

Western Snowy Plover incubating nest inside mini-enclosure photo by J. Fancher

Western Snowy Plover Nesting at Bolsa Chica, Orange County, California 2002

by Jack Fancher, Loren Hays, and Peter Knapp



Fish and Wildlife Service
Carlsbad Office
December 2002

Introduction

In February 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. In the six years since, the restoration planning, Environmental Impact Statement/Report, and permitting have been completed. A Biological Opinion, prepared pursuant to section 7 of the Endangered Species Act and considering the information gathered in these studies, concluded that the western snowy plover would not be harmed by the proposed Bolsa Chica restoration project.

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 expected to continue through construction of the Bolsa Chica restoration project. This report addresses the 2002 snowy plover breeding season at Bolsa Chica.

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.



Snowy plover male with chick by J. Fancher

The breeding season of the western snowy plover extends from March 1 through September 15. Generally, three eggs are laid in a nest which consists of a shallow depression scraped in the substrates. 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 reneest 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, thermoregulation 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

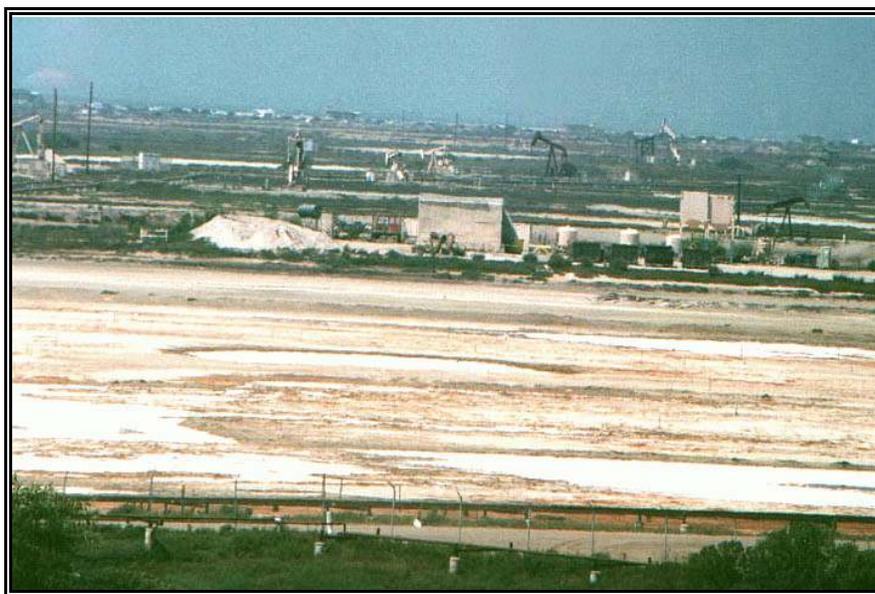
approximately 31 days of hatching. Double brooding and polyandry are the norm. Snowy plover females may leave very young chicks to find another mate, leaving the male to care for the brood. Western snowy plover adults and young forage on invertebrates along intertidal areas, along beaches in wet sand 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 beachgrass, 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 June 2002 U.S. breeding season range-wide survey estimated 1,501 individuals, found mostly in California.

Our studies from 1997-2002 have examined the scope, magnitude, and problems of snowy plover breeding activity at Bolsa Chica.

Bolsa Chica Study Area

Bolsa Chica, while under full tidal influence 105 years ago, is now diked-off from direct tidal influence. The State's Ecological Reserve, adjacent to but not within the study area, is under a muted tidal influence that was restored in 1978. Bolsa Chica is a lowland area between two mesas, the Bolsa Chica Mesa and the Huntington Beach Mesa (Figure 1). Its soils and groundwater are highly influenced by salt of ocean origin and most of the study area remains below mean sea level and has no drainage. The human presence in our study area is almost entirely related to the operation of the oil field, such as large and small oil service vehicles on the roads and well pads.



Bolsa Chica cell 22 and 23 looking west

by J. Fancher

Today, the approximately 900-acre study area, with its crisscrossing pattern of roads and dikes, is artificially subdivided into smaller cells of varying area and configuration. Some cells display the physical features of tidal channels formed a century ago, others have been modified by oil field operations decades ago but are not now actively disturbed. This situation has resulted in three general surface conditions within the cells of the study area: 1) thickly vegetated with salt marsh plants, primarily non-tidal pickleweed, *Salicornia virginica*, 2) unvegetated flats, and 3) shallow ponds. Within the unvegetated areas (roughly 340 acres), the extent of ponded water or exposed flat varies with the seasons and between years. Typically, following winter rains the ponded areas are more extensive, but as evaporation begins to dominate in summer, the ponded areas shrink and more unvegetated flats are exposed. A few small areas are covered with water year-round.

Study Methods

The study area is demarcated into subareas (cells) by the network of slightly elevated roads constructed for access to the oil wells. These cells were numbered and formed the basis for observer navigation, nest mapping, and data recording. 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 tidal mudflats of outer Bolsa Bay, or the tidal flats. See figure 1. The study area included all the numbered cells, except cells 47 and 64, which remain in private ownership.

The cells are of different configuration and area. The gross area of some key cells are: cell 4, 30 acres; cell 8, 20 acres; 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 3, 5, 30, and 38) are unsuitable for nesting but the margins were regularly checked for nesting plovers.

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 an automobile 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 several 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. Rarely, the observer would 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 conducted only once or twice per nest. Upon discovery, most nests were marked with a two-foot long stick stuck in the substrate about 15 feet from the nest to facilitate relocation during subsequent observations.

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 feasible to track and record histories of individual broods since there was dispersion over space and time sufficient to differentiate between broods. (Banding of chicks was not done in 2001 or 2002, as had been done in 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.

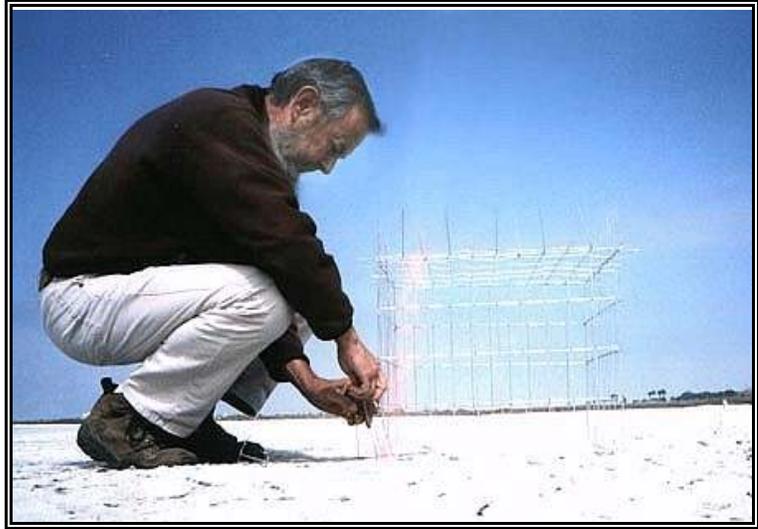
Observations were made of potential predators during our surveys. Predator management actions were then enacted commensurate with the threat to snowy plover breeding activity by that specific predator. Because crows have been a serious, omnipresent predator of snowy plover eggs in previous years at Bolsa Chica, eradication measures were begun in March and continued while plover breeding was continuing. A crow trap was activated in June and discontinued in July. Three still cameras, with built in motion detector triggers, were placed 4-5 meters from individual snowy plover nests. The camera motion sensor was blocked and aimed to photograph any potential predators that closely approached the plover nest but not the plover. The cameras were aimed just above the plover nest to avoid photographing the snowy plover as it moved around the nest scrape. These cameras were deployed throughout the plover breeding season.

To preclude plover egg losses to predators, plover nest enclosures were deployed during the second half of the snowy plover breeding season. The enclosure design we employed departs somewhat from those found in the snowy plover draft Recovery Plan and other pertinent literature. The enclosure design we elected to use is much smaller, more easily and quickly constructed and placed than those found in the draft Recovery Plan. Our design was specifically aimed at preventing crow/raven predation on plover eggs at Bolsa Chica. We dubbed the reduced-size design “mini-enclosure” (ME).



Mini-enclosure over snowy plover nest by J. Fancher

The ME's were constructed from galvanized, welded 18-gauge wire with 2 inch by 4 inch openings. Five 20-inch square panels were fastened together to make a cube with an open bottom. (The panels were fastened together in a manner that allows folding the ME flat for storage when not in use.) Zip ties were used for final assembly once the panels were unfolded and the top panel was in place. When a snowy plover nest was first discovered, the ME was assembled away from the nest site and quickly carried out to the nest location by the observer and stapled into the substrate over the nest so that it could not be dislodged. Weeks later, when the nest hatched and the brood left the scrape, the ME was recovered.



ME placed over snowy plover nest and "stapled" into mud. by autcamera

Results and Discussion

NEST CHRONOLOGIES AND DISTRIBUTION

Plentiful unvegetated flats were available for snowy plover nesting early in the 2002 breeding season, because of the below average winter rainfall. As in years before, individual nest locations, substrates, and configurations vary. Most were located in largely unvegetated areas, although some are next to or within small tufts of pickleweed. Most were simple scrapes, excavated slightly into the mud or sand. A couple were among salt crystals. Some were lined with small gravel and shell fragments, or dried pickleweed parts and a few were pre-existing shallow depressions.

No snowy plover nest was attempted in 2002 on either of the two tern nesting islands. No nests were found on a road top, although nest scraping was evident. All of the 2002 nests were located in cells that had extensive exposed flats (Figure 2, Table 2). In 2002, four cells (4, 11, 17, and 22) supported 66% of 50 total nests. Cell 17 has usually had ponded water throughout the breeding season in other years and was rarely used by nesting plovers. It was mostly dry during 2002 and attracted five plover nest attempts. Similarly, cells 13 and 14, usually with ponded water, but mostly dry in 2002, attracted 6 total nests between them. Three cells that had been well used in previous years were hardly used at all in 2002 (9, 10, and 19).

In 2002, the first nest was found April 9. The last nest was started July 15, and the latest nest hatching occurred on August 7 (Table 1, Figure 3 and 4). Through April, the number of active nests was 3 or 4, jumping to 10 in May. The number of active nests built to a peak of 17 in early July (Figure 5).

Nine nests were initiated early in the 2002 breeding season, before May 1st (18% of total nest attempts), with 11 (22%) in May, 20 (40%) in June, and 10 (20%) in July (Figure 4). The average proportion of nest initiations by month over the 6 years of this study (246 total nests initiated) are: 14.2% of nests were initiated in March and April, 28.5% in May, 41.1% in June, and 16.2% in July. On average and in 2002, the peak month for nest initiations at Bolsa Chica is June. Comparing the 2002 season to the 6-year monthly distribution of nests starts, shows a slightly above average number of nests started before May 1, but below average nest starts in May. June 2002 was close to, and July 2002 was slightly above, the 6-year average.

EGG, CHICK, AND FLEDGLING PRODUCTION

Out of 50 total nests in 2002, 32 were 3-egg clutches (Table 1). Of the other 18 nests, 11 were 2-egg clutches and seven were lost before the clutch was determined to be complete. At least 132 snowy plover eggs were produced at Bolsa Chica in 2002 (Figure 8). Twenty one of the 50 total nest attempts were unsuccessful (19 predated, 2 abandoned, nest failure rate of 42%, Figure 7). Twenty nine nests survived to hatch. From those 29 nests that hatched, 75 chicks were produced. Of these 75 total chicks, just 27 chicks survived to fledge (36% chick survival). In only four broods did all three chicks survive to fledge, and 13 broods had no chick survive to fledging.

Severe nest losses between April and early June moved us to deploy ME's to protect nests from presumed corvid predation. Of 30 total nests, 18 nests or 60%, were lost before June 18, primarily to egg-robbing predators. Following June 18, nest failure fell to 15% (3 of 20). ME's and their apparent effectiveness will be discussed in the Predation section, below.

Despite high nest loss early in 2002 breeding season, 75 chicks were produced. This was the highest of all study years (2001-63, 2000-51, 1999-71, 1998-67, 1997-44). See Figure 8. However, chick survival (27 fledglings produced) was much lower than 2001 or 2000, and about the same as 1999 and 1998 (Table 3). The number of fledglings produced per nest attempt in 2002 was 0.54 fl/nest, the lowest of all years (1.04 fl/nest in 2001, 1.08 in 2000, 0.74 in 1999, 0.61 in 1998). Of the 29 nests that hatched in 2001, an average of 0.9 fledglings were produced per hatched nest and chick survival was 36%. This chick survival rate is similar to 1998 (37.3%) and 1999 (32.4%), and much lower than 2001 (90.5%) or 2000 (82.4%). In 2002, the average number of fledglings produced per adult male was the lowest of any previous year at 1.4 (27 fledglings and 20 males). In 2001, it had been 3.2 (57 fledglings and 18 males) which was higher than any previous year (2000-2.6, 1999-2.1, and 1998-1.6).

NUMBERS OF MALE, FEMALE, AND JUVENILE SNOWY PLOVERS

During the winter it is not uncommon to find many more snowy plovers out on the adjacent beaches than in the wetland area. By middle March 2002, between 36 and 44 snowy plovers were seen in the Bolsa Chica wetlands. In the second week of April, when the first three nests were initiated, there were about 15 females and 15 males present (Figure 3). Through May, with active nests varying between 4 and 6, there were between 5-15 females and 6-25 males. The peak numbers of males and females in late May/early June indicate that the breeding population at Bolsa Chica in 2002 was 19 females and 20 males. (The U.S. range-wide window survey report for Bolsa Chica was June 4 when there were 20 male and 12 female adults, and 8 active nests.) This is about the same as 2001, although the number of males and females continued to swing up and down through the remainder of the breeding season. Active nests peaked in early July at 17, at which time we estimated 16 males and 19 females were present.

During most of April and May of 2002, the total number of snowy plovers present at Bolsa Chica was between 25 and 50, although occasionally there were as many as 55 (Figure 6). Starting in June, with the increasing presence of juveniles and migrating plovers, the total number of plovers at Bolsa Chica swells to between 50 and 80. This pattern is very similar to previous years, although total number of snowy plovers present during June of 2001 was higher than the corresponding total in 2002.

BROOD TRACKING

We again observed that females did virtually all of the incubation of eggs and males did all of the brood rearing. Sometimes the male was seen to take over incubation of eggs just prior to the hatching of the clutch. 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 comingling with other broods. In 2002, perhaps because of the drier or "low prey" conditions or perhaps because of "harassment" by predators, many broods rapidly dispersed away from the nest cell and could not be found regularly in brood rearing areas. For example, broods from cells 22, 13, 14 moved toward cells 11 or 8, and from cells 17 and 6 to cell 4. This apparently greater degree of brood movement may have contributed to the high chick loss observed in 2002 by increasing stress, starvation, greater exposure to predators, or even by the clear dangers associated with crossing roads. Broods hatched in cells 4 and 11 stayed in those cells. Six "nests" were discovered after they had hatched and the location of the "new" brood, when first observed, was inferred to be the location of the nest.

OBSERVATIONS OF BANDED ADULTS

Four banded snowy plovers nested at Bolsa Chica in 2002. One female (YKGY) that was hatched at Camp Pendleton in 1997, nested there and Bolsa Chica in 1998, has nested at Bolsa

Chica twice in 1999 and twice in 2000. She nested three times at Bolsa Chica in 2001, with two of these nests producing six chicks. In 2002, YKGY nested twice at Bolsa Chica (nest 10 in cell 11 and nest 44 in cell 4) producing two chicks. Another female (øKKK), hatched at Camp Pendleton in 1999, nested twice at Bolsa Chica in 2000, and three times in 2001, with two surviving nests hatching five chicks. In 2002, øKKK nested twice (nest 20 in cell 11 and nest 32 in cell 14), producing two chicks. A female hatched at Bolsa Chica in 1999 (YNRR♀) nested twice at Bolsa Chica in 2000 and again twice in 2001. YNRR♀ is known to have nested once at Bolsa Chica in 2002, but this nest was abandoned. A male (YNGW♂) hatched at Bolsa Chica in 1999, was not seen in 2000, unsuccessfully nested once at Bolsa Chica in 2001, and raised two fledglings from nest 41 in 2002. It is possible that each of these banded birds may have participated in other undetected nest attempts at Bolsa Chica.

PREDATION

In 2002, about 38% of all nests (19 of 50 nests, 2 abandoned, Table 2), were lost to predation. Although nest loss/egg predation was highest in 2001 of all study years in both raw numbers and proportion of total nests, 2002 ranks second in this category (Figure 7). Despite the severe egg predation early in 2002 before deployment of MEs, the numbers of nests hatching and chicks produced was higher than all previous years. Actually, nest predation is probably underestimated since it may occur before we discover the nest.

Disturbance signs are largely absent from most predated plover nests. However, circumstantial evidence indicated that corvids, specifically the very abundant and omnipresent American crow (*Corvus brachyrhynchos*) and the common raven (*Corvus corax*), are responsible for most nest depredation. Several photographs taken by the motion sensitive cameras aimed at snowy plover nests confirmed that crows and ravens are indeed the primary snowy plover egg robber at Bolsa Chica. The photographic evidence only shows the crow or raven as it approached the plover nest. No pictures were obtained of the crow/raven lifting an egg from the scrape because of the 3 minute delay in taking the next picture. That is, the entire clutch was removed before the next picture was taken, leaving no visible evidence behind.



American crow approaching snowy plover nest 14

Due to the great abundance of crows and their seemingly endless encroachment into the

wetland from the surrounding urban area, removal of crows from Bolsa Chica has been emphasized (Table 6). As in 2000 and 2001, crows were removed from Bolsa Chica starting in March. Fifty-two crows were removed from Bolsa Chica in 2002 (Ross 2002). However, the tally of crows removed from Bolsa Chica in the last three years, greatly understates the actual problem for nesting snowy plovers. Many crows apparently learn to avoid our removal efforts by moving back and forth between the wetland and safe refuge of the adjacent urban areas. The adjacent urban area may also have such a large “reservoir” of crows to replace the Bolsa Chica intruders that removal is practically ineffectual. Also, the loss of snowy plover eggs has been highest in these last two years even though crow removal has been greatest. More effective defensive methods against crows appears warranted, such as improved crow traps or plover nest exclosures.

We activated a modified Australian crow trap in 2002. While initially successful, the crow trap eventually appeared to attract more crows to the area than were ever induced to enter it. Since the crow trap was located between cells 12 and 13, with plover nests in surrounding cells, the crow trap was deactivated to reduce crow attraction to the area.



Modified Australian crow trap deployed at Bolsa Chica by P. Knapp

By mid-June with crow removal underway and the crow trap deployed, 60% of snowy plover nests had still been lost to predation. Experimentation with an easily constructed and deployable ME began June 18. It was rapidly evident that the incubating female plovers quickly ignored the ME. The ME was easily prefabricated and assembled elsewhere. When the researcher exited the vehicle and began walking toward the nest the incubating plover stood and ran some distance away. The ME was anchored in place over the nest and the researcher walked quickly away. Typically, by the time the researcher had reentered the vehicle and looked back at the nest, the adult plover was returning to the nest. The total elapsed time was 3-4 minutes. Later, when the nest was nearing hatching and the male was seen to share in incubation, he too appeared to ignore the presence of the ME. We began placing an ME on each nest as soon as the nest had been discovered.

An ME was placed on the 20 nests discovered after June 18 (Figure 9). All but three of those 20 nests were thought to have hatched. Of these three nests that failed after deployment of the MEs, one was abandoned due to rising water level and one was abandoned late in the breeding season for unknown reasons. The third nest was lost to predation after the ME was removed. The ME was removed June 28 because activity of native fire ants around the nest was agitating and displacing the incubating female probably leading to nest abandonment. It was hypothesized that the ME may have constrained her defense against the ants. Ant bait (*Maxforce*

granular) was applied around the nest and a camera was aimed at the nest. The nest was predated July 2, but the camera did not fire, possibly due to weak batteries.

Several of the nests protected by an ME also had a motion-sensitive camera aimed at them. For the most part, no attention by any potential predator was recorded or observed to be given to an ME. In one instance, a crow was photographed stalking around the ME but the nest was not lost, and did successfully hatch days later. In a second instance, a red-tailed



Red-tailed hawk prowls around nest #23 ME for new plover chicks

hawk (*Buteo jamaicensis*) was repeatedly photographed over a 30 minute period stalking around a very recently hatched nest with three chicks. Only one chick survived this event, presumably by not having left the protection of the ME. A family of red-tailed hawks from a nest in cell 32 was routinely observed foraging in, or immediately adjacent to plover breeding areas in Bolsa Chica in 2002. Plovers incubating eggs would largely ignore the hawks, but leave the area of their chick brood while the chicks lay motionless. The red-tailed hawk clearly will, at least occasionally, take snowy plover chicks, as the photographs around the ME indicate.

The ME-protected plover nests fared much better than unprotected nests. The loss of nests decreased significantly at the study site during the 2002 breeding season after we began universally placing MEs over newly discovered nests ($P < 0.005$; multiple contingency chi-square [Yates correction factor applied]; statistic=10.47). However because plover chicks are almost immediately motile and typically leave the nest scrape within hours of hatching, the ME had no value in protecting chicks. It is possible that chick predators, such as crows, ravens, red-tailed hawk, American kestrel (*Falco sparverius*), and loggerhead shrike (*Lanius ludovicianus*) may eventually learn that the ME increases their chances of capturing a plover chick. Since the plover chicks are associated with the ME for such a short time and there were no observations of predators investigating or inspecting an ME, except for the above instance, this seems unlikely. On the current absence of data to the contrary, we conclude that there is, overall, large nest protection benefit that results from utilizing this ME design at Bolsa Chica.

The low survival rate of snowy plover chicks in the 2002 breeding season, following the much higher chick survival rates of 2000 and 2001, suggests several potential scenarios. One possibility is that the drier conditions created fewer insect and crustacean prey for snowy plover chicks and more chicks starved to death. A second possibility is that plover broods moving across roads and through unfamiliar cells, in search of food, were more exposed to vehicle or predator mortality. A third possibility is that broods were pressured to move across roads and away from familiar brood territories by the greater and/or more regular presence of predators, such as crows, thus increasing their exposure to vehicle or predator induced mortality. The fourth and most likely reason for higher chick mortality in 2002, compared to 2001 and 2000, is

the principal snowy plover chick predators, kestrels and shrikes, had re-occupied areas or were more abundant than in previous years. Our 2002 predator management response to kestrels and shrikes (live capture and transport) was perhaps not sufficiently timely or effective given the large number of small snowy plover chicks that a few of these birds can take in a relatively short time.

Predator management efforts at Bolsa Chica have been increased in the last several years with emphasis on matching the response effort and removal method to the threat to breeding snowy plovers posed by the predator and an appropriate regard for the predator. Consequently, we still have taken no action against large hawks, owls, peregrine falcon, or coyote. (To protect least tern and other breeding terns, a peregrine falcon may occasionally be live-captured at Bolsa Chica and transported away. None were captured at Bolsa Chica in 2002.) Crows remain a major problem because of the seemingly endless supply of them entering Bolsa Chica from the adjacent urban area. Continued and increasingly aggressive crow management appears warranted. Kestrels seem to be abundant and can do great harm very quickly. Therefore, efforts to remove them from Bolsa Chica during the snowy plover breeding season must continue. Shrikes are not abundant however a few shrike foraging territories cover large portions of Bolsa Chica snowy plover breeding areas. It is not clear that shrikes can or will capture larger snowy plover chicks, but plovers are greatly agitated by the presence of shrikes and small plover chicks are vulnerable. We conclude that continued live-trapping and transport of shrikes from Bolsa Chica during the breeding season is warranted.

SUMMARY

Less than average rainfall in 2002 resulted in extensive exposed flats early in the breeding season, but this did not facilitate a large pulse of early season plover nests. The number of males and females was about the same as 2001 and total nest attempts were slightly lower. High nest loss to predation during April to early June induced our deployment of mini-exlosures (ME) to prevent egg loss to crows and ravens. The MEs virtually eliminated nest predation thereafter. Even with severe nest loss in the first half of the season, more chicks hatched in 2002 than in any prior year of this study at Bolsa Chica. Unfortunately, chick survival was as low as 1998 and 1999, and very much below 2000 and 2001 levels. The presumed chick predators are American kestrels and loggerhead shrikes. Lastly, despite our finding no dead chicks, the dryer than normal conditions at Bolsa Chica in 2002 may have reduced the plover chick's prey base significantly, thus potentially causing chick starvation.

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. We thank the USGS Biological Research Division for the loan of the cameras.

Literature Cited

Tables

- Table 1. Snowy plover eggs laid, chicks hatched, and fledged at Bolsa Chica, 2002
- Table 2. 2002 Nest and Fledgling Distribution by Cell
- Table 3. Males, Females, Nests and Fledgling production
- Table 4. Predator Removal Summary

Figures

- Figure 1. Bolsa Chica Vicinity Map
- Figure 2. 2002 Nest Location Map
- Figure 3. 2002 Males, Females, and Active Nests over Time
- Figure 4. Nest Initiation, Hatching, & Loss Dates
- Figure 5. 1997-2002 Active Nest Chronologies
- Figure 6. 1997-2002 Total Individuals
- Figure 7. 1997-2002 Nest Fates and Fledglings Produced
- Figure 8. Egg, Chick, and Fledgling Production 1997-2002
- Figure 9. Nest Hatching Success With and Without Mini-exclosure

Literature Cited

- Fancher, J. 1998. Western snowy plover nesting at Bolsa Chica, Orange County, California. 1997. A report of the Fish and Wildlife Service, Carlsbad Office. April 1998. 22pp.
- Fancher, J., R. Zembal, L. Hays, and P. Knapp. 1998. Western snowy plover nesting at Bolsa Chica, Orange County, California. 1998. A report of the Fish and Wildlife Service, Carlsbad Office. October 1998. 27pp.
- Fancher, J., L. Hays, and P. Knapp. 2001. Western snowy plover nesting at Bolsa Chica, Orange County, California 1999 and 2000. A report of the Fish and Wildlife Service, Carlsbad Office. February 2001. 34pp
- Fancher, J., L. Hays, and P. Knapp. 2002. Western snowy plover nesting at Bolsa Chica, Orange County, California 2001. A report of the Fish and Wildlife Service, Carlsbad Office. February 2002. 34pp
- Ross, W.L. 1999. Bolsa Chica wetlands 1999 breeding season predator management report. A report for the Fish and Wildlife Service. 3pp.
- Ross, W.L. 2000. Bolsa Chica wetlands California least tern, western snowy plover, 2000 breeding season predator management report. A report for the Fish and Wildlife Service. 10pp.
- Ross, W.L. 2001. Bolsa Chica wetlands California least tern, western snowy plover, 2001 breeding season predator management report. A report for the Fish and Wildlife Service. 9 pp.
- Ross, W.L. 2002. Bolsa Chica wetlands California least tern, western snowy plover, 2002 breeding season predator management report. A report for the Fish and Wildlife Service. 9 pp.
- U.S. Fish and Wildlife Service. 2001a. Formal section 7 Biological Opinion on the Bolsa Chica Lowland Restoration Project, Orange County, California (FWS No. 1-66-01-1653). April 16, 2001. 22pp with attachment.
- U.S. Fish and Wildlife Service. 2001b. Western Snowy Plover (*Charadrius alexandrinus nivosus*) Pacific Coast Population Draft Recovery Plan. Portland, Oregon. Xix + 630 pp.
- U.S. Fish and Wildlife Service, Corps of Engineers, and State Lands Commission. 2001. Final environmental impact report/environmental impact statement for the Bolsa Chica Lowlands Restoration Project. April 2001. Appendices A-H and Volumes I-VI.

Table 1. Snowy plover eggs laid, chicks hatched, and fledged at Bolsa Chica, 2002.

<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	22	4-9	5-6	3	P	-	-
2	22	4-9	5-2	3	H	3	1
3	4	4-9	4-12	2	P	-	-
4	22	4-16	4-29	3	P	-	-
5	9	4-21	4-23	2	P	-	-
6	6	4-21	5-18	3	H	3	1
7	22	4-25	4-29	2	P	-	-
8	22	4-26	4-29	2	P	-	-
9	4	4-30	5-8	2	P	-	-
10	11	5-8	5-16	3	P	-	-
11	36	5-10	5-13	2	P	-	-
12	10	5-13	5-16	2	P	-	-
13	11	5-15	5-18	2	P	-	-
14	22	5-15	6-3	3	P*	-	-
15	4	5-18	6-18	2	H	1	1
16	4	5-18	6-18	3	H	3	3
17	8	5-24	6-14	3	H	3	3
18	11	5-30	6-12	2	P	-	-
19	22	6-2	6-18	3	P*	-	-
20	11	6-2	6-12	3	P	-	-
21	11	6-2	6-12	3	P	-	-
22	62	(5-5)	6-2	3	H	3	3
23	22	6-4	6-25	3	H*	1	1
24	4	6-5	6-27	3	P*	-	-
25	11	6-5	6-13	3	P	0	0
26	13	6-18	7-9	3	H	3	1
27	4	(5-21)	6-18	3	H	3	2

<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>
28	13	6-20	7-19	3	H	3	0
29	14	6-20	7-12	3	H	3	1
30	11	6-21	7-16	2	H	2	1
31	4	6-21	7-18	3	H	3	0
32	14	6-21	7-20	2	H	2	0
33	11	6-25	7-19	3	H	3	0
34	17	6-26	7-27	2	H	2	0
35	11	6-26	7-4	3	P	0	0
36	17	6-28	7-21	3	H	3	1
37	6	7-1	7-15	3	H	3	0
38	6	7-1	7-21	3	H	3	0
39	14	(6-4)	7-2	3	H	3	1
40	22	7-3	7-28	2	H	2	0
41	13	7-4	8-3	3	H	2	0
42	22	7-4	8-1	3	H	3	0
43	2	(6-7)	7-5	3	H	3	2
44	4	(6-11)	7-9	2	H	2	2
45	17	7-9	8-2	2	H	2	0
46	11	(6-13)	7-11	3	H	3	3
47	59	7-12	8-6	2	A	0	0
48	9	7-15	7-23	3	H	3	0
49	17	7-23	8-3	2	H	2	0
50	17	7-23	8-1	3	A	0	0
Season Totals				132	19P 29H 2A	75	27

*predation photographed, dates in parentheses indicate an inferred nest start date from discovery of a new brood

P = predated; A = abandoned; H - hatched

Table 2. 2002 Nest and Fledgling Distribution by Cell

Location		# total nests	# nests lost	# nests hatched	# fledged
cell	22	10	6	4	2
	11	10	3	7	4
	4	8	3	5	8
	17	5	1*	4	1
	14	3	0	3	2
	13	3	0	3	1
	6	3	0	3	1
other cells		8	4*	4	8
		50	21	29	27

*a total of two nests were abandoned

Table 3. Males, Females, Nests and Fledgling production

	Fem	Males	Total Nests	Fledglings	total Fl/nest	% chick survival	Fl/male
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

<u>2002</u>	<u>2001</u>	<u>2000</u>	<u>1999</u>	<u>1998</u>	<u>1997</u>
American crow 52	80	91	27	1	2
American kestrel 12	13	15	46	14	2
Loggerhead shrike 3	6	2	5	0	0
Common raven 5	6	3	2	0	0

Figure 1.

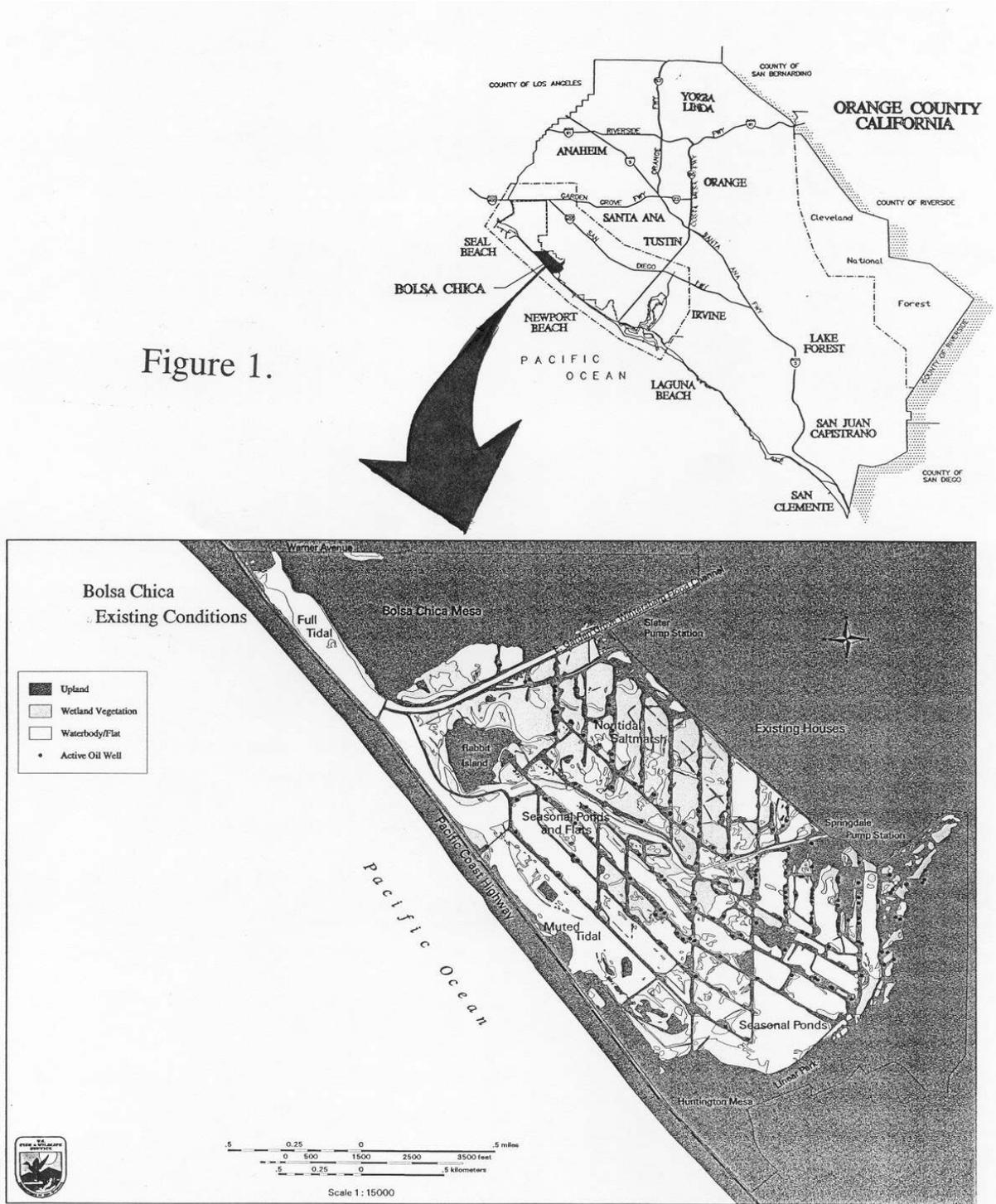


Figure 1. Bolsa Chica Vicinity Map

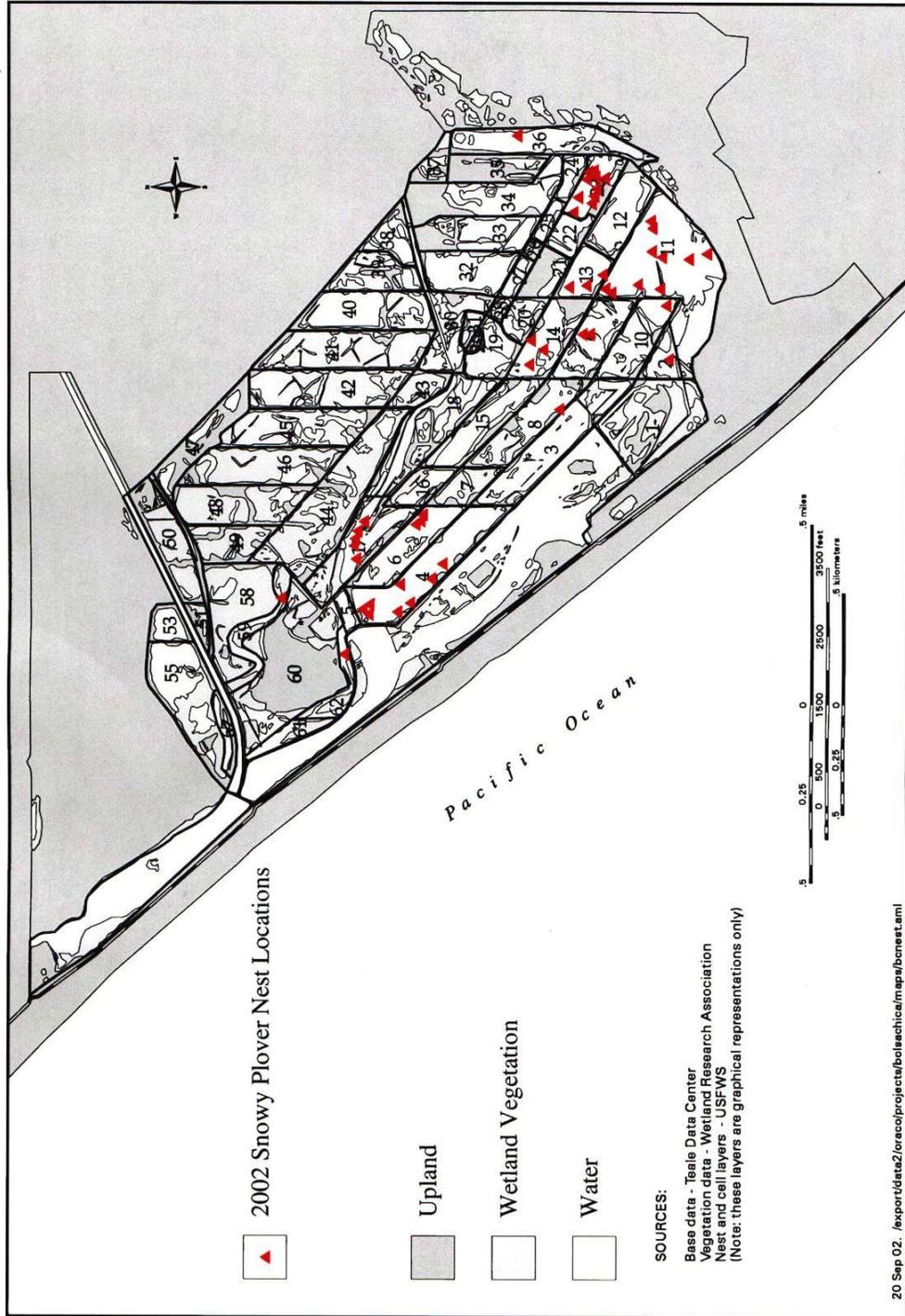


Figure 2. 2002 Nest Location Map

Western Snowy Plover

Bolsa Chica 2002 Survey

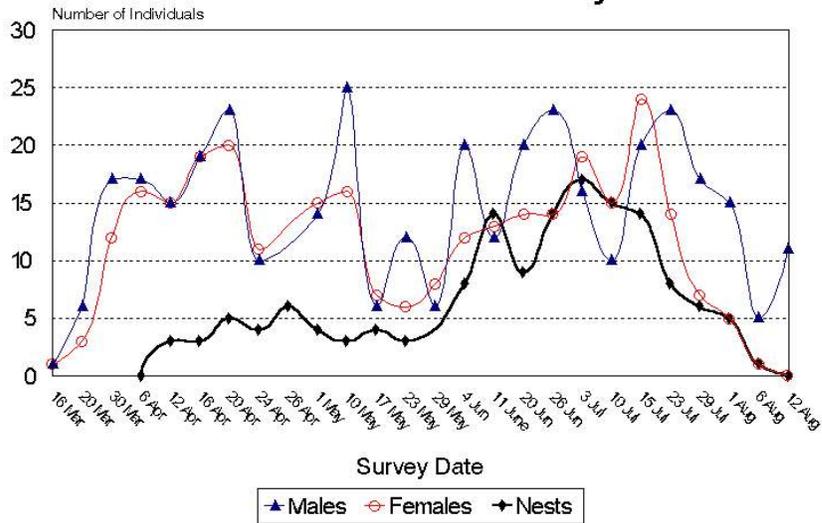


Figure 3. 2002 Males, Females, and Active Nests Over Time

Western Snowy Plover - Bolsa Chica 2002

Nest Initiation, Hatching, & Loss Dates

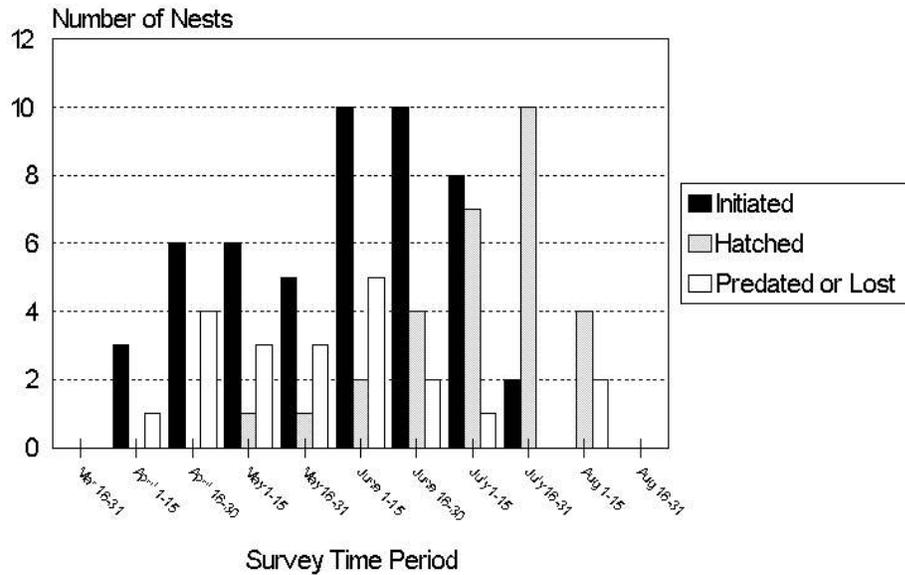


Figure 4. 2002 Nest Initiation, Hatching, and Loss Dates

Western Snowy Plover

1997-2002 Bolsa Chica Active Nest Chronology

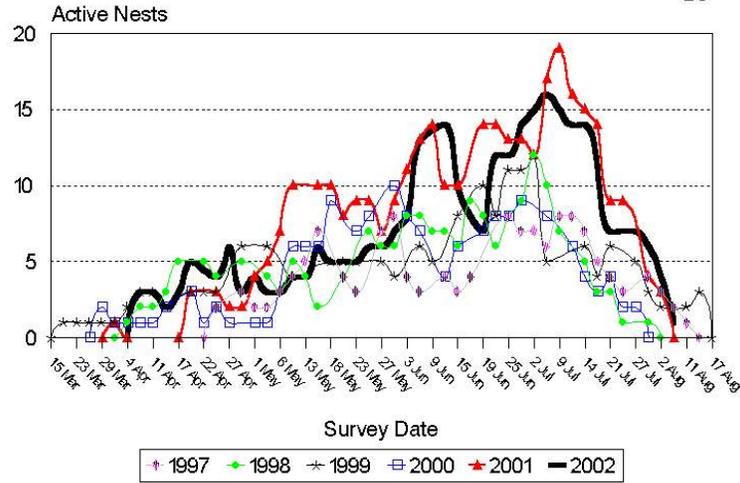


Figure 5. 1997-2002 Active Nest Chronologies

Western Snowy Plover

Bolsa Chica 1997-2002 Total Individuals

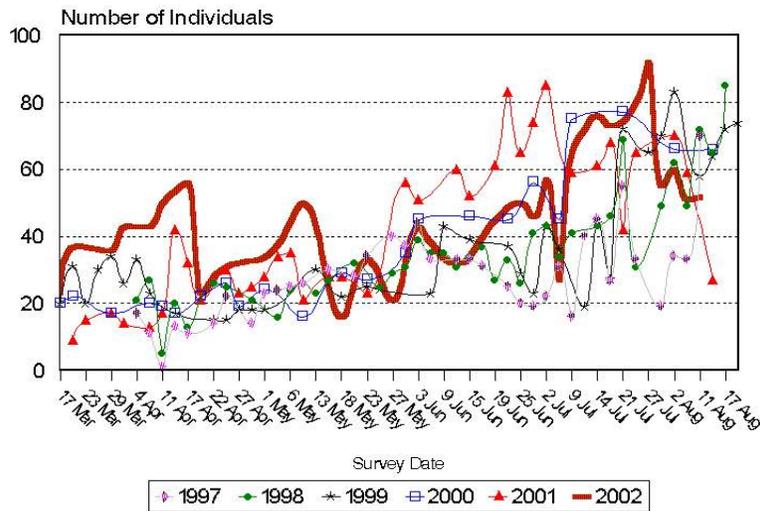


Figure 6. 1997-2002 Total Individuals

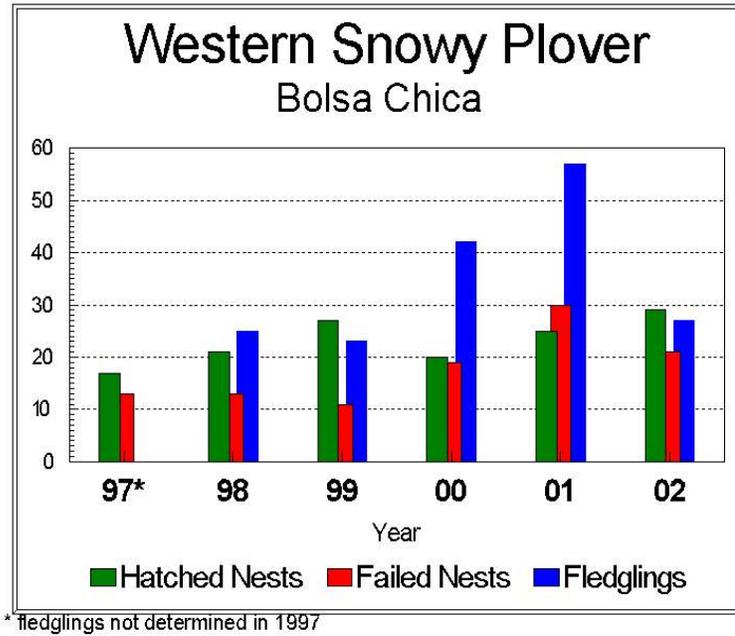


Figure 7. 1997-2002 Nest Fates and Fledglings Produced

Bolsa Chica Western Snowy Plover Egg, Chick, and Fledgling Production 1997-2002

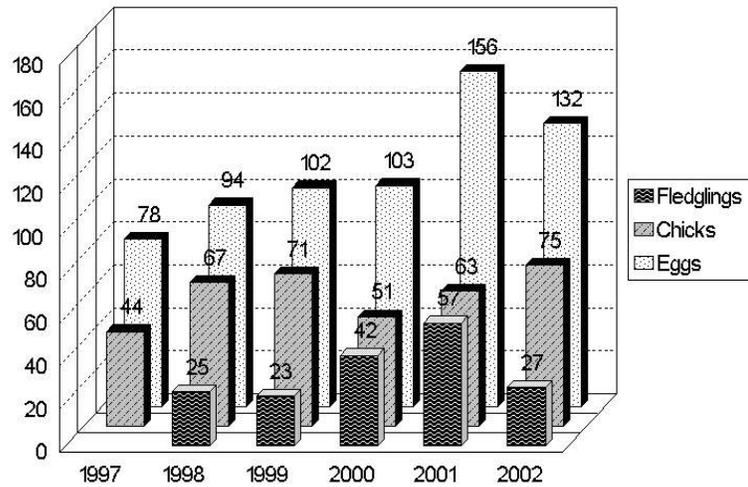


Figure 8. Egg, Chick, and Fledgling Production 1997-2002

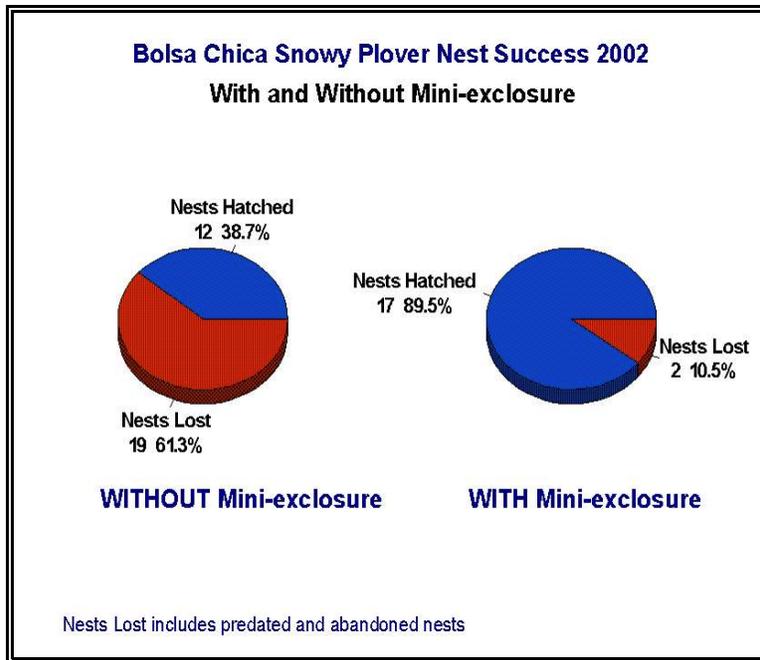


Figure 9. Nest hatching success with and without Mini-exclosure