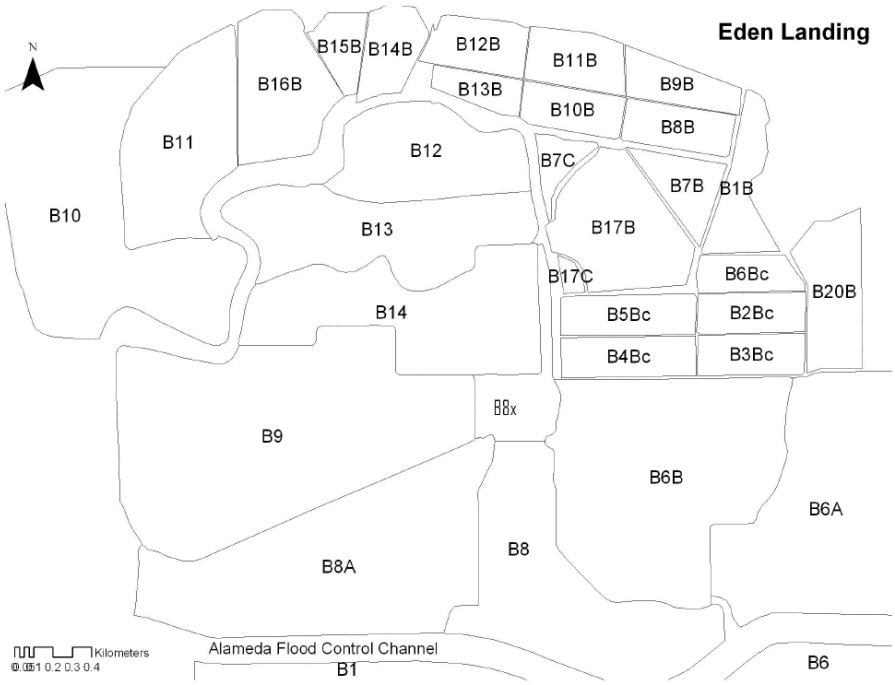


Figure 3: Salt ponds located in the southern part of Eden Landing, north of Alameda Flood Control Channel.

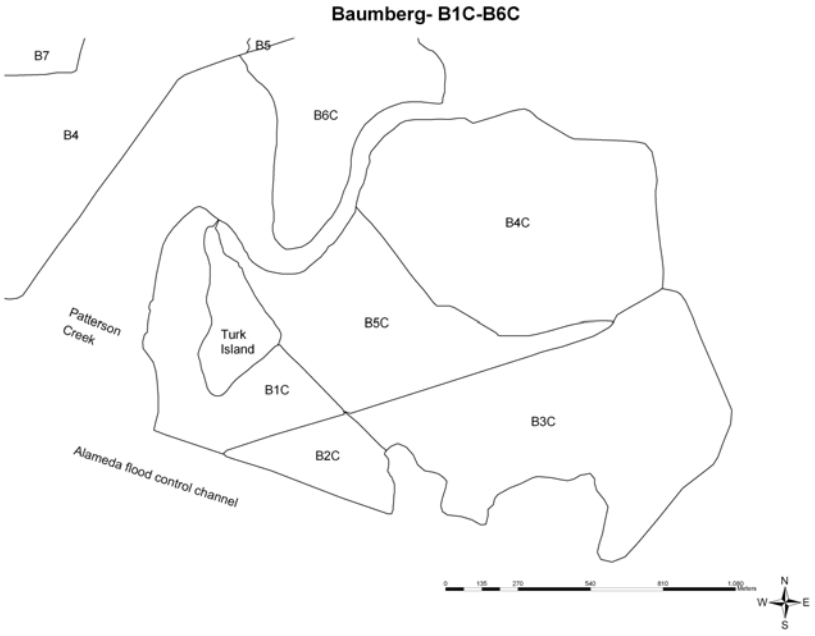


Figure 4: Salt ponds located in the Warm Springs area, near Fremont.

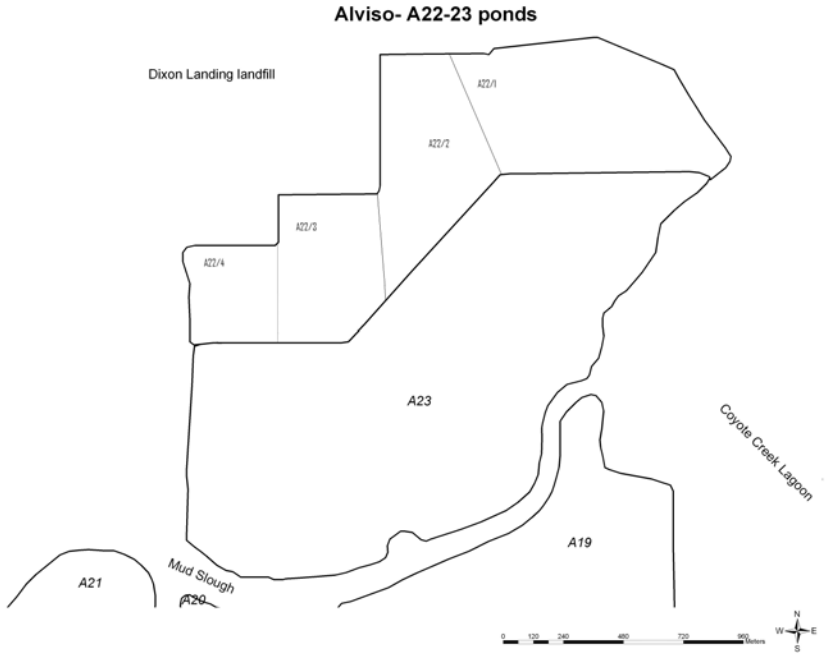


Figure 5: Salt ponds located in the Alviso area, at the southern end of the Bay.

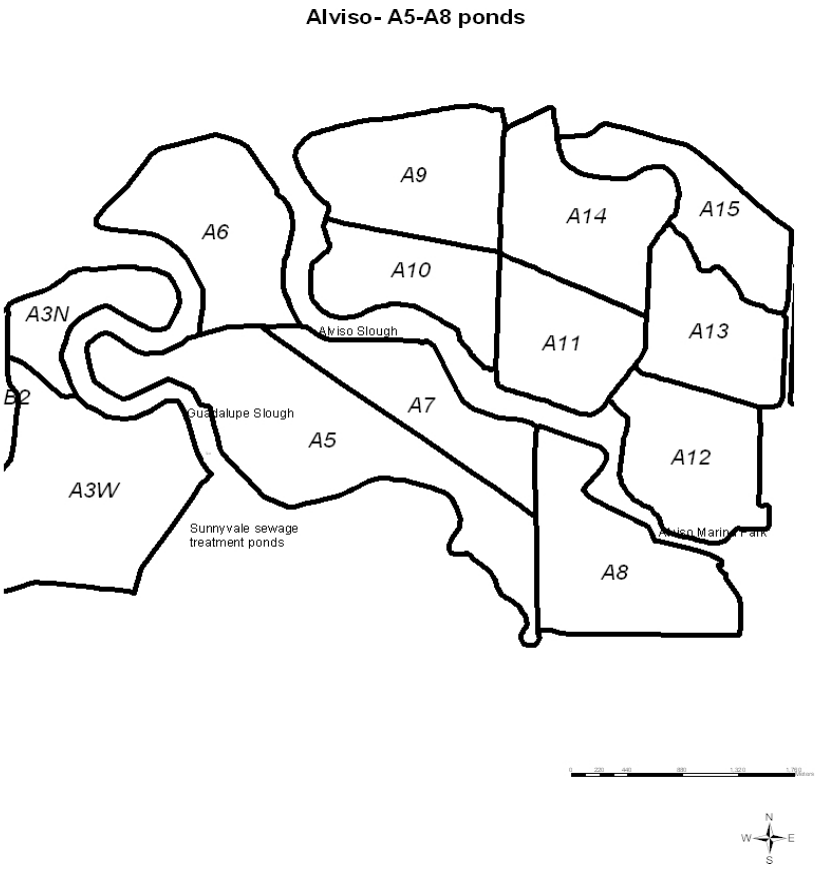
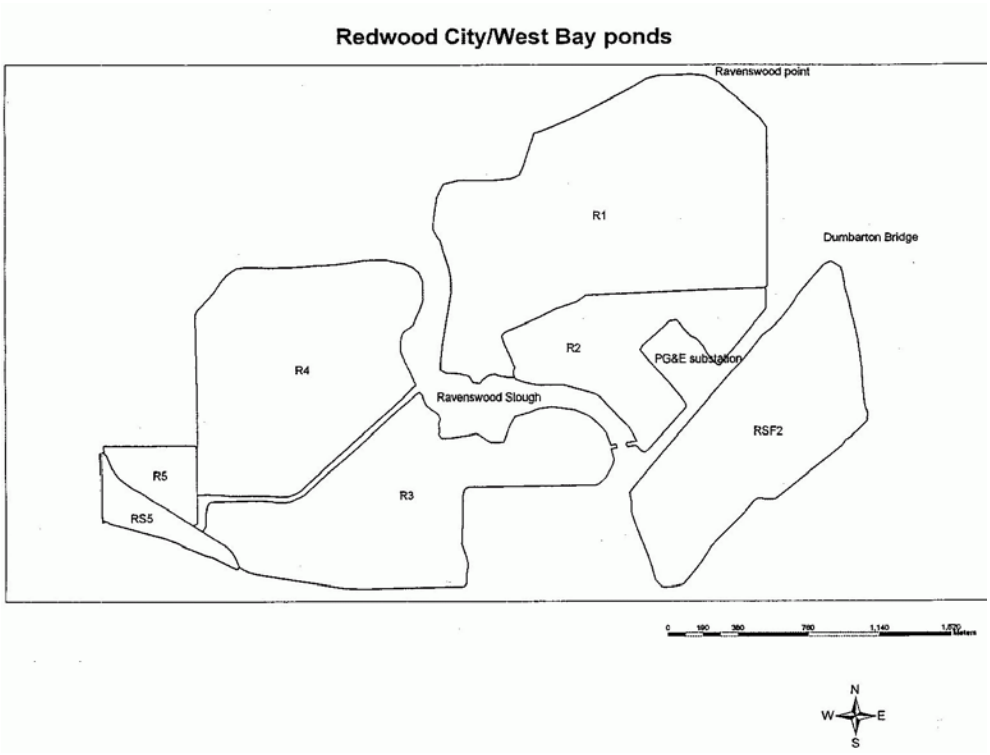


Figure 6: Salt ponds located in the Ravenswood area, at the west end of the Dumbarton Bridge.



METHODS

Adult and Nest Monitoring

In the San Francisco Bay, plovers nest predominantly on the bottom of dry salt ponds that are in close proximity to water-filled channels or other ponded areas which provide high-salinity foraging habitat. Plovers are site-faithful in choosing their nesting sites (Warriner et al. 1986) therefore; we monitor nesting in many of the same ponds every year. The water levels vary from year to year in many ponds and levels fluctuate throughout the season, leading to constantly changing foraging and nesting habitat quality. Therefore, as conditions change throughout the season, we monitor any additional areas that may provide suitable plover habitat.

The study sites were split into two categories: focus ponds and monthly survey ponds. SFBBO and Refuge biologists and interns surveyed the focus ponds every week from the beginning of March until the end of August. We were able to survey more ponds weekly in 2007 than in past years because of a larger field crew. We recorded the number of adult plovers as well as the number of nests and chicks in each pond. We also conducted avian predator surveys in plover breeding areas.

SFBBO staff and volunteers surveyed the monthly ponds, during the last weekend of every month. In 2007, we surveyed all areas monthly with the exception of the Coyote Hills ponds and the Mowry ponds. Coyote Hills was surveyed once in May and it did not have any dry habitat. We did not survey the Mowry ponds because they did not contain suitable plover nesting habitat. The monthly surveys were conducted with the same method as the weekly surveys.

In 2007, sixteen ponds were surveyed for plovers and avian predators on Refuge property, with seven ponds surveyed weekly as focus ponds and the remaining nine surveyed monthly. (Table 1). We surveyed seventeen ponds at Eden Landing, with ten surveyed weekly as focus ponds and seven ponds surveyed monthly (Table 2).

Volunteers, interns and biologists monitored the ponds by driving slowly on the levees surrounding the salt ponds and stopping every 0.3 miles to scan for plovers. Surveying ponds from inside the vehicle disturbs the plovers less so we limited walking surveys to where the levees were impassible by vehicles. During each survey, we scanned the ponds for plovers, recording the behavior of each plover, the leg band combination (if it was banded), and its location.

During the focus surveys, we watched plovers for 10 minutes if we suspected the plover was incubating a nest. Once we determined that a bird was most likely incubating a nest, biologists and interns searched the area where the bird appeared to be incubating. If an active nest was located, the position was recorded with a GPS unit. During the monthly surveys, volunteers did not search for potential nests, but instead marked the locations of possible nests on maps and described any nearby landmarks. Later, SFBBO and Refuge

biologists and interns searched for these potential nests. Volunteers did not approach nests or walk out onto ponds.

Table 1: Ponds surveyed within the Refuge. *Denotes focus ponds.

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

Table 2: Ponds surveyed within ELER. *Denotes focus ponds.

Location	Ponds
Eden Landing Ecological Reserve	B6, B6A*, B6B*, B8*, B8A*, B8X*, B9, B10, B11* B12*, B14*, B16B*, B1C, B2C, B3C, B4C*, B5C

Reproductive Success

Biologists and interns monitored nests weekly until we determined the fate of the nest and knew the number of eggs hatched. If the nest was not successful, we recorded the fate of the nest, either predated, abandoned, flooded or unknown. We were not able to monitor all nests due to the inaccessibility of some areas within the ponds. Nest success or egg hatching data for inaccessible nests were not included in this report because it was impossible to determine the number of eggs and nest fate.

Each nest that we visited was assigned a unique nest number using the pond number where the nest was located, followed by a sequential number (e.g. B12-1, B12-2, B12-3, etc.). The exact location of the nest was recorded with a GPS unit, either a Trimble® Geo XT or a Garmin® GPS 60. We recorded whether or not the nest was intact, the number of eggs or chicks in the nest, and whether there was an adult incubating or present in the area.

To estimate the age of the eggs and predict the hatch date, we floated the eggs (Hays and LeCroy1971). This involved placing the eggs individually in a container of room temperature water. We recorded the maximum diameter of exposed egg and the approximate angle of the floating egg. The angle recorded was the angle of the long axis of the egg to a horizontal line. We checked nests weekly to record nest status and float the eggs.

To determine the nest fate, we used the estimated hatch date, looked for chicks, and searched the nest scrape. When there were no longer eggs in the nest, we searched the scrape for small eggshell fragments that would indicate the nest hatched (Mabee 1997). If

no eggshell fragments were found we looked for other signs of predation such as yolk, large pieces of eggshell and disturbance in and around the nest scrape. If eggs disappeared more than two weeks before the estimated hatch date, and there were no eggshell fragments, we assumed the nest was predated. If eggs were present for more than a week after the estimated hatch date and there were no adults in the area or signs that the nest was being incubated, we recorded the nest as abandoned. Abandoned eggs were collected and transferred to U.S. Geological Survey staff for use in a contaminants analysis study.

If we observed chicks hatching or wet chicks in the nest, we recorded that date as the hatch date. If we visited a nest where the eggs were pipping, we considered the next day to be the hatch date. If we returned to a nest that had no eggs or chicks but evidence that it had hatched, we used the estimated hatch date from the egg floating data.

From the data we collected from floating the eggs we back-calculated the nest initiation dates for all the nests. Plover nests are active for an average of 33 days, from initiation to hatching (Page et al. 1995). This data was used to analyze peak nest initiation weeks.

We measured nest success, hatching success and Mayfield hatching success in the South Bay plover population. Nest success is defined as the percentage of total nests that hatched at least one egg. Hatching success is the percentage of eggs hatched per total eggs laid. 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 age at hatching (Mayfield 1961)).

Avian Predator Surveys

SFBBO and Refuge biologists and interns conducted weekly avian predator surveys on focus ponds and joined volunteers counting predators once a month on monthly ponds. These surveys were conducted to gauge the potential predator pressure on the nesting plovers and to focus predator management activities. Avian predators were defined as a species that could potentially prey on a snowy plover adult, chick or nest. The species recorded were: common ravens, American crowns, 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 (*Lanius ludovicianus*) and burrowing owls (*Athene cunicularia*). We conducted the surveys similarly to the snowy plover surveys: we stopped every 0.3 miles along the levee to survey for predators. We recorded the predator species present, number of individuals, their behavior and marked their location on a map. We also recorded any avian predator nests in the area and attempted to determine the nest fate. To compare the predators between areas and throughout the season, we used the average number of predators seen per week in each area. This number was calculated by dividing the total number of individuals seen in each area by the number of surveys conducted.

Predator Management Methods

The Refuge supervised and directed the predator management program that was conducted by Wildlife Services. Target mammalian predators were removed from Refuge property as well as Eden Landing and other adjacent properties. During the breeding season, efforts were focused in areas where plovers were breeding. The avian predator management program targeted individual ravens, crows, and northern harriers that were seen foraging in plover nesting ponds at Eden Landing. This management program also involved removal of avian predator nests on electrical transmission towers and in marshes near plover nesting areas.

Public Access

There is currently no public access allowed at Eden Landing. On Refuge property there is limited public access allowed near plover nesting areas: the northern levee by A22 in Warm Springs, levees around the Dumbarton ponds, a loop trail around R1 and R2 and the western side of R4 at Ravenswood. Public access is allowed around HARD property.

RESULTS

Overall Plover Numbers

During the 2007 breeding season window survey of the Pacific Coast (May 24 through June 7) we counted 207 plovers in the San Francisco Bay. This is 7.43% of the total number of plovers (1537) counted along the Pacific Coast.

The total number of individual plovers recorded was between 111 and 279, based on two of the most complete survey weeks. The numbers of plovers using individual ponds varied greatly throughout the season although we consistently saw the highest numbers of plovers at Eden Landing (Figures 7 and 8). The ponds with the highest mean number of plovers were B8A and B14, which were managed to enhance plover nesting and foraging habitat in 2007 (Appendix 1). Due to the lack of rainfall this spring, many of the seasonal ponds were partially dry at the beginning of the nesting season, providing additional nesting habitat early in the season. Plovers were also regularly seen on Refuge ponds A8, A22, A23, R1, R2, R3 and R4 (Appendix 1).

The ponds with the highest number of plover nests were B8A (26 nests), B12 (14 nests) and B14 (13 nests) (Table 3). Chicks were not always seen on ponds that had nests. For example we had 3 nests hatch on B11 and never observed any chicks on that pond. The highest number of chicks seen in the South Bay in one week was 25, on the week beginning July 1 (Appendix 2).

Table 3: Egg success in the South Bay, by pond.

Location	Number of Eggs	Eggs Hatched	% Hatched	Total nests
Eden landing				
B6B	7	5	71%	4
B8	10	3	30%	3
B8A	71	42	59%	26
B8X	14	3	21%	5
B11	18	7	39%	7
B12	33	23	70%	14
B14	35	6	17%	13
B16B	6	0	0%	2
B6	15	11	73%	5
Alviso				
A8	6	6	100%	2
Ravenswood				
R1	12	5	42%	4
R3	6	3	50%	2
RSF2	3	3	100%	1
Total South Bay	236	117	50%	88

Refuge

Alviso pond A8 and the Ravenswood ponds had the highest number of plovers on the Refuge with the mean number of adults seen per survey of 12.77 and 11.82, respectively. The plovers in Ravenswood were concentrated on pond R1 with an average of 7.5 adults seen per survey. We saw plovers on both A22 and A23 at Warm Springs but never in large numbers (Mean: 2.75 on A22; 0.88 on A23) (Appendix 1). Plovers were sporadically seen foraging at New Chicago Marsh in Alviso.

Eden Landing

Eden Landing had the highest number of plovers all season with an average of 137 adults seen per week. We observed plovers on all ponds except B1C, B2C and B5C. Throughout the season, ponds B8A and B14 had the highest consistent use with a mean of 44.2 and 43.2 adults seen per survey, respectively (Appendix 1). These ponds were managed to have dry areas that supported nesting and nearby water for foraging birds.

During a majority of the plover nesting season, water management did not occur in ponds B6A, B6B and B8 due to danger of flooding plover nests. As a result, these ponds dried throughout the season and plover use decreased steadily. When water was added to the ponds near the end of the season, we observed large groups of plovers roosting and foraging near the water.

Hayward Shoreline

One plover was seen in the Hayward ponds in April and May. We observed eight plovers there in June. A plover with chicks was reported on pond OBN-15 during the week of 24 June.

Table 4: Summary statistics of plover numbers by area.

Location	Statistic	Males	Females	Unknown Adults	All Adults	Juveniles	Chicks	Juveniles and chicks
Alviso	Mean (n=18)	2.22	1.33	9.22	12.78	0.11	1.06	1.17
Dumbarton	Mean (n=4)	0.25	0.50	0.5	1.25	0.00	0.00	0.00
Eden Landing	Mean (n=27)	36.74	23.11	73.37	137.04	1.19	4.85	6.04
Hayward	Mean (n=7)	0.29	0.14	1.29	1.71	0.43	0.29	0.71
Ravenswood	Mean (n=17)	4.88	2.59	4.35	11.82	0.41	3.59	4.00
Warm Springs	Mean (n=24)	1.42	0.50	1.71	3.63	0.08	1.29	1.38
Alviso	Std Error	0.76	0.35	2.08	1.90	0.11	0.47	0.51
Dumbarton	Std Error	0.25	0.29	0.5	0.75	0.00	0.00	0.00
Eden Landing	Std Error	3.73	2.92	10.78	10.67	0.49	0.97	1.21
Hayward	Std Error	0.18	0.14	0.97	1.08	0.43	0.29	0.47
Ravenswood	Std Error	0.93	0.18	0.87	1.89	0.12	0.69	0.72
Warm Springs	Std Error	0.34	0.16	0.51	0.72	0.08	0.48	0.50

Figure 7: Sum of snowy plover adults by week and area. The circled points represent incomplete surveys of the area.

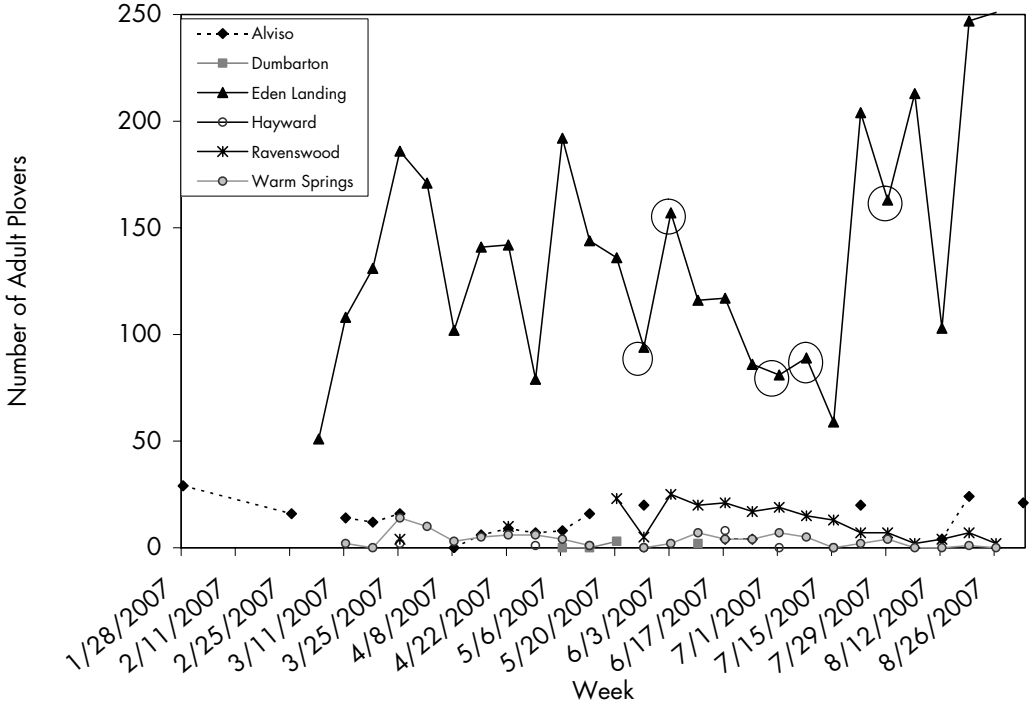
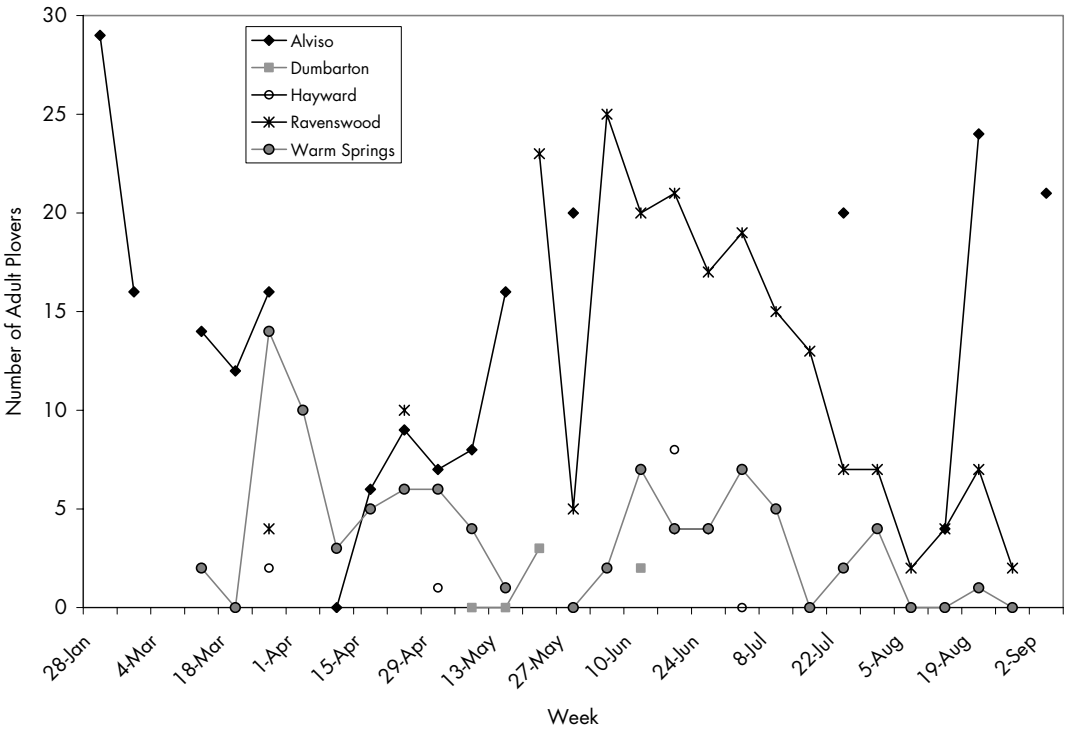


Figure 8: Sum of snowy plover adults by week and area, not including Eden Landing.



Banded Bird Re-sightings

We observed three banded plovers this season. On March 30th we saw bird o/w:a/w on pond RSF2. This bird was banded as a chick in 2005 at Salinas NWR. On April 18, we saw bird o/g:y/o on pond B16B, that had been hatched and released from the Monterey Bay Aquarium in 2003. We observed bird y/y:w/g twice on pond B14. This bird was present for our April 19th and 25th surveys and was banded as an adult in 2006 at Fort Ord.

Reproductive Success

Refuge

We monitored nine nests on Refuge property, two nests on A8 south in Alviso, four nests on R1, two nests on R3 and one nest on RSF2 at Ravenswood (Table 5). Both of the monitored nests in Alviso, with 3 eggs each, hatched (100%). Four of the Ravenswood nests hatched (57% for Ravenswood), one was depredated (14%), and two were abandoned (29%) (Table 4). One egg disappeared from one of the R1 nests, and the adult abandoned the nest. The cause of the other nest abandonment was unknown. Out of the 27 eggs found on the Refuge, 17 (63%) hatched (Table 3).

We did not find any nests at Warm Springs but we observed at least four separate broods, suggesting that we missed at least four nests on A22 and A23. One snowy plover nest was observed on Dumbarton (pond N1). This nest was inaccessible and the fate is not known. It was not included in the nest data. We also observed additional broods from nests we did not monitor in R1 (3 broods), R4 (2 broods) and A8 (4 broods).

Eden Landing

We monitored 80 nests in eight ponds. Two nest cards were lost due to a car accident during the breeding season, and some of the data from those nests were not used in all of the analyses.

Of these nests, 38 hatched (47.5%), 37 were depredated (46.2%), 3 were abandoned (3.75%), 1 was flooded (1.25%) and 1 had an unknown fate (1.25%) (Table 5). We found and monitored 26 nests on B8A. In addition, it is likely that there were at least five more successful nests on this pond that we never found because several times we observed and recorded chicks of ages that did not correspond to those of monitored nests. The flooded nest and the nests with the unknown fate were both on B8A (Table 5). The nest with the unknown fate was the first nest we found this season, but we could not relocate the scrape on a subsequent visit to verify the fate. However, we suspect it was depredated because when we first located the nest it had one egg, and the following week we could not find any eggs or a scrape in the area.

Of the 195 eggs we found at Eden Landing, 97 (50%) of them hatched (Table 3).

South Bay Overall

We monitored 89 nests this season in the entire study area. Forty-four of the nests hatched, 38 were depredated, 5 were abandoned, 1 was flooded, and 1 had an unknown nest fate (Table 5). One hundred and seventeen chicks hatched, however we do not band chicks and have no information on chick survival or fledging success.

Mayfield Estimates

We observed 2085 nest exposure days. Forty-one of our nests were lost due to predation, abandonment or flooding. Therefore, mortality was 41/2085 or 0.019. Survival was calculated as 1 – 0.019 or 0.980. Therefore, the probability that a nest survived the 33 days between nest initiation and hatching was $0.980^{41} = 0.509$.

Table 5: Hatching success of all known-fate nests in the South Bay, by pond.

Location	Hatched	Predated	Abandoned	Flooded	Unknown	Total nests
Alviso						0
A8	2					2
Eden Landing						0
B6B	2	1	1			4
B8	1	3				4
B8A	16	8		1	1	26
B8X	1	4				5
B11	3	3	1			7
B12	9	5				14
B14	2	10	1			13
B16B		2				2
B6	4	1				5
Ravenswood						0
R1	2	1	1			4
R3	1		1			2
RSF2	1					1
Total South Bay	44	38	5	1	1	89

Nest Density and Breeding Chronology

To determine the nest density in each pond, we divided the number of nests in the pond by the pond acreage. The pond with the highest nest density was pond B8A (0.1 nests per acre; Tables 6 and 7).

The peak nest initiation week in the South Bay was June 24. We had two waves of nest initiation this season. The first wave peaked the weeks of April 4th and April 29 with 8

nests initiated in each of these weeks (Figure 9). The second wave peaked the week of June 24, with 12 nests initiated that week.

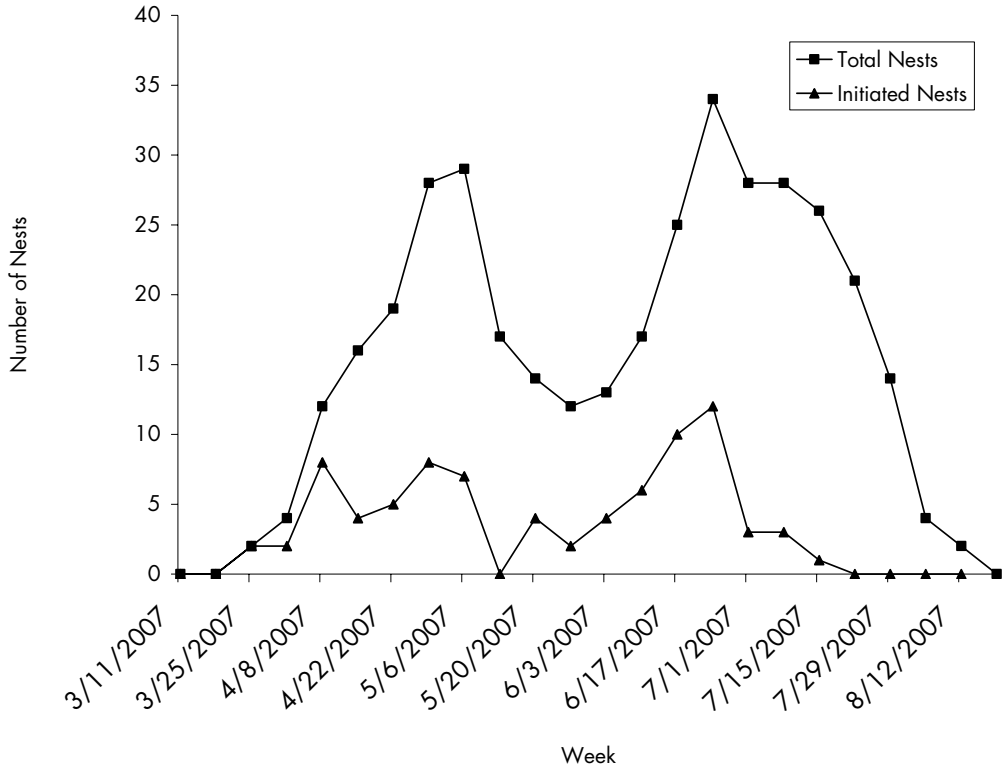
Table 6: Nest densities within each pond, per acre on Refuge property.

Refuge				
Nests per acre	A8	R1	R3	RSF2
	0.005	0.01	0.0073	0.0041

Table 7: Nest densities within each pond, per acre at Eden Landing.

Eden Landing									
Nests per acre	B6B	B8	B8A	B8X	B11	B12	B14	B16B	B6
	0.01	0.02	0.10	0.42	0.05	0.06	0.08	0.07	0.02841

Figure 9: Number of initiated and active nests per week for entire South Bay.



Avian Predators

Refuge

The most commonly seen avian predators at Alviso were California gulls (Table 8). The colony on pond A6 hosted approximately 24,696 breeding adults this year (SFBBO, unpublished data). Other predators in the pond complex were common ravens, great and snowy egrets, peregrine falcons and red-tailed hawks. We observed one common raven nest in the power towers north of pond A6. There were two harrier nests found in Guadalupe Slough and two found in Alviso Slough.

California gulls and unidentified gulls were the most commonly seen predators at Warm Springs (Table 8). In the beginning of the season thousands of gulls roosted on the levee between A22 and A23. Throughout the season, there was a constant stream of gulls traveling to and from the Newby Island landfill and the Tri-City landfill over the Warm Springs ponds. Ponds A22 and A23 are located close the Mowry colony with 7384 individuals nesting there (SFBBO unpub.data). We also observed high numbers of common ravens throughout the season with an average of 25.4 ravens per survey. There was one common raven nest in the PG&E tower just north of A22. Red-tailed hawks also nested in the PG&E towers. We regularly saw a pair of American kestrels by the north side of A22 but never located a nest. A loggerhead shrike was often seen along the north side of A22, perched on the barbed wire fence and power line. We searched the barbed wire fence for evidence of the shrike taking plover chicks but did not find any.

Unidentified gulls were the most frequently seen predator at Ravenswood (Table 8). We also observed American crows and common ravens feeding near the Sun Microsystems business park on the southwest side of the complex. Northern harriers were frequently seen hunting the marsh north of the ponds and we watched the female take two California ground squirrels.

Gulls were also the most common predator at the Dumbarton ponds. Red-tailed hawks were also observed perched near or in the ponds. We observed one American crow in pond N1.

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

Eden Landing

The predominant avian predators seen at Eden Landing were California gulls and unidentified gulls (Table 8). We also observed northern harriers, common ravens, snowy egrets and great blue herons. Just south of Eden Landing, approximately 4,384 gulls nested at the Coyote Hills California gull colony (SFBBO unpub.data). We noticed a

huge increase in the number of gulls at Eden Landing around the first week in June. The number of gulls increased from under 20 observed weekly to over 100 observed most weeks. They roosted on B6A, B8A, B9 and B14: however, we did not see any gulls nesting at Eden Landing. On B9, their numbers ranged from 78 during the week of 11 June to 755 during the week of 28 August.

We observed groups of two to three common ravens throughout the season. They were usually hunting along the levees near Old Alameda Creek, Whale's Tail Marsh and the newly tidal area just east of B12 and B14.

Northern harriers were frequently seen hunting in the marshes and ponds at B6B, B8, B8A, B8X, B12 and B14. This season we located four northern harrier nests at Eden Landing. Two nests were found in Old Alameda Creek, one by the tide gates near pond B6A and one by the mouth of the creek. We also located one nest in the diked pickleweed marsh north of B6A and one along Alameda Flood Control Channel. We observed two incidents of direct predation by harriers, discussed in the direct avian predation section below.

We did not locate any red-tailed hawk nests at Eden Landing, though we did see them regularly roosting on the power poles near Old Alameda Creek and on the power towers near the old crystallizer ponds east of B12 and B14. A peregrine falcon consistently hunted ponds B6B, B12 and B8A. It usually perched on posts throughout the pond. White-tailed kites were seen near Mt. Eden Creek, perched on debris in the marsh and on the power poles near the creek. A burrowing owl burrow was found on the east side of Old Alameda Creek by B6A. We examined the feathers outside the burrow and found no evidence that they depredated plovers. We later found a large burrowing owl feather spot near the burrow and never saw live owls there again.

The old hunting blind, referred to as the "heron house", on B6B that has supported great blue heron nests in the past is slowly collapsing. There were six nests on it this year, a decrease from 12 last year. Likely, in response to the "heron house" collapse, the herons nested on hunting blinds in B9, B12 and B14. We counted a total of 17 heron nests at Eden Landing.

Table 8: Mean number of predators per survey in each area (not including the Alviso California gull colony).

	Species	Alviso	Dumbarton	Eden Landing	Hayward	Ravenswood	Warm Springs
Predators of Concern	Northern harrier	3.63		1.21	0.02	0.89	0.88
	Common raven	5.11		0.43	0.01	1.22	25.42
	Peregrine falcon	0.68		0.12		0.11	0.04
	American crow		1	0.04		2.11	0.04
	White-tailed kite	0.58		0.24		0.22	0.04
	American kestrel	0.11		0.09			0.71
	Red-tailed hawk	0.68	3	0.91	0.02	1.50	2.00
Other Predators	California gull	3093.16	50	1.91	0.04	0.56	
	Other gull	343.47		67.03	1.37	33.83	1225.21
	Ring-billed gull	0.89		0.11			
	Western gull	2.00		0.02			
	Black-crowned night heron	4.11		2.29	0.05	0.06	0.21
	Great blue heron	7.84		3.23	0.07	0.67	0.00
	Snowy egret	84.05		13.64	0.28	8.39	0.54
	Great egret	43.00	1	9.74	0.20	4.44	0.29
	Loggerhead shrike	0.11		0.08			0.29
	Merlin	0.05		0.01			
	Golden eagle						0.21
	Number of Surveys	19.00	1	92	7	18	24

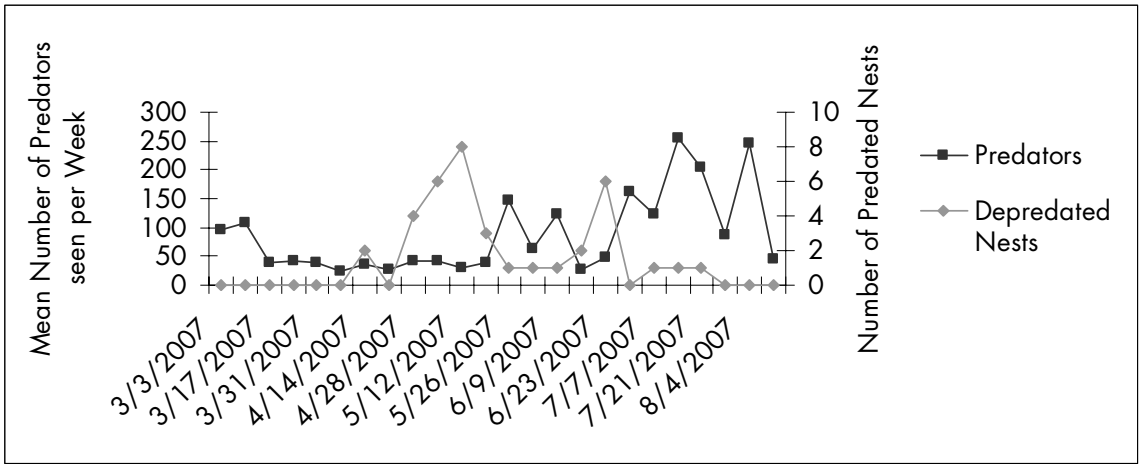
Hayward Shoreline

Unidentified gulls were the most frequently seen predator at Hayward Shoreline. We also observed northern harriers and suspect they nested in the marsh near the ponds (Table 8).

Predator Pressure on Plovers

In 2007, there was no correlation between the number of predators seen per survey in the South Bay (Table 8) and the number of predated nests (Table 5) ($p = 0.416$, $r=-0.136$). There was no significant correlation between the number of predators seen per survey at Eden Landing and the number of predated nests ($p = 0.135$, $r=-0.314$), as shown in Figure 10.

Figure 10. The mean number of predators per week and the number of depredated nests at Eden Landing.



Direct Avian Predation

We observed three direct avian depredations in 2007. On May 15th we observed a female northern harrier depredate a snowy plover nest on pond B8A. We went out to the nest and found yolk and blood in the scrape. There was also a spot of yolk approximately 10 cm outside of the scrape. We found small eggshell pieces inside the scrape; all had a diameter of less than 3 mm.

We observed another northern harrier eat a plover chick on B8A on June 25th. The chick was approximately two to three weeks old. The harrier was flying east, hunting low over B8A. After we observed the harrier take the chick, it landed on the pond to eat the bird. We then went out onto the pond and found the feather spot left by the depredated chick.

During the first week in July, we saw a common raven depredate a plover nest on pond B6.

Mammalian Predators

As part of the mammalian predator management program, Wildlife Services conducts daytime scouting and night-time spotlighting. No additional mammalian predator surveys were conducted by SFBBO or Refuge personnel at the Refuge or at Eden Landing; however we did see and record mammals opportunistically during snowy plover and avian predator surveys in these areas. A grey fox was seen on Refuge property by A8. At Eden Landing, we regularly saw a grey fox and her two kits on the machinery parked by Mt Eden Creek. In April, we found a tan pitbull between ponds B6B and B8 and returned it to its owner. Feral cats were seen near the north gate (Eden Landing Road entrance) and by the B12 pump house. A feral cat feeding station set up by a community member outside the Veasy Street gate at the east entrance to Eden Landing included a

large pile of dry cat food and many cans of food. Cats were frequently observed at the feeding station. Skunks were seen near Old Alameda Creek and a raccoon was seen foraging in the creek channel.

DISCUSSION

Plover Numbers

It is very difficult to estimate exactly the number of breeding snowy plovers in the San Francisco Bay due to the lack of banded birds, and the fact that single surveys of areas take several days to complete. A rough estimate of the number of snowy plovers would be 207, based on a complete survey done during breeding window survey conducted the last week of May.

In 2007, we observed higher mean numbers of plovers at Eden landing and Ravenswood than in 2006. Mean numbers of plovers in Alviso, Warm Springs, Dumbarton and Hayward Shoreline declined slightly from last year. The higher number of plovers recorded at Ravenswood in 2007 may partially be due to increased survey frequency at ponds R1-R5 this year (bi-weekly) compared to 2006 (monthly). This observed change in plover use could also reflect differences in plover use and habitat quality in these ponds from year to year. All of these ponds were managed as seasonal (dry) ponds in 2007.

Few plovers used the salt ponds at Hayward this year for foraging although there was at least one nest; our volunteer observed a male and chicks at this site. This year tidal water did not overtop the levees as they have in years past. However, until water levels can be managed more effectively for nesting plovers, the area should be managed for foraging non-breeding snowy plovers and shorebirds to avoid flooding nests.

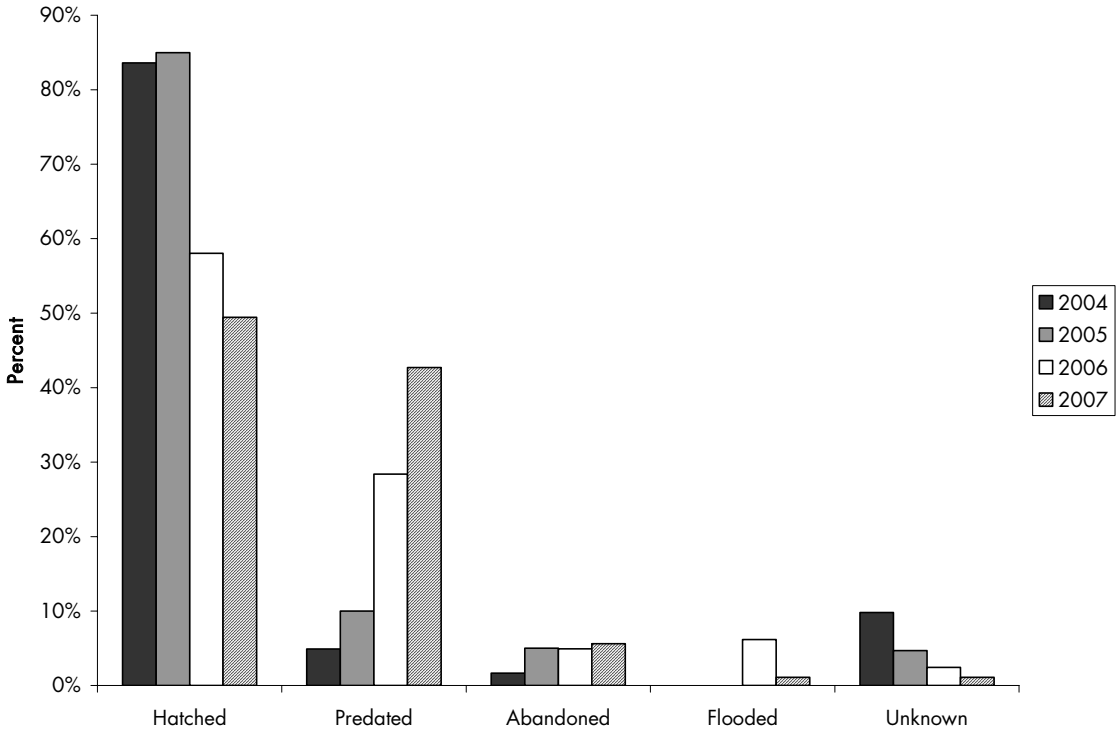
Reproductive Success

We found a similar number of nests in the South Bay this year (89 nests) as in 2006 (81 nests). The number of nests found on Refuge property decreased slightly from 11 nests in 2006 to 9 nests in 2007. The number of nests at Eden Landing increased from 70 nests in 2006 to 80 in 2007.

As shown in Figure 11, nest success in the South Bay decreased from 58% in 2006 to 49.4% in 2007. There has been a fairly steady decline in nest success since 2004 and 2005 when it was 83.6% and 84% respectively (Robinson et al 2007, Strong et al. 2004, Tucci and Strong 2006). Thirty-seven nests were depredated this year, compared to 23 in 2006. Because there was usually no sign of predation other than missing eggs at depredated nests, we have no way of positively identifying the predators. The ground on the salt ponds is hard-packed and no tracks were found around depredated nests. At a few depredated nests we found broken egg shells covered in yolk. We have no way of quantifying predator impact on chicks and adults because we do not band plovers.

Similar to 2006, we had two "waves" of nesting plovers in 2007. This second wave of nesting likely represents second clutches of early nesting birds in the area and, to a lesser extent, plovers coming into the South San Francisco Bay from elsewhere during the latter part of the breeding season.

Figure 11. Percentage of Nest fates in the South Bay in 2004, 2005, 2006 and 2007 in all areas.



In 2007, plovers nested on more ponds than they have in the past two breeding seasons. They nested on five ponds in the Refuge area (A8, A22, R1, R3 and RSF2). This year the two monitored nests at A8 were both in the southern portion of the pond, located in an old mussel bed near the small channel of water in the western end of the pond. We observed at least two other nests in the main portion of the pond but they were never visited. Although both nests we monitored hatched, the California gull colony north of A8 in pond A6 could have a significant impact on any nesting plovers in the Alviso pond complex.

The Ravenswood ponds were surveyed regularly this nesting season, starting at the end of May. This year we monitored seven nests at Ravenswood. In 2006, volunteers located one potential nest, but no nests were monitored. Since the borrow ditches in the Ravenswood ponds are mostly steep-sided, there is often a very steep drop off from the pond bottoms into the borrow ditches when low water levels occur in the ponds. This is not ideal foraging habitat for plovers and may limit the number of plovers using the complex. In order to enhance plover nesting and foraging habitat in these ponds, water

levels should be managed to maintain a mosaic of wet and dry areas in each pond throughout the breeding season.

We observed adults and broods in Warm Springs' ponds A22 and A23; however, we never located any nests in the ponds. The plovers were primarily in the western section of A22 and in the northwest corner of A23. A large amount of vegetation is growing in pond A22 and this may limit the numbers of plovers using this pond. Pond A23 was dry from the beginning of the season and the northwestern corner may have supported nesting plovers. The large numbers of common ravens and California gulls in the Warm Springs area are a potential source of predation on nesting plovers. Ponds A22 and A23 are located between two large landfills and there is a constant stream of gulls flying between the landfills. Starting in July, groups of over 30 ravens were seen foraging and roosting in the western part of A22 and the adjacent vernal pool area.

At Eden Landing, plovers nested on nine ponds. The highest numbers of nests were on B8A, B12 and B14. The highest number of chicks was seen on B8A and B14. Both of these ponds were heavily used by foraging plovers throughout the season. B8A always had water in the borrow ditches and parts of the flat pond "bottom" were flooded throughout the season. This created the mosaic of dry and wet areas that plovers seem to prefer for nesting and foraging. B14 had water in the borrow ditch throughout the season and the eastern end was flooded a few times. The ground slopes gradually into the borrow ditch and makes foraging easy near the water.

This is the second year that CDFG actively managed pond water levels for nesting plovers at Eden Landing as part of the South Bay Salt Pond Restoration Project. In 2007, the two ponds managed for plovers were B8A and B14. Water levels were drawn down in February to create dry areas for plovers to nest. Ponds are managed to have a mosaic of dry nesting habitat and shallowly flooded areas for migratory shorebirds and plovers to forage. Although active water management was also planned for ponds B6B and B8, these ponds were effectively managed as seasonal ponds most of the year due to the danger of flooding low elevation plover nests initiated early in the breeding season. Plovers also nest in ponds that dry out seasonally, and have large areas of dry land exposed. The seasonal ponds that plovers nested in this year were B6, B6B, B8, B8X, B11, B16B, B12 and B13.

In 2006, the actively managed ponds were the first areas that plovers nested because they were some of the only dry areas available. This year we had very little winter rainfall and many of the seasonal ponds were dry at the beginning of the nesting season. As a result, plovers nested in numerous ponds early in the season, including both seasonal and managed ponds. The first ponds that plovers nested were B8A, B8X and B14. They also nested early in B11, B16B, B8 and B6B. The number of nests in B8A and B14 was fairly consistent throughout the season, Plovers abandoned B8X after four of the five nests were depredated early in the season. The two nests in B16B were depredated as well and plovers did not use the pond after the predation event.

Plover use of B6B and B8 was low this season compared to the 2006 breeding season, when both ponds were heavily used for nesting and foraging. Two factors likely contribute to this change in plover use between the two years: depredation of the first nests of the season may have caused plovers to abandon the area and lack of sufficient water in the ponds may have discouraged nesting. When ponds are very dry or when water is stagnant, ponds may not possess sufficient high quality foraging areas adjacent to nesting habitat that is preferred by plovers.

Similar to last year's breeding season, pond B12 dried throughout the season and provided nesting habitat for the second "wave" of nests that started in mid-June. Plovers first nested on the berms that run through the pond but as the pond dried, they nested on the pond bottom. Many of these early nests on the berms were depredated, probably because the linear berms are easy features for predators to hunt along.

Mid-season, plovers nested in the dry dredge lock on the north side of pond B6. Inside the dredge lock, there was enough dry beach habitat to support six plover nests. The plovers were often seen foraging on the raised berm forming the lock.

Restoration and Snowy Plover Nesting Success

The Bay's snowy plover nesting habitat is predominantly located within the South Bay Salt Pond Restoration Project area (the Project). The Project will restore large areas of former salt ponds to tidal habitat and will manage other former salt ponds as snowy plovers nesting habitat or as waterbird foraging habitat during migration and winter. The former salt ponds can be managed to provide habitat that is critical for the nesting plover population in the Bay. During restoration and management activities, the Project should work carefully to maintain enough habitat to support the existing population and begin implementing recovery actions for the species.

Ponds managed for plovers should be located in various parts of the Bay and locations should vary from year to year. This management style may help reduce predation levels by changing predator foraging areas yearly. Individual predators may be prevented from "learning" the locations of plover ponds and teaching their offspring to hunt these plover ponds as well.

The plovers in the San Francisco Bay seem to prefer to nest in dry salt ponds on large, open salt pan areas located near foraging habitat. This type of habitat should be actively managed and maintained in the future as the primary nesting habitat, unless research indicates that the Bay's plovers are able to nest successfully on created islands or other features.

Another goal of the Project is to increase public access to certain areas. This includes establishing public use trails at Eden Landing and in other areas. In order to minimize disturbance to plovers, public access should be limited or prohibited on trails adjacent to plover nesting ponds during the breeding season. Additional fencing or barriers may need

to be constructed to prohibit pedestrians from entering sensitive closed areas to limit human disturbance.

Avian Predators

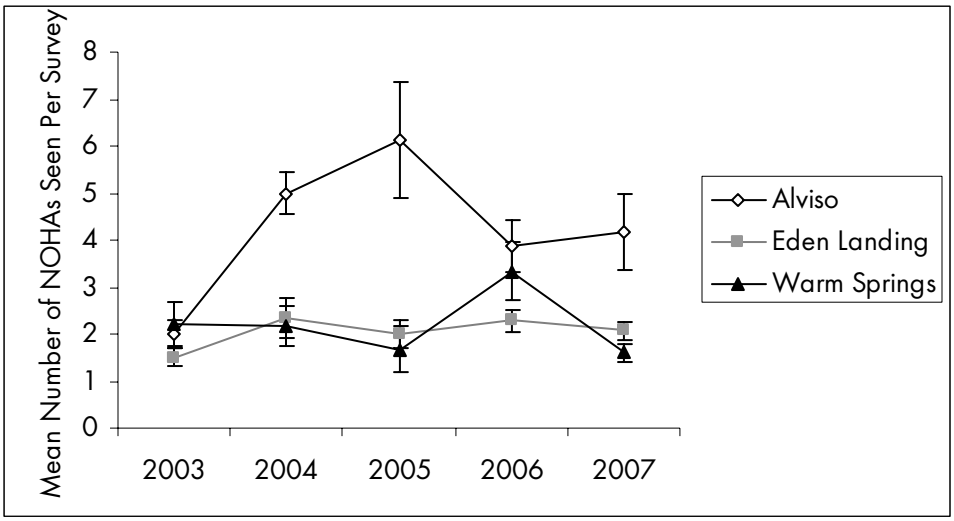
Northern harriers remain one of our primary snowy plover predators of concern. We witnessed two accounts of direct predation by harriers on pond B8A, one of a nest and one of a chick. Eight of the 26 nests on that pond were depredated. Throughout the season we saw numerous small chicks on this pond but observed very few large chicks, suggesting that many chicks were depredated prior to fledging. Individual harriers were frequently seen hunting the snowy plover nesting ponds and the levees surrounding the ponds at Eden Landing. We observed harriers flying from Whale's Tail Marsh, over B14 to hunt by B6B and B8. Subsequently, 10 of the 13 nests in B14 were depredated.

Over the past five years, the mean number of harriers seen per survey at Eden Landing has remained relatively constant (Figure 12). The number of harriers in Alviso peaked in 2005 and remained relatively constant in 2006 and 2007, at around 4 harriers per survey. We observed the highest numbers of harriers at Warm Springs in 2006 when an average of 3.3 harriers were seen per survey. In 2007, that number dropped to 1.6 harriers per survey, which is close to the 2003-2005 numbers.

The restoration of marsh habitat in the future will increase the potential northern harrier nesting habitat in the South Bay. Local populations of harriers are likely to increase and this may result in higher predation pressure on adjacent salt pond nesting birds such as snowy plovers. Further investigations will be necessary to examine how to manage snowy plovers and northern harriers at a landscape level.

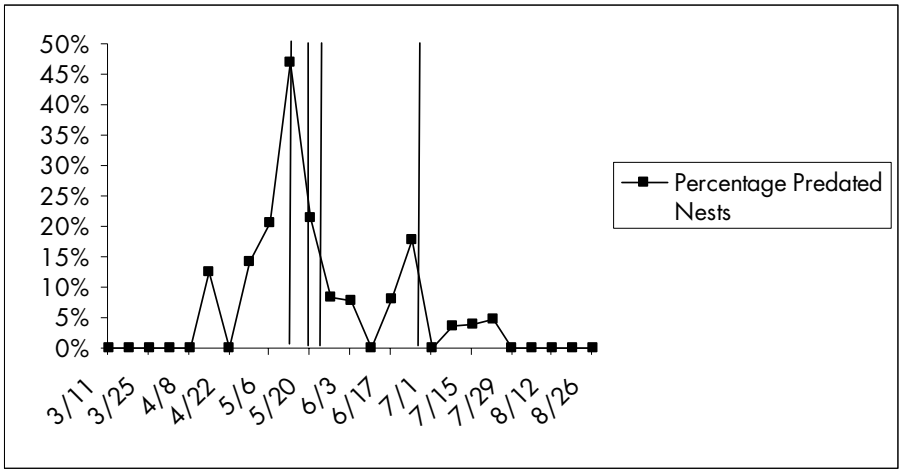
The lack of correlation between the number of predators seen per survey and the number of depredated snowy plover nests in each area (Figure 10) suggests that something besides the actual number of predators present may determine predation pressure. Instead, it is likely that individuals of predominant predator species, such as harriers at Eden Landing, may be cueing in to plovers as a food source and becoming specialized in plover predation. It follows that several individual harriers could be responsible for much of the harrier-caused plover depredation at Eden Landing at any point in time. Comparing 2007 weekly nest depredation data from Eden Landing to dates when several harriers that were hunting these ponds were removed (Figure 13), the predation rate is shown to decreases sharply in the weeks following harrier removal. This relationship indicates that the "problem" harriers that were responsible for a majority of the nest depredation were effectively removed. In fact, the harriers that were targeted for removal were individuals that had been seen actively hunting several plover nesting ponds. Removal of individual harriers that are targeting snowy plovers appears to be an effective method of decreasing nest depredation from this species and will also be a useful tool to decrease chick and adult mortality. To be effective, however, "problem" harrier removal may need to begin earlier in the season to prevent high nest depredation rates in the first "wave" of nesting, which occurred in mid-May in 2007 (Figure 13).

Figure 12. Mean number of northern harriers seen per survey from 2003 to 2007 in the South Bay (error bars depict standard error).



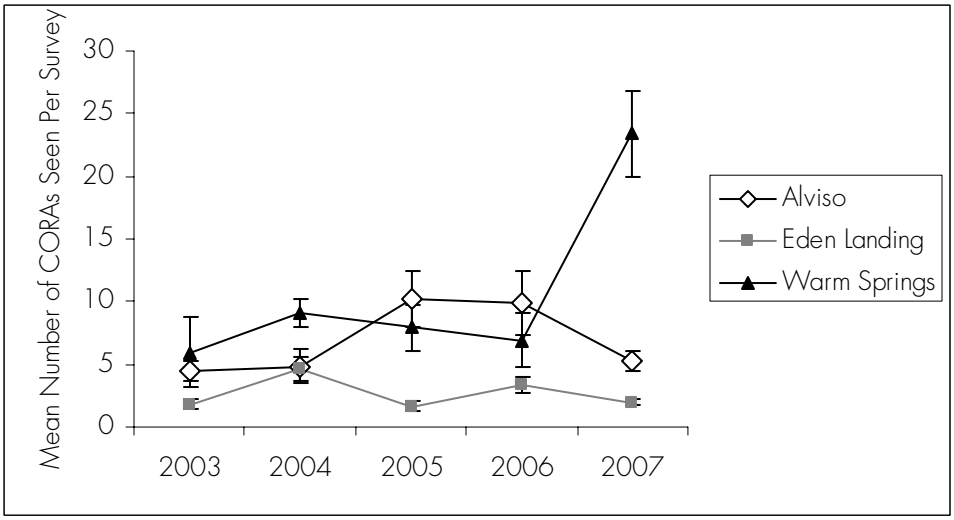
The California gull colonies in pond A6, Mowry and Coyote Hills continue to grow (SFBBO unpub. data). There was a new California gull colony this year at the Palo Alto Flood Control Basin with approximately 206 individuals (SFBBO unpub. data). This year we saw more gulls using the ponds for roosting and foraging at Eden Landing. Gulls are opportunistic feeders and are known to feed on eggs and chicks in the South Bay (Ackerman et al. 2006). The expansion of the gull population threatens nesting habitats of plovers, terns, avocets, stilts and black skimmers. The increasing gull population may also lead to additional predation pressure on eggs and chicks. Managing the gull population will be necessary in the future, particularly if gulls initiate new colonies in Eden Landing or other high density plover breeding sites.

Figure 13. Percentage of predated nests during the breeding season at Eden Landing. Vertical lines depict when harriers were removed from Eden Landing.



Common ravens were seen frequently throughout the South Bay salt ponds. Nests are commonly built on PG&E towers throughout the south bay, often on towers within snowy plover nesting ponds. This season, we witnessed one direct predation event on a plover nest by a common raven at Eden Landing. Over the past five years, the number of ravens at Eden Landing has remained relatively constant (Figure 14). The avian management program at Eden Landing is effective in keeping numbers of ravens low and should continue in the future. This year, the number of ravens at the Alviso ponds declined, to roughly the same numbers as in 2004. The number of ravens seen per survey has greatly increased over the last five years at Warm Springs, which is located between two landfills. The ravens are likely feeding at the landfills and roosting in the Warm Spring area. Future predator management in the south bay should focus on removing raven nests from power towers early in the season to reduce pressure from raven adults feeding nestlings.

Figure 14. Mean number of common ravens seen per survey from 2003-2007 (error bars depict standard error).



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. Banding and tracking of plover adults and chicks to examine how they use the managed and seasonal ponds throughout the breeding season as well as general movements and habitat use. Banding birds would also give us data on 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 South Bay Salt Pond Project area.
2. Plover foraging habitat use (borrow ditches, open channel, muted tidal, shallow pools, dry substrate) and invertebrate availability within the salt ponds.
3. Experimental designs to determine whether snowy plovers in the Bay will nest on islands constructed as part of the South Bay Salt Pond Restoration Project.
4. Further studies on northern harrier territory size and habitat use.
5. Research on the effectiveness of the avian predator management on increasing plover nest success.
6. Studies of the water levels and snowy plover use of ponds, and water management techniques to improve habitat quality for plovers.
7. Nest site density and carrying capacity within the salt pond habitat.
8. Further research should be conducted into the potential impacts of disturbance from trail use at Eden Landing.

Monitoring Recommendations

1. 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 chicks fledged per male.
2. 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 plover habitat will be determined by historical use, water levels, rainfall and other variables within the ponds. Assuming water levels in 2008 comparable to 2007, A8, B6B, B8, B8A, B8X, B11, B12, B14, B16B, and the “R” ponds should be monitored weekly for plover use.
3. Snowy plover monitoring surveys should be conducted in the early morning or late afternoon when lighting is best for looking for plovers.
4. The plover nest monitoring program should continue next year, including floating the eggs to estimate incubation stage, nest initiation dates and hatching dates.
5. More volunteers should be recruited and trained this winter to survey all potential plover nesting areas throughout the season.

6. SFBBO, along with CDFG and the Refuge should develop a snowy plover outreach program in areas adjacent to 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.

Management Recommendations

1. Management should continue to meet 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 plovers to reduce the potential impacts from predation, flooding, or disease, c) varying the locations of plover ponds should from year to year to reduce predation rates.
2. The predator management program should continue in 2008 in the South Bay. This should include removing mammalian and avian predators, predator nests, and when necessary, adults.
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 poles around the ponds.
4. Pond B6A and A22 should be flooded to kill off vegetation that is growing on the pond bottoms. The increasing vegetation could be discouraging the plovers from using these is ponds.
5. Pond B11 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 plover chicks. We had five nests hatch in B11 this year and never saw one chick in the pond, indicating that chicks could have fallen in the cracks. Filling of these cracks or scraping the pond surface may be necessary if this pond is to be managed for plover nesting in the future. In the interim, the pond should be flooded to prevent plover nesting.
6. If the Ravenswood ponds are to support more 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 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 Veasy Street gate needs to 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 South Bay Salt Pond Restoration Project.

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ACKNOWLEDGEMENTS

This project was supported by grants to SFBBO from the San Francisco Estuary Project and the US Fish and Wildlife Service Endangered Species Branch, funding from the Refuge, the Coastal Program and the membership of SFBBO. Thanks to our plover field crew: Erica O'Driscoll, Leslie Tucci and Yiwei Wang. Special thanks to all of the diligent volunteers who surveyed ponds monthly, looking for plovers: Rich Ferrick, Lisa Gadsby, Richard Jeffers, Sheila Junge, Mike Mammoser, Larry Manning, Spike Marlowe, Ron and Barbara McDow, Dolores Morrison, Mary Lou Ramsey, Mike Rogers, Mark Taylor, and Shirley Wodtke.

APPENDICES

Appendix 1. Total number of adult snowy plovers per pond and averages for all weeks. Blanks indicate the pond was not surveyed that week, * indicated managed ponds.

Week Number	A22	A23	A8	A8S	B10	B11	B12	B14*	B16B	B3C	B4C	B6	B6A	B6B	B8	B8A*	B8X	B9	N1	OBN-15	OBN-16	OBN-2	OBN-8	R1	R2	R3	R4	RSF2
25-Feb				16																								
4-Mar					0	27	0	0	0	0	0			1	4	15	4											
11-Mar	2	0		14	0	48	0	4	0	0	0		0	6	15	24	11											
18-Mar	0	0		12	0	14	0	0	0	0	0		0	9	1	88	19											
25-Mar	14	0		16	0	7		68	3	0	1		1	20	11	67	8			0	0	0	2	0	0	0	0	4
1-Apr	10	0			0	3		127	0	0	0		0	8	2	24	7											
8-Apr	3	0	0		0	3		72	1		0		3	17	2		4											
15-Apr	3	2	6		0	1		85	2	0	0		1	23	0	23	6											
22-Apr	5	1	5	4		18	4		5	0	5		16	37	2	43	9	2						4	0	5	1	
29-Apr	6	0	7		0	5	6	14	7	0	1		5	25	5		8			0	0	1	0					0
6-May	4	0	5	3	0	6	3	99	6	0	0		0	22	12	41	3	0	0									
13-May	0	1	15	1	0	0	13	44	4	0	0		3	32	12	35	1			1	0	0	0					
20-May					0	1	25	51	0				0	13	0	64	3		3					16	0	2	5	
27-May	0	0	10	6	0	2	22	12	1				4	14	6	29	2			0	0	0	0	5	0	0	0	0
3-Jun	2	0			0	2	32	38	1							84	0							13	12	0	0	
10-Jun	6	1			0	6	68	17	0							25	0		2					18	2	0	0	
17-Jun	3	1	4		0	3	31	28	0	0	3		3	31	0	18	0			7	1	0	0	7	9	0	5	
24-Jun	3	1	3	1	0	1	20	34	0	2	0	6	8	7	0	8	0							11	0	1	5	0
1-Jul	1	6			2	4	5	37	3			6	0	4	0	20	0			0	0	0	0	14	2	2	1	
8-Jul	1	4				4	29	3	4			6	0	8	1	34	0							6	4	2	3	
15-Jul	0	0				3	6	23	0							27	0			0	0	0	0	8	2	3		
22-Jul	1	1	19			2	23	89	2			6	0	1	0	81								6	0	0	1	
29-Jul	2	2			0	0	16	113	0				0	1	2	31	0							4	1	0	2	
5-Aug	0	0				0	46	109	0							58	0							2	0	0		
12-Aug	0	0	4			0	12	37	0	0	0	2	16	2	7	26	1							4	0			
19-Aug	0	1	23			0	63	11	0	0	0	1	14	46	53	59	0							7	0	0	0	
26-Aug	0	0			0	0	20	9	0	0	0	0	0	76	9	137	0							2	0	0	0	
2-Sep			21				13	0																				
Mean	2.75	0.88	9.38	8.11	0.11	6.2	20	43.2	1.5	0.13	0.63	3.9	3.52	18.3	6.5	44.2	3.44	1	1.7	1.1429	0.1429	0.143	0.2857	7.47	1.88	0.94	1.64	1

Appendix 2. Total number of snowy plover chicks per pond and averages for all weeks. Blanks indicate the pond was not surveyed that week, * indicate managed ponds.

Week Number	A22	A23	A8	A8S	B12	B14*	B16B	B6	B6A	B6B	B8	B8A*	B8X	OBN-15	R1	R2	R3	R4
25-Feb			0	0														
4-Mar				0														
11-Mar					0	0	0			0	0	0	0					
18-Mar	0	0		0	0	0	0		0	0	0	0	0					
25-Mar	0	0		0	0	0	0		0	0	0	0	0					
1-Apr	0	0		0		0	0		0	0	0	0	0	0	0	0	0	0
8-Apr	0	0				0	0		0	0	0	0	0					
15-Apr	0	0	0			0	0		0	0	0		0					
22-Apr	0	0	0			0	0		0	0	0	0	0					
29-Apr	0	0	0	0	0		0		0	0	0	0	0		0	0	0	0
6-May	0	0	0		0	0	0		0	0	0		0	0				
13-May	0	0	3	4	0	2	2		0	0	0	10	0					
20-May	0	0	0	0	0	1	0		0	0	0	7	0	0				
27-May					0	4	0		0	0	0	0	1		4	0	1	0
3-Jun	0	0	0	0	0	1	0		0	0	0	5	0	0	4	0	0	0
10-Jun	2	0			0	1	0					7	0		8	0	0	0
17-Jun	5	0			0	0	0					10	0		4	0	0	0
24-Jun	2	1	0		0	1	0		1	4	0	2	0	2	5	0	0	3
1-Jul	7	2	4	0	0	1	0	0	0	0	0	6	0		4	0	0	1
8-Jul	1	5			3	0	0	0	0	0	0	1	0	0	5	0	0	2
15-Jul	1	2			0	0	0	3	0	0	0	0	0		0	2	0	0
22-Jul	0	0			0	0	0					2	0	0	0	0	3	
29-Jul	1	0	3		3	0	0	2	0	0	0	0			5	0	0	1
5-Aug	2	0			4	7	0		0	2	3	0	0		3	0	0	3
12-Aug	0	0			0	6	0					6	0		0	0	0	
19-Aug	0	0	2		3	2	0	1	0	0	1	0	0		1	0		
26-Aug	0	0	3		1	5	0	2	0	0	0	6	0		2	0	0	0
2-Sep	0	0			0	2	0	0	0	0	0	0	0		0	0	0	0
Mean	0.88	0.42	1.15	0.40	0.64	1.32	0.08	1.14	0.05	0.27	0.18	2.58	0.04	0.29	2.65	0.12	0.25	0.71