



RBRPink foraging male snowy plover photo by P. Knapp

Western Snowy Plover Nesting at Bolsa Chica, Orange County, California 2006

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U. S. Fish and Wildlife Service
Carlsbad Fish and Wildlife Office
February 2007

Introduction

In 1997, the Bolsa Chica lowlands in Orange County, California were acquired into public ownership. This marked the beginning of a multi-agency effort to design, evaluate, and implement a plan for restoring the fish and wildlife habitats of the lowlands which had been cut off from the ocean for a century and an operating oil field for 50 years. Construction of the restoration project began after the 2004 snowy plover breeding season and was completed after the end of the 2006 breeding season.

The purpose of this investigation is to continue to improve the level of knowledge about the western snowy plover, a federally listed Threatened species that currently uses Bolsa Chica, and to attempt interim management actions to benefit the reproductive success of this species. This annual study was first initiated in 1997 and is now concluded with the completion of construction of the Bolsa Chica restoration project in 2006. This report addresses the 2006 snowy plover breeding season at Bolsa Chica, during the last year of Project construction.

Background and Current Status

The western snowy plover, *Charadrius alexandrinus nivosus*, is a sparrow-sized, white and tan colored shorebird with dark patches on either side of the neck, behind the eyes, and on the forehead. The coastal western snowy plover population is defined as those individuals that nest adjacent to or near tidal waters and includes all nesting colonies on the mainland coast, peninsulas, offshore islands, adjacent bays, and estuaries. The breeding range of the coastal population of the western snowy plover extends along coastal beaches from the southern portion of Washington State to southern Baja California, Mexico. The Pacific coast population of the western snowy plover is reproductively isolated from the interior populations.

The breeding season of the western snowy plover extends from March 1 through September 15. Generally, three eggs are laid in a nest on the ground which consists of a shallow depression scraped in the substrate. Some nests are lined with plant parts, small pebbles, or shell fragments. Both sexes incubate the eggs for an average of 27 days. Snowy plovers will renest after loss of a clutch or brood.

Snowy plover chicks are precocial and leave the nest within hours of hatching in search of food. The tending adult(s) provide danger warnings, thermo-regulation assistance, and guide the chicks to foraging areas, but do not provide food to their chicks. Broods rarely stay in the immediate area of the nest. Young birds are able to fly within approximately 31 days of hatching.



Male with brood

photo by P. Knapp

Double brooding and polyandry are the norm. Snowy plover females may leave very young chicks to find another mate. The male typically tends the brood until the chicks fledge. Western snowy plover adults and young forage on invertebrates along intertidal areas, along beaches in wet sand and surf cast kelp, in foredune areas of dry sand above the high tide, on salt pans, and along the edges of salt marshes and salt ponds. The snowy plover is primarily a run and glean type of forager.

Poor reproductive success resulting from human disturbance, predation, and inclement weather, combined with permanent or long-term loss of nesting habitat to urban development and the encroachment of introduced beach grass, has led to the decline in active nesting colonies as well as an overall decline in the breeding and wintering population of the western snowy plover along the Pacific coast of the United States. In southern California, the very large human population and the resultant beach recreation activities by humans have precluded the western snowy plover from breeding on historically used beach strand habitat. As a result of these factors, the Pacific coast population of the western snowy plover was federally listed as a Threatened with extinction March 5, 1993 (58 Federal Register 12864).

The May 2006 coastal U.S. range-wide breeding season survey estimated 1,879 individuals with 1,719 of those birds seen in California. About 360 snowy plovers were found south of Ventura County and 62 of those were present at Bolsa Chica during the 2006 breeding population assessment.

Our studies from 1997-2006 have examined the scope, magnitude, and problems of snowy plover breeding activity at Bolsa Chica, before and during the implementation of the restoration project. With the completion of the restoration project in 2006, conduct of snowy plover surveys and management actions hereafter, likely fall to the land manager, the California Department of Fish and Game.

Bolsa Chica Study Area

Bolsa Chica is a coastal lowland area between two mesas, the Bolsa Chica Mesa and the Huntington Beach Mesa (Figure 1). While under full tidal influence 107 years ago, Bolsa Chica was diked-off from direct tidal influence, remained below mean sea level, and has been a sump for local drainage. The study area is adjacent to the State's Ecological Reserve which is under a muted tidal influence that was restored in 1978 and which contains two small islands (NTI - North Tern Island and STI - South Tern Island) created for nesting California least tern, *Sternula antillarum browni*, State and Federal endangered species. North Tern Island has been usurped in recent years by nesting elegant terns, *Thalasseus elegans*. Public access is not allowed and the human presence in the study area is mostly related to the operation of the oil field, consisting of large and small oil service vehicles and small work crews along the roads and well pads.

Bolsa Chica - January 2006, nest sites complete but dredging and inlet are not.



By the 2006 breeding season, the large and complex restoration project was nearing completion. The earthmoving with land-based equipment was completed. The three new nest sites were completed to augment the pre-existing North and South Tern Islands in Inner Bolsa

Bay. The full tidal basin had been partially filled with seawater to float the hydraulic dredge in September 2005. The new ocean inlet was not opened until after the conclusion of the breeding season, August 24, 2006, whereby the full tidal basin has been subjected to water level rise and fall that matches the unequal semi-diurnal tidal range of southern California's ocean waters.

Study Methods

The study area is demarcated into subareas (cells) by the network of slightly elevated roads constructed decades ago for access to the oil wells. These cells were numbered and formed the basis for observer navigation, nest mapping, and data recording. In 2006, the numbered cells in the full tidal basin were no longer evident, being largely covered with seawater that had been pumped in so that the dredge could finish its work. Some areas in the vicinity of our Bolsa Chica study area were not surveyed in this study, although western snowy plovers may have used the habitats for foraging or loafing. Those areas are the ocean beach immediately to the west at Bolsa Chica State Beach, the full tidal area of outer Bolsa Bay. The study area also did not include 64 (the Edwards Thumb), which remains in private ownership and a different oil lease.

Each cell is unique in configuration and area. The gross areas of some key cells are: cell 10, 17 acres; and cell 11, 54 acres. Some cells were thickly vegetated with pickleweed and considered unsuitable for western snowy plover nesting (cells 41 through 50). Similarly, areas covered with water during most of the breeding season (cells 30, and 38) are unsuitable for nesting but the margins were regularly checked for nesting plovers.



Knapp anchors an ME in Cell 22

photo by J. Fancher

Beginning late-March, observers surveyed for nesting western snowy plovers at least twice a week, sometimes 4 or 5 times a week, until mid- September. The large majority of suitable western snowy plover nesting habitat was visible from the road network. Usually between 8 am and noon, the observer(s) would slowly drive in a motor vehicle along the roads that subdivide Bolsa Chica. Frequent stops were made to examine specific areas adjacent to the road with binoculars or spotting scope without exiting the vehicle. In this manner, it was possible to discover most nests within a few days of eggs having been laid. Most of the time, a nest was evident when an adult was incubating. Other times the adult was foraging or preening

near the nest and soon returned to it. Once a nest was discovered, a welded wire mini-exclosure (ME) was anchored in place over it and left in place until the eggs in the nest hatched. In 2006, cameras were not deployed near nests. The observer would occasionally exit the vehicle in order to inspect an area not visible from the road or to verify the presence of eggs or chicks in a nest. Close examination of nests was usually conducted only once or twice per nest.

Data collected during this study included the gender of the incubating adult, length of incubation (days), number of eggs in the clutch, condition of the nest (e.g., signs of disturbance), and the fate of each nest (hatched, predated, or abandoned). Observations were also recorded of western snowy plover distribution by cell number, throughout the study area, not just those birds associated with nests.

It was usually possible to follow the movements and determine the fate of chicks of each brood since there was dispersion over space and time sufficient to differentiate between broods. (Banding of chicks has not been done at Bolsa Chica since 1999 and 2000.) Broods were observed 3 - 5 days per week. These regular brood observations were conducted to determine chick survival or fledgling production, as well as to detect movement between cells and use of specific cells for brood rearing.

Observations were made of potential predators during our surveys. Predator management actions were then enacted commensurate with the threat to snowy plover breeding activity by that specific predator. (Predator management has been a necessary recovery action for the least tern for decades. In places, such as Bolsa Chica, where snowy plover nests in proximity to the least tern, predator management activities on behalf of one species will also benefit the other species.) Since June 2002, anchored ME's were usually deployed on every nest from the time the nest was discovered until hatching. Crows have been a serious, omnipresent predator of snowy plover eggs in previous years at Bolsa Chica. However, loss of snowy plover eggs to crows has been virtually eliminated due to the ME protection such that there was no emphasis on removing crows or ravens from Bolsa Chica in 2006. When digging marks or egg loss evidence indicated visitation by a mammalian predator, drop-door traps would be deployed. When ground



coyote attack on aversion nest

photo by P. Knapp

squirrels were implicated, commercial poison bait stations were also deployed. Predator management efforts at Bolsa Chica in 2006 focused primarily on certain raptors.

In 2006, simulated nest scrapes were again constructed using quail eggs injected with bitter tasting, non-lethal contents. This was an attempt to deter, *Canis latrans*, depredation of snowy plover eggs. (Several “digging” attempts, some successful at stealing plover eggs, some not, in 2005 suggested that coyotes were possibly cueing in on the MEs and learning to reach through the wire mesh to rake eggs out.) The use of “aversion” nests was intended to teach coyotes to leave ME-covered eggs alone, without harming or removing coyotes. From February 1 through April, these “aversion nests”, 3 baited eggs each, were constructed in areas where snowy plovers had nested in the past. Some nests were covered with an ME and some were not.

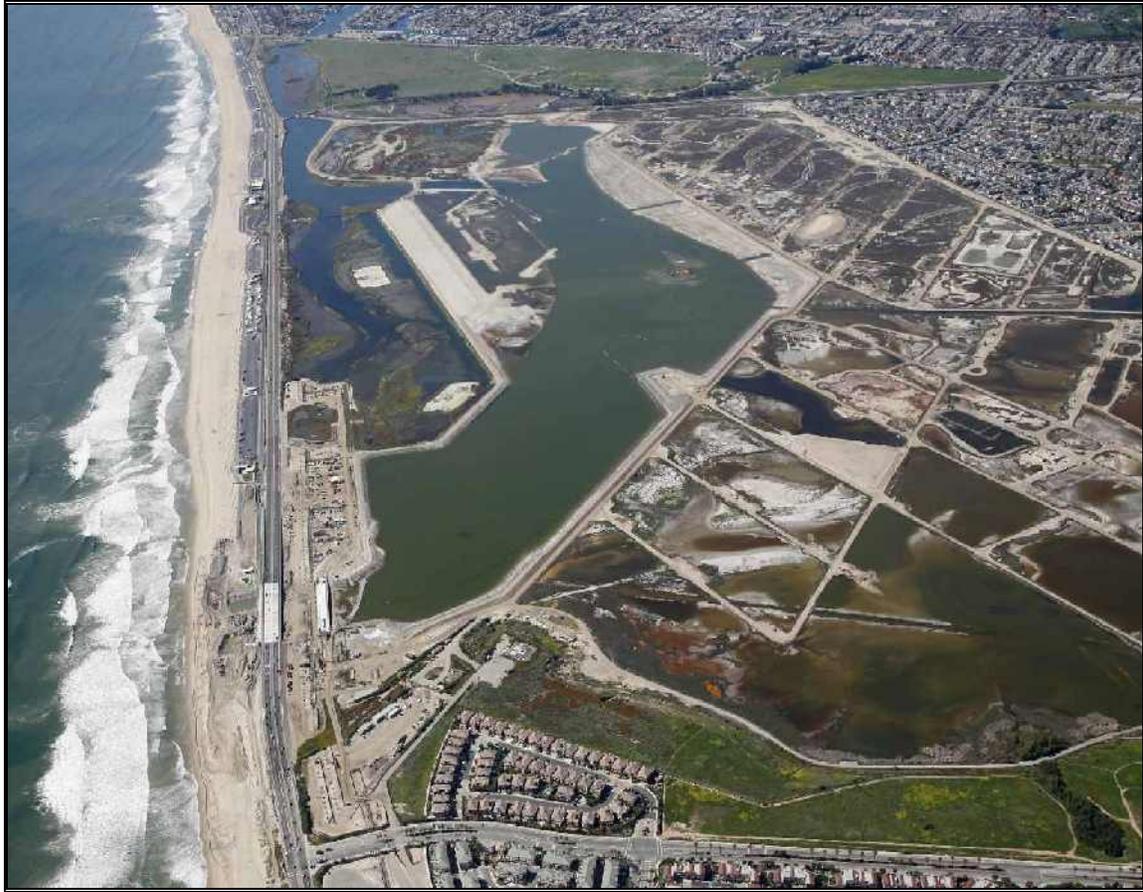
The MEs used in previous years (2-inch x 4-inch welded wire mesh, forming a cube 20 inches on a side), when centered over the nest, provides a distance of about 10 inches that a coyote must extend its forelimb through the ME opening to reach the eggs. Since some coyotes have been able to reach the eggs with this dimension, a wider ME (28-inch width on all four sides and 16-inch height) was deployed in 2006 which requires a 14 inch reach to rake eggs out of the center of the ME-protected area. Most but not all MEs in use in 2006 were of the wider variety after April 23rd, as explained below.

Results and Discussion

NEST CHRONOLOGIES AND DISTRIBUTION

Table 1 provides the cell location, start and end dates, nest fates, eggs and chicks produced for each nest. Figure 2 depicts the location of nests in the cell map of Bolsa Chica. Figure 3 shows the chronology of active nests for 2006-2004 and the 97-03 average. This chronology shows, not only greater number of active nests, but also, much greater numbers of active nests in April and May.

In 2006, the first nest was found April 6. Although 2-3 weeks later than the first nest found in the preceding nine years of this study, the proportion of nests initiated before May 1 is greater than all other years except 2005. Through April, 25 percent of the total 2006 nests (18/71) had been initiated. Eighteen nest initiations before May 1 is a much greater number than in any previous year (12 nests before May 1 in 2005, 4 in 2003, 9 in 2002, 4 in 2001, 5 in 2000, 8 in 1999, 6 in 1998, and 3 in 1997), except 2004 with 18 of 65 nests before May 1. The proportion of total nests initiated in the early 2006 breeding season, March/April, (25%) also exceeded previous years (13% in 2003, 18% in 2002, 7% in 2001, 13% in 2000, 21% in 1999, 18% in 1998, and 10% in 1997) except 2004 at 28% and even with 2005 at 24%. Increasing numbers of “early season” nests appear to be a trend of 2004-2006, not evident in the preceding 7 years of study. The last nest was found August 7 although it was determined to be abandoned by August 12 (Table 1, Figure 4).



Bolsa Chica aerial photo April 2006

The 2006 rainfall was about average and both flats and prepared nest sites were available and unflooded throughout the nesting season. (The April 2006 aerial photo above shows seasonal ponds mostly flooded although they were mostly dry by June.) Table 2 lists the nest distribution by cell. Nests were located on new nest sites and flats within cells, particularly Nest Site 1 and 3, Cell 22 and the Full Tidal area 3 near the south end of Nest Site 1. (FT3 was suitable for snowy plover nesting only between March and August of 2006. During that time, water level of the Full Tidal Basin was held static near mean sea level, so the floating dredge could finish its work, temporarily leaving some areas of dry flats inside the Full Tidal Basin. At the end of August, the new ocean connection was opened to tidal influence and the FT3 area became intertidal mudflat and salt marsh.) The STI in the Bolsa Chica Ecological Reserve attracted only three nest attempts. Two mid-season nests were initiated on the road shoulder atop the west levee (nests 36 and 39). In 2005, cell 11 attracted twelve nest attempts three of those nests were lost to predation. In 2006, Cell 11 attracted only 6 nest attempts and none were lost to predation. About 42% of all 2006 nests were on Nest Site 1 or Cell 22. Plates showing examples of weekly nest and brood locations from each month are attached.

The State and Federal Endangered California least tern, *Sternula antillarum browni* also nests at Bolsa Chica, usually on South Tern Island. In 2006, they nested on South Tern Island

and on the new Nest Site 1. Snowy plover egg-laying typically begins several weeks before the least tern begins its egg-laying. This has been the case at Bolsa Chica. However, in 2006, fewer snowy plover nests were initiated on South Tern Island and the first plover nest initiated there was April 25, just days before least tern nesting began there. The north end of new Nest Site 1, which had become sparsely vegetated, attracted about one dozen snowy plover nests and more than 40 least tern nests. The two species tolerate the co-location of their nests, although inter-specific antagonism between adults and between adults and chicks was occasionally evident.



Snowy Plover and California least tern yelling match

photo by P. Knapp

EGG, CHICK, AND FLEDGLING PRODUCTION

Of 71 total nests in 2006, 67 nests were judged to be completed clutches. This was the highest total number of nests in the ten years of this study. Six completed clutches were 2-egg clutches, while 61 were 3-egg clutches (Table 1). Five of the 71 total nest attempts were lost to predators, while four nests were abandoned. Thus, 62 nests survived to hatch (hatching success rate of 87.3% or nest failure rate of 12.7%). At least 198 snowy plover eggs were produced at Bolsa Chica in 2006, 11 eggs were taken by predators and 21 eggs were abandoned or failed to hatch. From those 198 total eggs produced, 166 chicks were produced. Of these 166 total chicks produced in 2006, only a maximum of 64 chicks were estimated to have survived to fledge (39% chick survival). This high degree of chick loss must be considered severe.

The April and May nests resulted in a peak of nests hatching in late May/early June (Figure 4). A second peak of nest hatching occurred in the second half of June and early July. Thus, between May 15 and July 14, 69% of nests hatched. Approximately 135 chicks were produced in just these eight weeks. Without obvious signs of predation losses, the majority of these chicks simply disappeared.



snowy plover chick among iceplant species on Nest Site 1

photo by P. Knapp

Abandonment of nests (adult failed to complete incubation) and frequency of dead eggs (failed to hatch when others of the clutch did hatch) were higher than in previous years. While only 4 out of 71 nests were abandoned in 2006, this is the highest number and proportion (5.6%) of nests abandoned of all other nine years of this study. The ten-year average percent of nests abandoned is 3.01% (14/465). In five of the preceding years, the number of nests abandoned was zero or one, and in the other 4 years, only two nests per year were abandoned.

In the early morning of May 22, two snowy plover nests (#29 & #32, three eggs each,

incubated for 4 days and 1 day, respectively) located in the FT3 area (south of the south end of NS1) were flooded in a shallow pond that resulted from a rain shower. The nest scrapes were in a shallow depression that had no drainage and the eggs were partially or completely inundated for 6-8 hours without an incubating adult. An adult was seen standing over the eggs of #29. The nest monitor cut a small drainage ditch to let the pond drain off the nest sites. The females resumed incubation of both of the nests once the water had drained off of the eggs. All eggs from both clutches hatched normally 24 and 26 days, respectively, after the flooding event.

In 2006, 14 dead eggs were observed (not counting eggs in abandoned nests). With 198 total eggs laid in 2006, 7.1% of total eggs were dead eggs. (No analysis was made of these 14 dead eggs to determine whether they were sterile or had exhibited some degree of development before expiration.) Over the ten years of this study, nearly half of all dead eggs occurred in just 2005 and 2006 (25/52). The average number of dead eggs per year for the nine years preceding 2006 is 4.2 eggs per year and the proportion is 3.4%. Including the 2006 breeding season, the ten-year average percent of dead eggs is 4.0% (52/1299).

The total fledgling count was more difficult in 2006 than in past years due to insufficient geographic and temporal separation of broods, defying efforts to maintain brood identity all the way to fledging during the middle part of the season. Most broods were hard to follow due to rarity of banded parents, dense packing of broods, and continual reconfiguration of brood territories or boundaries. Through field observation and comparing actual chicks to expected chicks, we did conclude that a maximum total of 64 chicks was produced in the 2006 breeding season.

Several factors may have contributed to the low production of fledglings in 2006. The most likely cause would be predation on chicks, discussed more below. Non-predation chick mortality may have severely reduced fledging success in 2006. Food shortage could be such a cause. That is, chicks hatched from relatively sterile nesting areas could not be relocated to areas where there was sufficient prey base to sustain them. Of approximately 78 chicks produced on new Nest Sites 1 and 3 nearly all moved off the nest site tops to other locations where they were no longer detected. (No method of assessing the adequacy of the prey base for snowy plover chick survival has been developed for Bolsa Chica. Brood movement out of an area is a symptom of a problem. However, broods may be relocated because the adult is evading a potential predator or been the loser in a brood territory dispute, or because there is no food available for chicks.) A disease that causes chick death but not illness in adults seems improbable. Another unlikely possibility is that terrain rugosity and/or vegetation may have obscured chicks sufficiently to prevent accurate estimation of fledglings.

In this study, when one or more eggs of a clutch hatch, days are allowed to pass before any egg(s) that may have been abandoned is collected. No apparently abandoned egg has been seen to hatch. However, delayed hatching of the last egg of a clutch has been seen to split a brood, with one of the adults staying to incubate the "late" hatching egg while the other adult moves away with the "early" hatching chicks. In the case of nest 68, initially found as an

incubated 3-egg clutch on July 19, 2006, two eggs hatched on August 10. The adults and two chicks departed the nest area. On Aug 12, the third egg was seen to have hatched but no adults were in the area. The chick was captured and delivered to San Diego County snowy plover rehabilitation expert, Meryl Faulkner, for hand-rearing among the many other snowy plover chicks that had been removed from Navy managed snowy plover nest sites in San Diego County. This chick from Bolsa Chica survived and was released alone at Bolsa Chica State Beach November 1, 2006.

NUMBERS OF MALE AND FEMALE SNOWY PLOVERS

During the May 24, 2006 breeding season “range-wide population count” the total number of snowy plovers present at Bolsa Chica was 62 adults, plus 24 chicks (Table 3 and Figure 5). During this count, more males (35) were seen than in all previous years, except 2005 (between 11 and 20 during 1997-2004, 41 in 2005). The average number of males at Bolsa Chica from 1997 to 2004 is 17.1 each year. In 2005 and 2006, the average number of male snowy plovers is 38 individuals. This is a 123% increase over the preceding eight year average. Twenty seven females were observed during the 2006 count (18 active nests on that date). The number of females during previous window counts at the end of May have ranged between 11 and 19 during 1997-2003, but rose to 25 individuals in each of 2004, 2005. The average number of female snowy plovers at Bolsa Chica from 1997-2003 at the end of May in each year is 15. In 2004-2006, the average number of females at Bolsa Chica at the end of May has been 25.7, a 71% increase over the seven preceding years.

BROOD TRACKING

Due to the chronological and geographic spacing of each brood, it is usually possible to locate and identify individual broods over the entire several week period before they fledged. Each brood tended to stay together and the males prevented overlap or co-mingling with other broods. In 2006, as in 2005, many broods were moved around by the guiding male. Tracking of individual broods, in the absence of markings or bands, was very difficult under this circumstance. Broods hatched from Nest Site 1, Nest Site 3, and from Cell 22, relocated within days to other locations. Snowy plovers readily use the roads of Bolsa Chica that define the cells to cover distances of 1/3 to 3/4 mile. In June and July, area counts of snowy plover chicks indicated very low numbers were sighted compared to the expected number, especially around Nest Site 1. One brood from the north end of Nest Site 1 was seen to cross and re-cross a busy public trail by moving through a chain-link nest site boundary fence that had no chick barrier at its base. They eventually disappeared and were thought to have been lost.



2Adult Snowy Plover Pair with chicks

photo by P. Knapp

OBSERVATIONS OF BANDED ADULTS

One female (øKKK), hatched at Camp Pendleton in 1999, nested twice at Bolsa Chica in 2000, and three times in 2001, twice in 2002 and 2003. In 2004, she incubated one nest in cell 11 to hatching in May. She had one known nest at Bolsa Chica in 2005, which was abandoned, probably because pickleweed grew around and over the nest scrape. She was not seen in 2006. A male (RBRPink, see cover photo) hatched at Moss Landing in 2001 was seen with one brood at Bolsa Chica in 2003. He had two broods at Bolsa Chica in 2004. In 2005, he was seen very frequently but was associated with one brood that produced one fledgling. In 2006, this male was again seen frequently in June and was associated with one probably unsuccessful brood (nest 30) on Nest Site 1, but not seen after middle July. A male (WNGY) nested successfully at Bolsa Chica in 2004 and 2005, escorted one brood on Nest Site 1 in 2006, probably fledging two young, but was not seen after middle July. No other snowy plovers with decipherable bands were seen at Bolsa Chica in 2006.

PREDATION

In 2006, 7.0% of all nests (5 of 71 nests, Table 2), were lost to predation. Four more nests were abandoned. Nest loss/egg predation was highest in 2001 of all study years in both raw numbers and proportion of total nests. The 2006 breeding season ranked second lowest for failed nests after 2003 and tied with 2005 (Figure 6). The 2006 proportion of nests hatching (87%)

exceeded every other year. The number of eggs and chicks produced in 2006 exceeded every other year. However, the number of fledglings produced ranked third after 2004 and 2005. Fledglings per nest (0.90) (Table 3) ranked 6th out of the nine years we did fledgling estimates. This low rate of nest loss and high degree of chick production is attributable to the deployment of MEs. We placed an ME on each nest as soon as the nest had been discovered. The ME design is very effective at preventing crows or ravens from stealing snowy plover eggs.

In several instances where the snowy plover eggs were stolen, canid claw marks were evident inside the ME. No ME was bent or shoved out of place. The predator was certainly coyote. In each instance, the coyote did one of two things. The animal dug enough for the eggs to roll out of the nest scrape closer to the ME edge where the coyote could reach it. Or, the animal learned how to extend its paw through the ME mesh far enough to rake the snowy plover eggs gently out of the scrape. Egg shell fragments were not found inside the ME. Claw marks, and the frequency of coyote sightings in the Bolsa Chica lowland led to a conclusion that of the five snowy plover nests lost to a predator, three were lost to coyote.



Coyote sees snowy plover nest under wide ME photo by P. Knapp

One incident of snowy plover nest loss to coyote took place on Nest Site 3 on April 16. There were also three aversion nests located on Nest Site 3, at that time. Two of the three aversion nests were also attacked by coyote. There were no other nest attacks by coyote on Nest Site 3 after that, possibly due to the aversion nests fulfilling their function. A coyote attack a week later on another ME-protected nest in cell 10 led to the deployment of the “wider” ME thereafter. For the rest of 2006, there was only one other probable coyote attack on a snowy plover nest, June 10 in Cell 22, when coyote tracks were observed near the nest and the nest scrape was empty. There had been no ME placed on this nest due to soft, wet soil around it. No aversion nests had been placed in Cell 22, either. It was nevertheless concluded that the aversion nests fulfilled their purpose and should be continued at Bolsa Chica. The wide ME may also have served its function but we had no digging attempts or evident coyote attacks on any ME after deployment of the wider ME, so definitive conclusion is



Coyote trio trots along a road through Bolsa Chica photo by P. Knapp

not yet possible. Other than these two measures, the only action taken against coyotes at Bolsa Chica was occasional “hazing” by driving near them or watching them in a way that they trot away.

Based on observations of ground squirrel theft of snowy plover eggs, direct removal of squirrels and deployment of poisoned bait stations were continued in 2006. One certain snowy plover nest loss was attributable to ground squirrels in 2006, and eight California least tern nests in the same area were destroyed by ground squirrels before the bait stations were deployed. Another squirrel depredation event appears probable since evidence of digging around the ME by coyote was not seen. No squirrel depredation of snowy plover or least tern eggs occurred after bait stations were placed in the area. Drop-door traps were not deployed in 2006.

The great abundance of crows and their seemingly endless encroachment into the wetland from the surrounding urban area previously warranted removal of crows from Bolsa Chica. However, with the success of the MEs, removal of crows has been drastically de-emphasized (Table 6). No snowy plover eggs were lost to crows or ravens in 2006. No crows and two ravens were removed from Bolsa Chica in 2006 (Ross 2006).

The most likely culprit for snowy plover chick mortality in 2006 continues to be American kestrel, *Falco sparverius*. Kestrels were relatively abundant and can do great harm very quickly. Therefore, efforts to remove them from Bolsa Chica during the snowy plover breeding season continued by capturing and transporting them considerably inland. Six kestrels were transported away from Bolsa Chica. A moderate lapse in attentiveness toward kestrels is apparently sufficient opportunity for just one or two kestrels to radically deplete the snowy plover chick production at Bolsa Chica, as appears to have happened in June 2006. Loggerhead shrikes, *Lanius ludovicianus*, never numerous in the lowland were again present in 2006. Four shrikes were live-trapped and transported away from Bolsa Chica in 2006.

Red-tailed hawk, *Buteo jamaicensis*, was regularly present in the Bolsa Chica lowland but no known predation of snowy plover was evident. No hawk nest was known to be present in the Bolsa Chica lowland in 2006, as there had been in 2002. Consequently, no red-tailed hawk was live-trapped and transported away from Bolsa Chica in 2006.

While Cooper’s hawks, *Accipiter cooperii*, have been present during the snowy plover breeding season at Bolsa Chica for years, they had not been indicted as a harmful predator. In 2005, increased abundances of Cooper’s hawks in and around the periphery of the wetland and one direct observation of a Cooper’s hawk eating a likely snowy plover chick, led us to respond to their presence. However, in 2006, no action was taken against Cooper’s hawks, although present at the perimeter of the lowlands.



For the first time in ten years of this study, at least one Peregrine falcon, *Falco peregrinus*, was present at Bolsa Chica throughout the breeding season. One individual would prey on black skimmer chicks and elegant tern adults and an assortment of other shorebirds and waterfowl. It would regularly rest on the ground near a tern/skimmer nesting area causing agitation in the nesting birds simply by its presence. The falcon did not appear to cause trepidation in snowy plovers as with the elegant terns, least terns and black skimmers.

To reduce the likelihood that the presence of the falcon would cause the colonial nesting seabirds to abandon their nesting efforts at Bolsa Chica, several attempts were made to haze the individual away using cracker shells fired from a shotgun. The hazed individual would move to another distant part of Bolsa Chica, did not leave the site entirely, and eventually returned to its routine loafing locations and occasional foraging attacks near the nesting areas. (Rice-loaded shotgun shells would have been used but the falcon flew before our specialist could get within the effective range of the rice shell.) Had the threat of colony abandonment by the nesting seabirds been judged imminent, live-trapping and transportation out of the area of the falcon would have been the next step to stop the falcon's disturbance of the nesting birds. It is hoped that peregrine falcon transients will look elsewhere for a mate and not remain at Bolsa Chica during nesting season.

A lone burrowing owl, *Athene cunicularia*, had appeared in the Bolsa Chica lowland in late winter of the last several years. This transient bird typically left the area in early Spring and had no adverse affect upon seabird or snowy plover nesting at Bolsa Chica. In the winter of 2006-07, five individuals were noted in the lowland area. This rare and declining bird could establish a breeding presence at Bolsa Chica, to its benefit, but it could also severely harm the reproductive success of other State and Federally listed species. In that eventuality, thoughtful management actions may need to be considered.

The gull-billed tern, *Gelochilodon nilotica*, another rare and declining species has increased its nesting presence near least tern and snowy plover nesting areas of San Diego County in the last few years. This tern sometimes preys upon least tern and snowy plover chicks. Gull-billed terns have been occasionally observed at Bolsa Chica in recent years but not in 2006. Should they return and pose a significant threat to the reproductive success of the least tern and/or snowy plover, thoughtful management actions may need to be considered.

The elegant tern nesting at Bolsa Chica is not ordinarily a problem for least tern or snowy plover. However, because of their potentially large numbers, extreme density of nests, dense flocking/loafing behavior, “bullying” temperament, and/or dense groups of chicks, they can interfere with successful breeding by least tern or snowy plover. The existing North Tern Island seems perfectly suited to the elegant tern nesting. There are abundant other places for least tern and snowy plover at Bolsa Chica now, such that competition for nesting space does not appear likely. However, use of decoys to attract elegant terns to the “appropriate” nesting location, hazing, and/or the use of chick fences to prevent elegant tern chicks from trampling the nests of other birds can potentially be used to reduce conflicts should they arise.

No instance of predation on or disease mortality of adult snowy plovers was detected in 2006 at Bolsa Chica.

SUMMARY

In early 2006, the restoration project had ended the phase requiring earth moving equipment. The full tidal basin had been partially filled with water during the preceding Fall to allow the hydraulic dredge to operate. The levees and nest sites were completed and ready for use. The first nest was on Nest Site 3. Ultimately, one third of all snowy plover nests were on the three nest sites available for the first time in 2006. The highest number of active nests for all our ten survey years (23 nests) was recorded on June 7, 2006. Adult female numbers were higher than previous years and the number of males was much higher than most all years, except 2005. Total nest attempts (71) were highest of the 10 years of this study at Bolsa Chica, as was total egg production. A trend analysis (Figure 8) suggests improving fledgling at Bolsa Chica.

Deployment of mini-exlosures (ME) on nearly every nest was very effective at preventing egg losses to crows and ravens (Figure 9.). However, coyotes and ground squirrels

were verified to be egg stealers, defeating the ME a few times in 2006. Mimic nests, with bitter tasting eggs, appears to have ended the coyote egg predation, just as squirrel poison has eliminated their depredations. No adverse impacts to snowy plover from the heavy construction activities or dredging as part of the Bolsa Chica Restoration Project were detected.

The occurrence of dead eggs in 2006 was higher (7.1%) than in any preceding year (average of the nine preceding years 3.4%). The significance of this is not yet apparent to the authors.

While chick production in 2006 (166 chicks) was the highest in all 10 years, chick survival (38.5%) ranks fourth lowest. The major chick predator in 2006 was thought to be American kestrel. The use of MEs greatly reduced the number of snowy plover eggs lost to predation. On the other hand, chick losses after the eggs hatched and the chicks left the protection of the ME, were higher than chick losses without ME. However, chick survival/fledgling production was increased with ME protection of the nest. Thus, while chick losses were higher when an ME had been used to protect the eggs, fledgling production was also higher than without the use of MEs. The use of MEs did not create a reproductive sink for snowy plover at Bolsa Chica, but rather increased the production of fledglings. It is our view, that the effort expended on removal of kestrels and shrikes, in particular, is the best way to increase chick survival, whether mini-exlosures are used or not.

The extent of unvegetated flats at Bolsa Chica has been relatively stable during our years of study and decades before. However, in 2005, pickleweed sprouted and grew in areas that have never supported pickleweed before and which have been utilized by nesting snowy plover. In 2006, these pickleweed sprouts were the dominant cover such that these areas were unusable for snowy plover nesting. A few areas that had been plucked of pickleweed sprouts were still largely unvegetated and suitable for snowy plover nesting, but went unused in 2006.

Management actions are essential to improving western snowy plover reproductive success at Bolsa Chica, Orange and Los Angeles Counties. Bolsa Chica is a rare example of an “island” of habitat in a sea of urban sprawl and intensely used recreational beaches. There are currently no options for snowy plover breeding within a 60-mile radius.

Acknowledgments

We offer special thanks to Wally Ross and Ron Brown who performed the predator management actions that are so important to snowy plover reproductive success at Bolsa Chica.

Literature Cited

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Figure 9. Egg, Chick Losses and Fledgling Production Without and With ME Protection

Plates

Selected maps of 2006 Snowy Plover nests and brood locations

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Table 1. Snowy plover eggs laid, chicks hatched, and fledged at Bolsa Chica, 2006

<u>Nest #</u>	<u>Cell #</u>	<u>date found</u>	<u>date ended</u>	<u>eggs</u>	<u>nest fate</u>	<u>chicks</u>	<u>fledglings</u>
1	NS3	4-6	4-10	1	P	-	nests #1-18
2	FT3*	4-11	5-9	3	H	3	
3	10	4-12	4-21	3	P	-	
4	NS3	4-14	4-16	1	P	-	
5	22	4-17	5-18	3	H	3	
6	NS1U2	4-20	5-16	3	H	3	
7	NS1I1	4-20	5-14	3	H 1A	2	
8	FT3*	4-20	5-16	3	H	3	
9	22	4-20	5-22	3	H 1A	2	
10	22	4-20	4-22	1	1A	-	
11	FT3	4-20	5-21	3	H	3	
12	NS1R2	4-22	5-19	3	H	3	
13	NS2	4-22	5-24	3	H	3	
14	FT3*	4-22	5-18	3	H	3	
15	STI	4-23	5-24	3	H	3	
16	10	4-24	5-24	3	H	3	
17	11	4-24	5-21	3	H	3	
18	11	4-25	5-29	3	H	3	
19	NS3	5-5	5-30	3	H	3	nests #19-37
20	22	5-5	6-5	3	H	3	
21	FT3*	5-7	6-5	3	H	3	
22	NS1N1	5-8	6-8	3	H	3	
23	NS3	5-8	5-30	3	H	3	
24	22	5-12	6-8	3	H 1A	2	
25	22	5-12	5-25	3	H	3	
26	STI	5-12	6-10	3	H	3	

<u>Nest #</u>	<u>Cell #</u>	<u>date found</u>	<u>date ended</u>	<u>eggs</u>	<u>nest fate</u>	<u>chicks</u>	<u>fledglings</u>
27	FT3*	5-16	6-13	3	H1A	2	
28	NS1V2	5-16	6-5	3	P	-	
29	FT3*	5-18	6-16	3	H	3	
30	NS1B2	5-19	6-13	3	H	3	
31	NS1Q2	5-20	6-12	3	H	3	
32	FT3*	5-20	6-17	3	H	3	
33	NS1Q1	5-23	6-19	3	H	3	
34	11	5-23	6-20	3	H	3	
35	FT3	5-24	6-23	3	H	3	
36	STI/Rd	5-29	6-26	3	H	3	
37	NS1W1	5-29	6-25	3	H 1A	2	
38	NS1U2	5-31	6-25	3	H	3	
39	FT3/Rd	5-31	6-23	3	H	3	
40	11	6-1	6-28	3	H	3	
41	22	6-1	6-28	3	H 1A	2	
42	22	6-1	6-13	3	P	-	
43	STI	6-2	6-23	3	H	3	
44	NS1M3	6-3	6-30	3	H 1A	2	
45	22	6-5	6-30	3	H	3	
46	NS1CC	6-5	6-25	3	H 1A	2	
47	32	6-7	7-9	3	H	3	
48	10	6-8	6-12	3	3 A	-	
49	NS1Y2	6-12	7-7	3	H 2A	1	nests #38-51
50	NS1O2	6-13	6-25	3	H	3	
51	22	6-14	7-12	2	H 1A	1	
52	12	6-16	6-19	1	1 A	-	
53	22	6-16	7-11	3	H	3	

<u>Nest #</u>	<u>Cell #</u>	<u>date found</u>	<u>date ended</u>	<u>eggs</u>	<u>nest fate</u>	<u>chicks</u>	<u>fledglings</u>	
54	NS3	6-19	7-12	3	H	3	Nests 52-71	
55	NS3	6-19	7-1	3	H	3		
56	NS1K1	6-21	7-21	3	H	3		
57	11	6-21	7-19	3	H	3		
58	NS3	6-23	7-21	3	H	3		
59	NS3	6-23	7-18	3	H1A	2		
60	12	6-27	7-15	3	H	3		
61	22	6-27	7-24	2	H	2		
62	NS1U2	6-27	7-14	2	H	2		
63	FT6*	6-28	7-2	3	H	3		
64	FT6*	6-28	7-28	3	H	3		
65	11	6-29	7-15	3	H	3		
66	33	7-5	8-3	2	H	2		
67	12	7-11	8-7	3	H1A	2		
68	12	7-19	8-10	3	H	3		
69	32	7-22	8-6	2	H1A	1		
70	FTM*	7-22	7-23	2	H	2		
71	12	8-7	8-12	2	2A	-		
2006 Season Totals				198 eggs	5P, 4A 62H 71 Nests	166 chicks		64 fledglings

* FT3, FT6, and FTM were unflooded areas of the full tidal basin suitable and available for snowy plover nesting between March 2006 and September 2006. They became intertidal and unsuitable for snowy plover nesting after the Bolsa Chica full tidal basin was reconnected to the ocean August 24, 2006.

P = predated; A = abandoned; H – hatched

Table 2. 2006 Nest and Nest Fate Distribution by Cell

Location	total nests	nests failed	nests hatched
Nest Site 1	16	1	15
Cell 22	12	2	10
FT3*	9	0	9
Nest Site 3	8	2	6
Cell 11	6	0	6
Cell 12	5	2	3
STI	3	0	3
Cell 10	3	2	1
7 other areas	9	0	9
Totals	71	9	62

*became intertidal and unavailable for snowy plover nesting after August 2006

Table 3. Males, Females, Nests and Fledgling Production 1997-2006

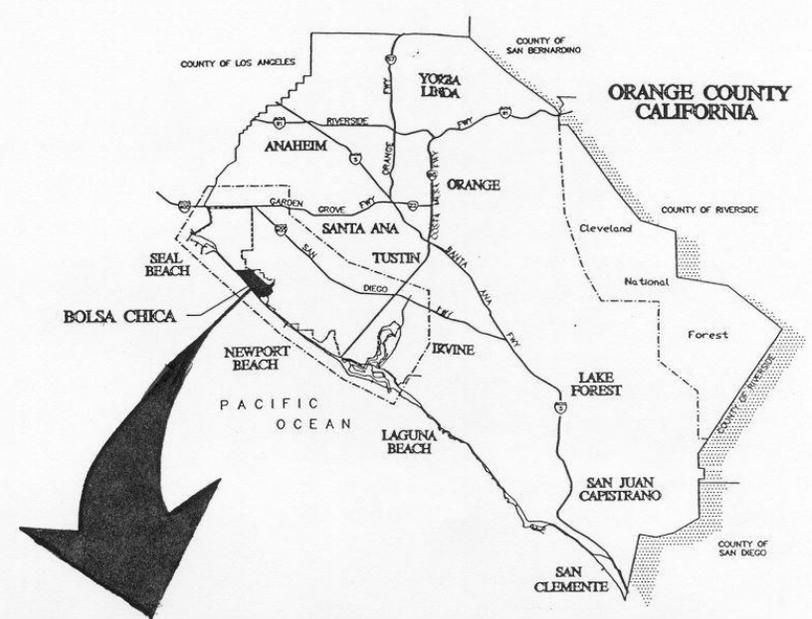
Year	Fem	Males	Total Nests	Fledglings	total Fl/nest	% chick survival	Fl/male
2006	27	35	71	64	0.90	38.5	1.8
2005	25	41	51	75	1.47	65.2	1.8
2004	25	20	65	79	1.22	53.0	4.0
2003	15	16	32	44	1.38	57.9	2.8
2002	19	20	50	27	0.54	36.0	1.4
2001	19	18	55	57	1.04	90.5	3.2
2000	15	16	39	42	1.08	82.4	2.6
1999	12	11	38	23	0.61	32.4	2.1
1998	11	16	34	25	0.74	37.3	1.6
1997	14	20	30	nd	nd	nd	nd

Fl = fledglings, nd = not determined

Table 4. Bolsa Chica Predator Removal Summary 1997–2006

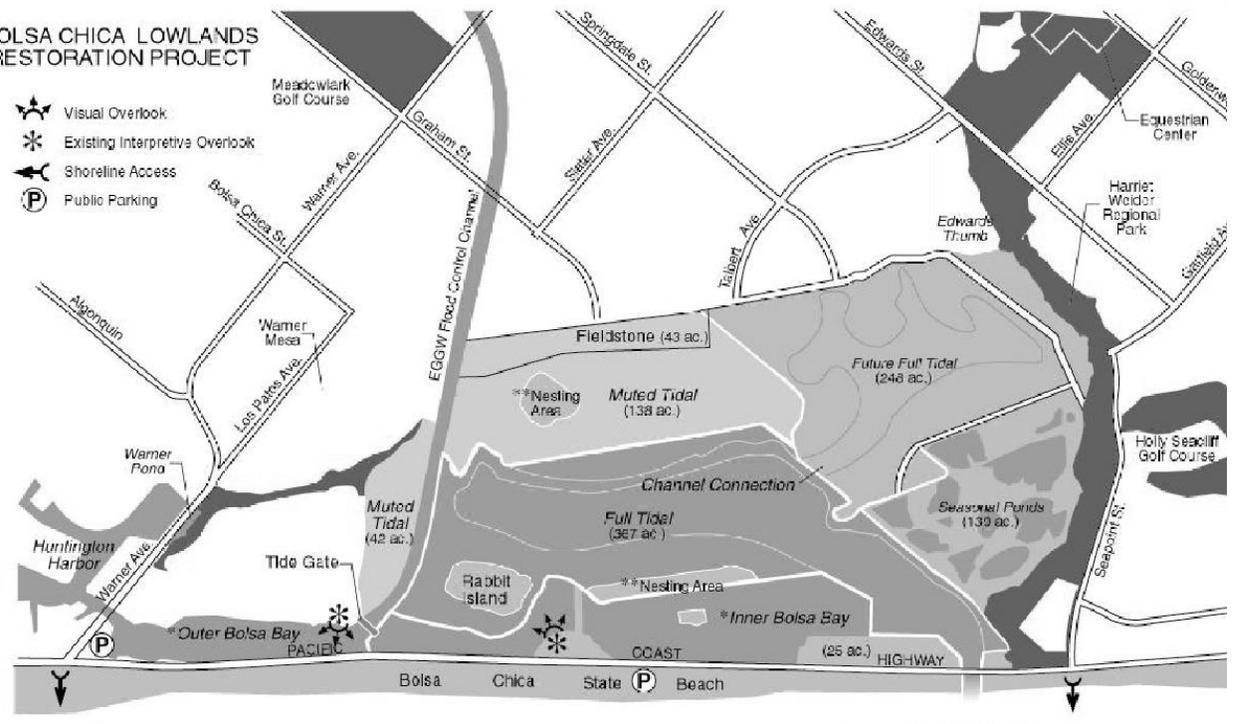
	<u>2006</u>	<u>2005</u>	<u>2004</u>	<u>2003</u>	<u>2002</u>	<u>2001</u>	<u>2000</u>	<u>1999</u>	<u>1998</u>	<u>1997</u>
American Crow	-	15	99	118	52	80	91	27	1	2
American Kestrel	6	13	19	5	12	13	15	46	14	2
Loggerhead shrike	4	1	10	5	3	6	2	5	-	-
Common raven	2	1	2	4	5	6	3	2	-	-
Coopers hawk	-	8	-	-	-	-	-	-	-	-
Ring-billed Gull	-	1	-	-	-	-	-	-	-	-
skunk	-	-	2	1	-	-	-	-	-	-
coyote	-	-	-	-	-	-	-	-	-	-
weasel	-	-	-	-	-	-	-	-	-	-

Figure 1.



BOLSA CHICA LOWLANDS RESTORATION PROJECT

- Visual Overlook
- Existing Interpretive Overlook
- Shoreline Access
- Public Parking



*Inner and Outer Bolsa Bay (210 ac.)
 **Nesting Areas (20 ac.)

Figure 2 2006 Bolsa Chica Snowy Plover Nest Map

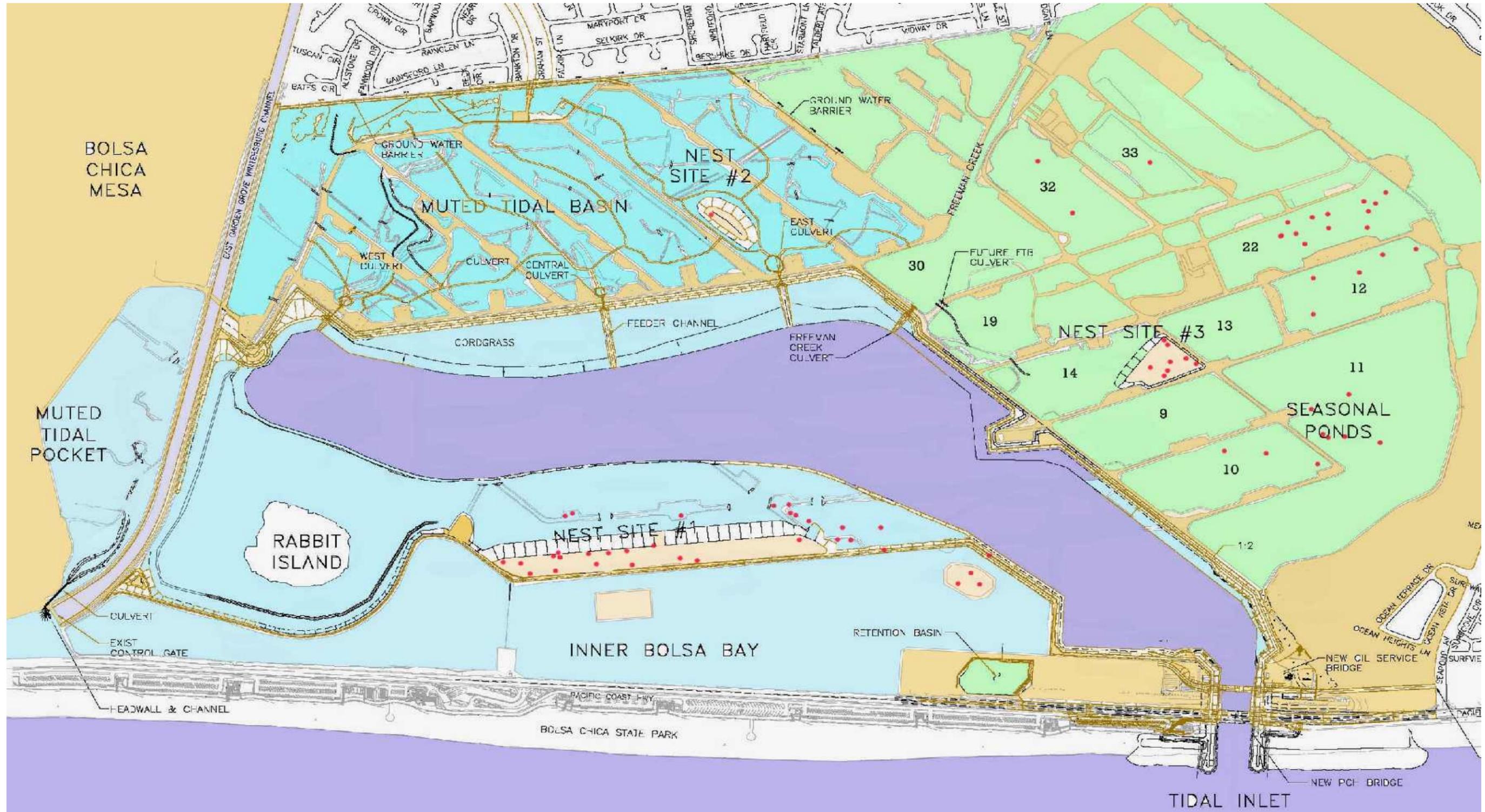
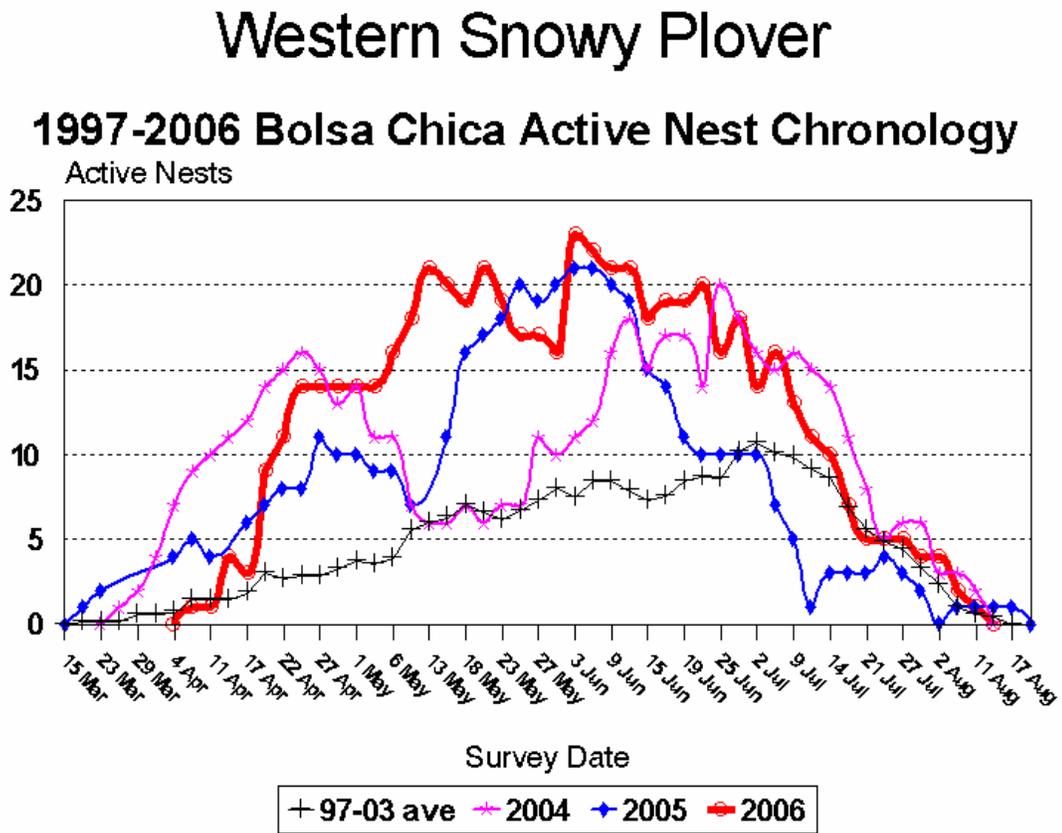


Figure 3



Western Snowy Plover - Bolsa Chica 2006

Biweekly Nest Initiation, Hatching, & Loss

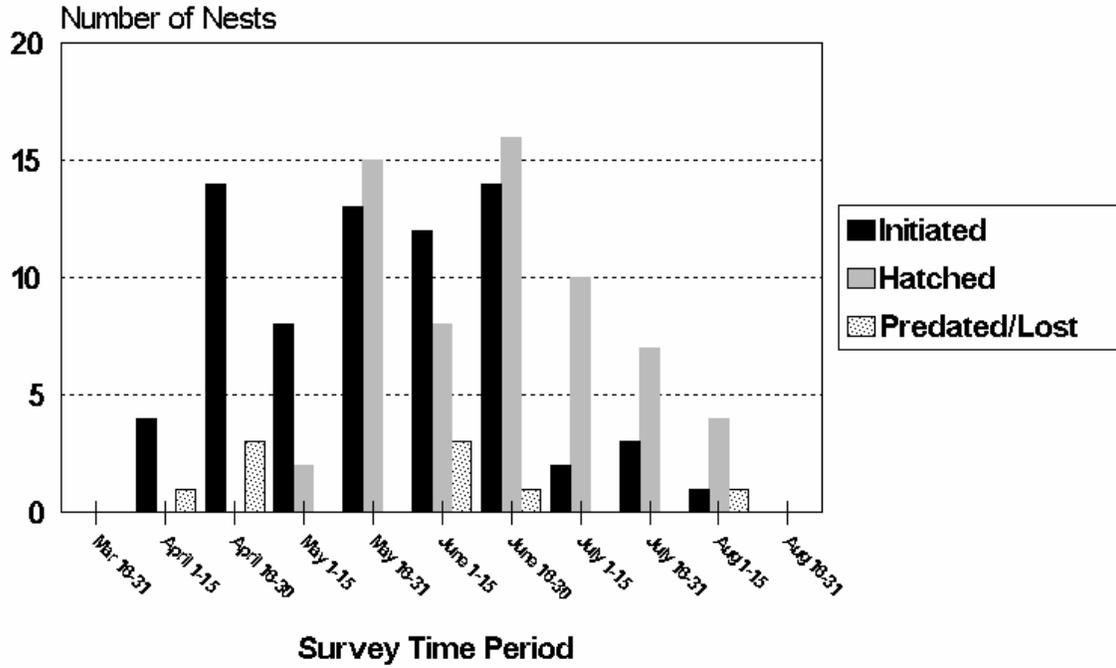


Figure 4. 2006 Biweekly Nest Initiation, Hatching, and Loss

Western Snowy Plover

Bolsa Chica - Males and Females

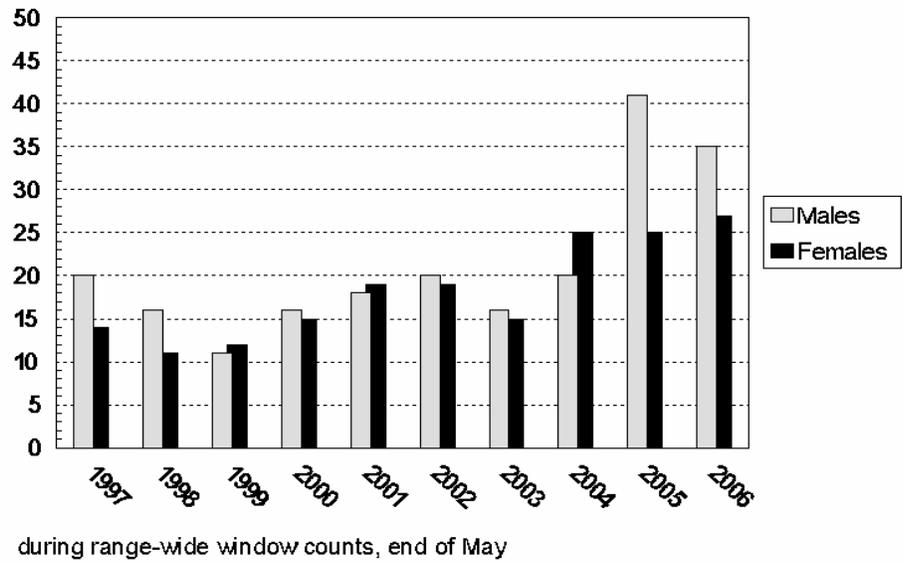
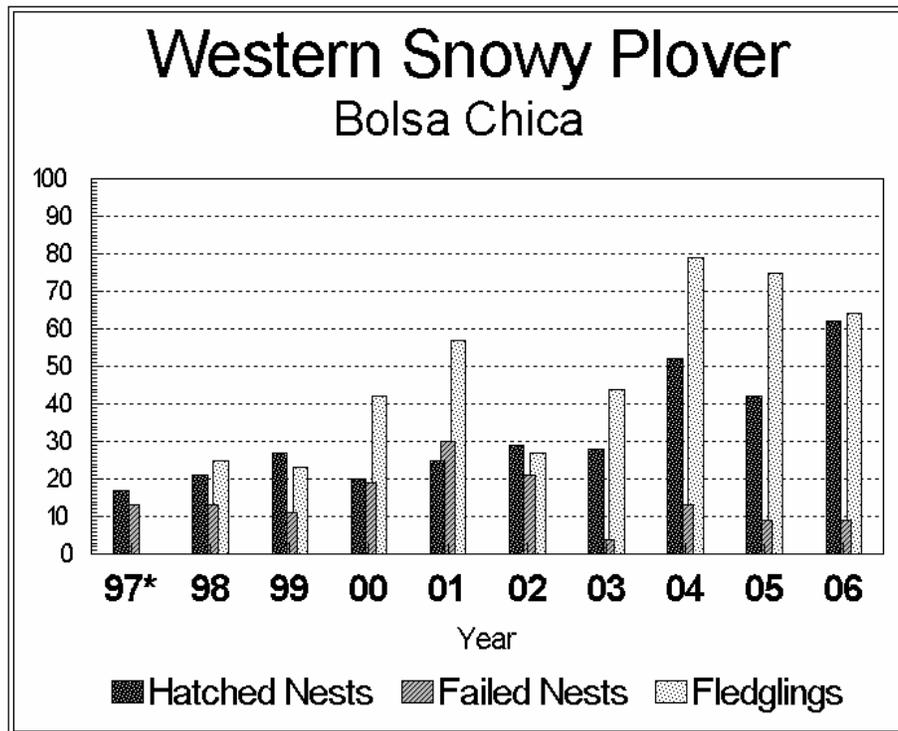


Figure 5 Male and Female Snowy Plovers in late May

Figure 6. Nest Fates and Fledglings Produced 1997-2006



* fledglings not determined in 1997

Figure 7.

Bolsa Chica Western Snowy Plover

Egg, Chick, and Fledgling Production 1997-2006

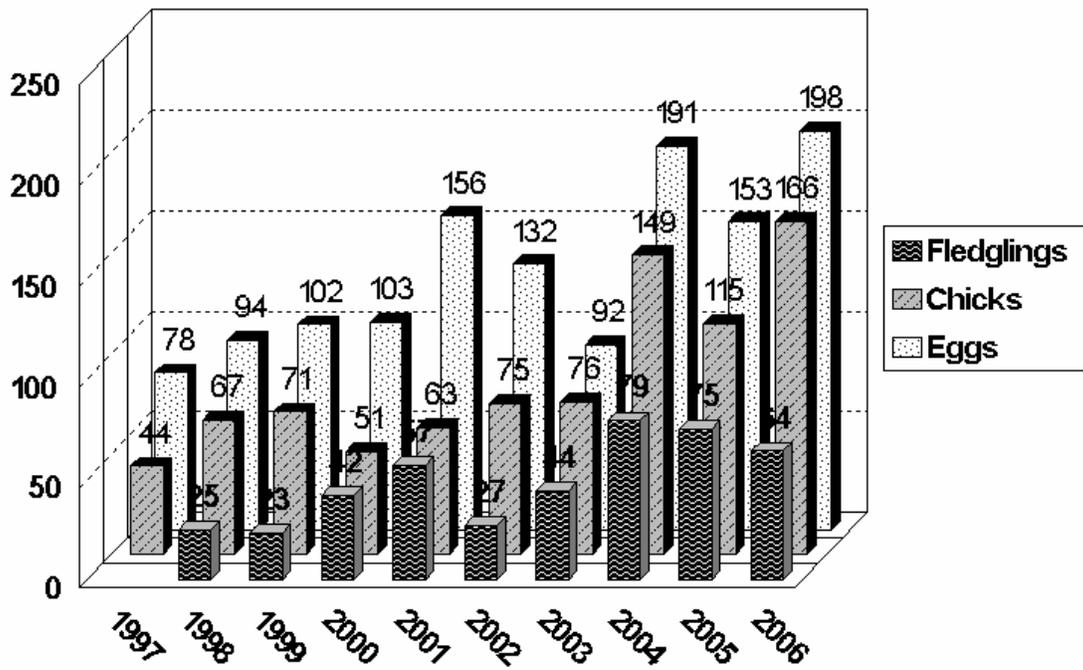
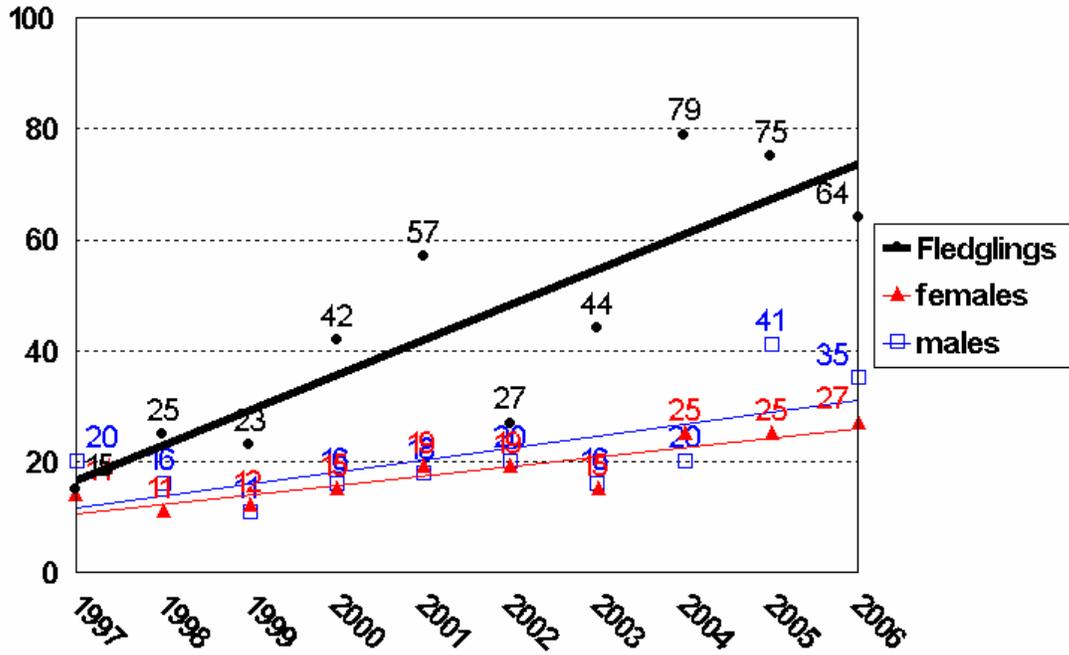


Figure 8. 1997-2006 Fledgling Production, Males, and Female Trends

Bolsa Chica Western Snowy Plover

1997-2006 Fledgling Production, Male, and Female Trends*



* number of males or females are from late May window surveys, fledgling estimates are the entire breeding season

Snowy Plover Egg, Chick Losses and Fledgling Production Without and With Miniexclosure Nest Protection

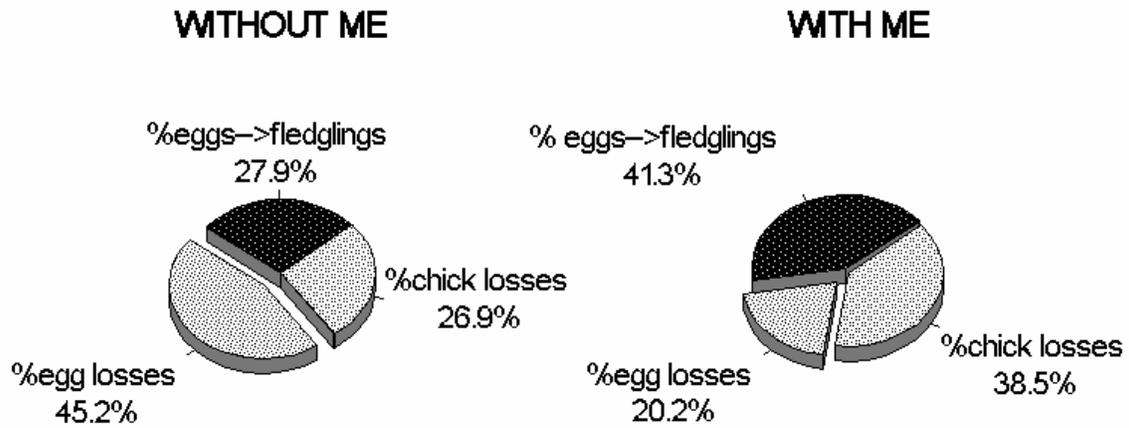
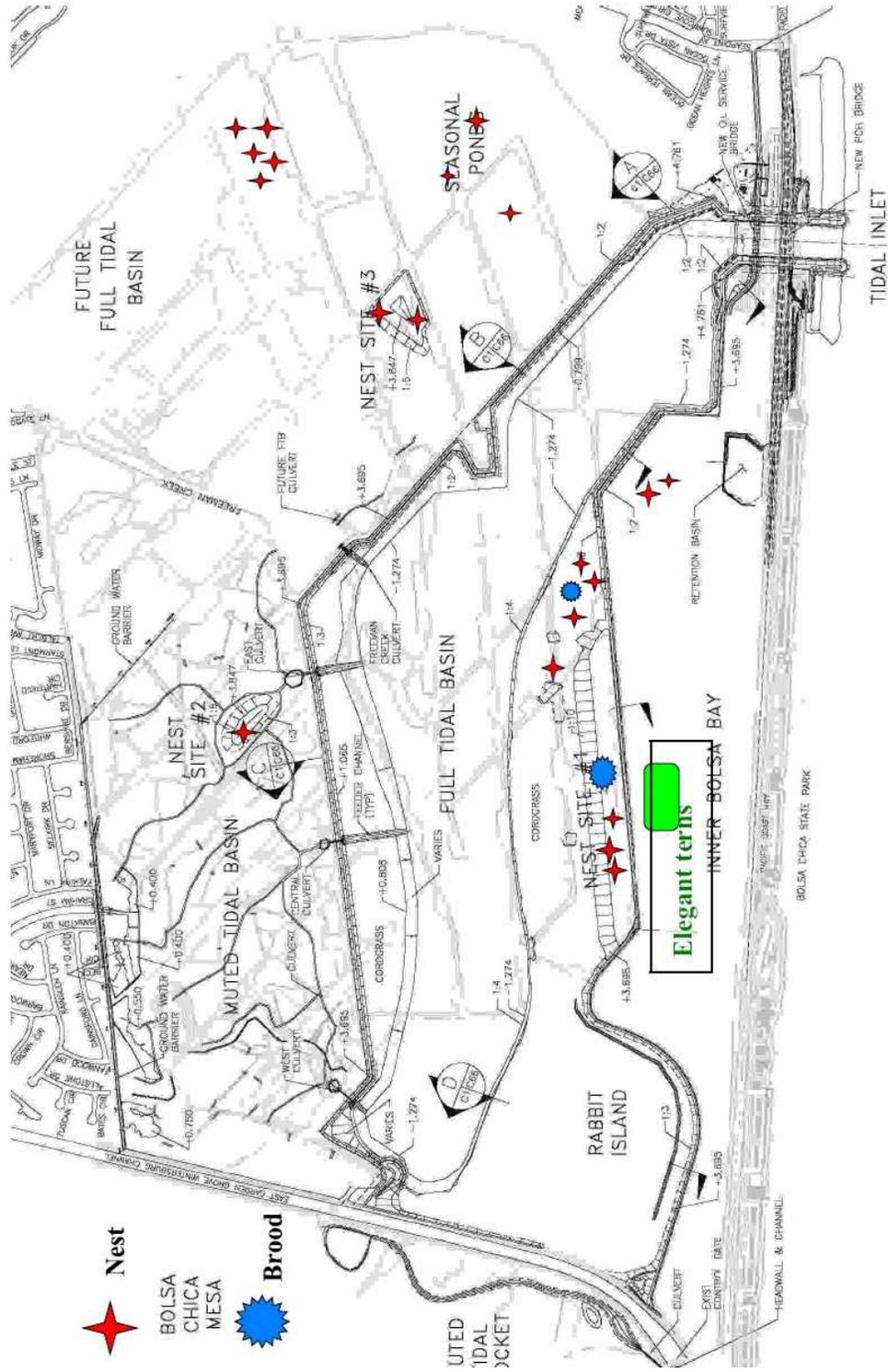


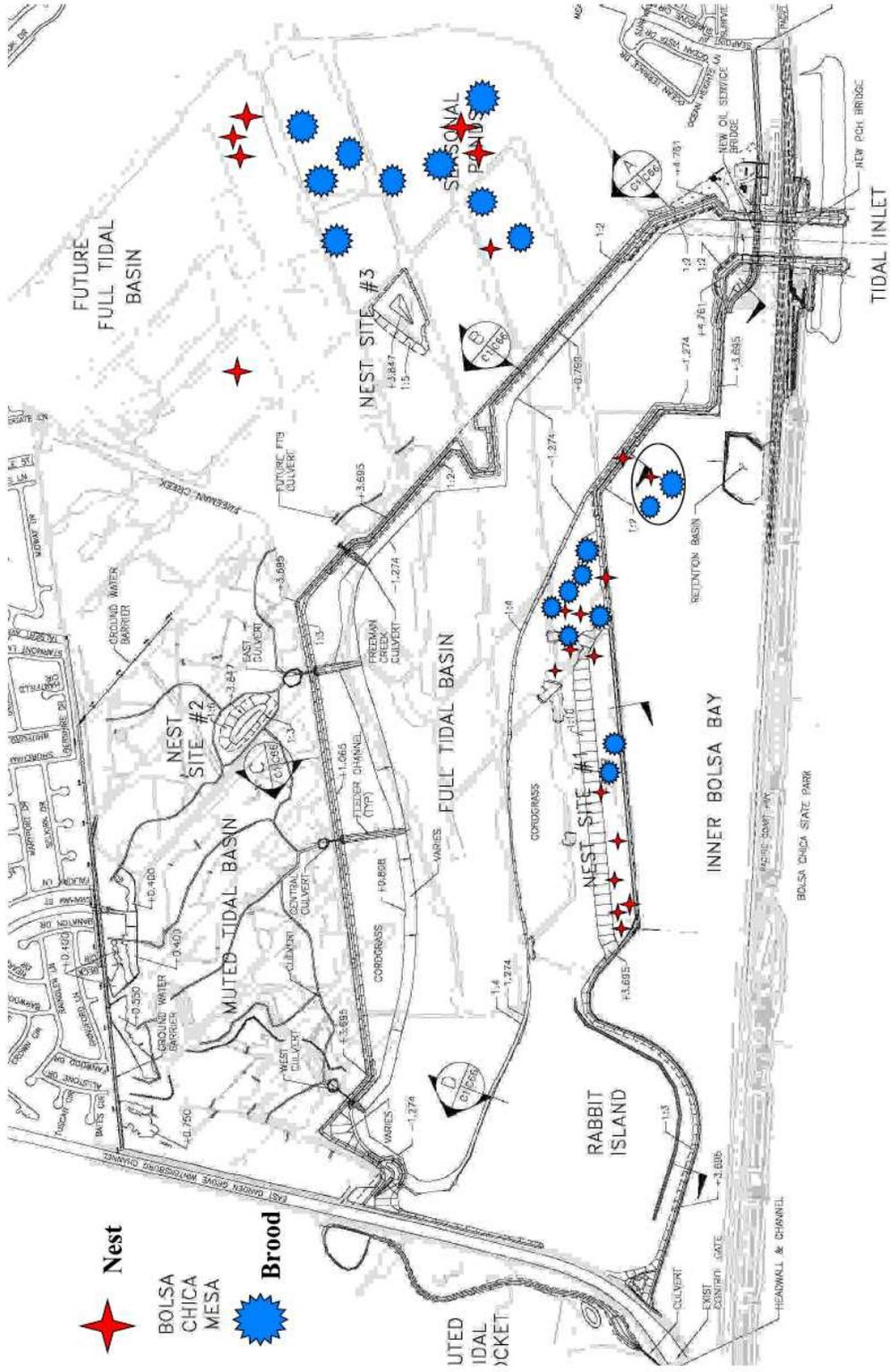
Figure 9. Snowy Plover Fledglings per Egg Without and With Mini-exclosure Protection

Plates
nest and brood locations
April 26, 2006
May 13, 2006
June 13, 2006
July 20, 2006



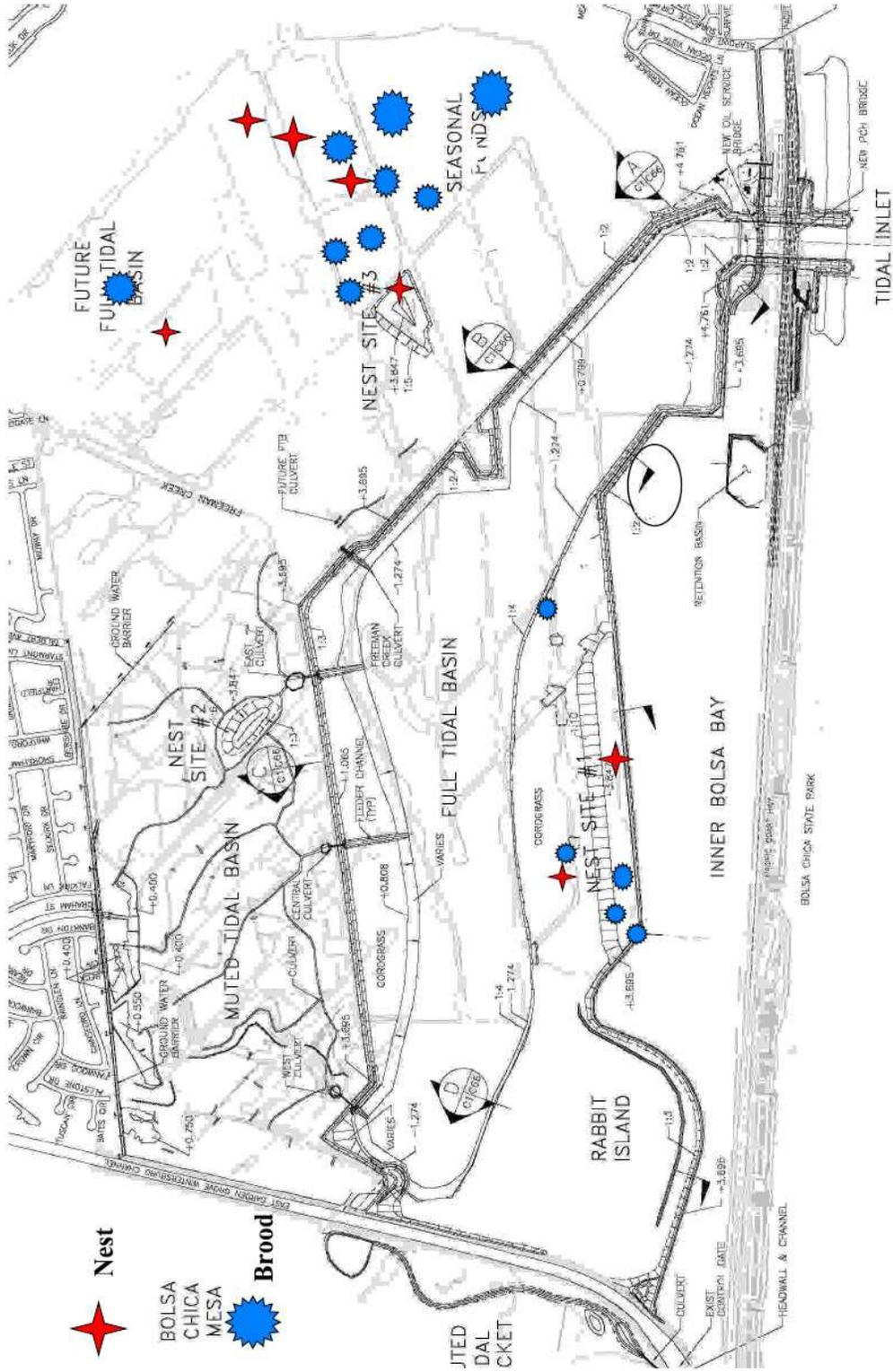
Jack Fancher USFWS (760) 431-9440x215

Snowy Plover nest and brood locations 2006 May 13



Jack Fancher USFWS (760) 431-9440x215

Snowy Plover nest and brood locations 2006 Jun 13



★ **Nest**
★ **Brood**
 BOLSA CHICA MESA

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Snowy Plover nest and brood locations 2006 July 20