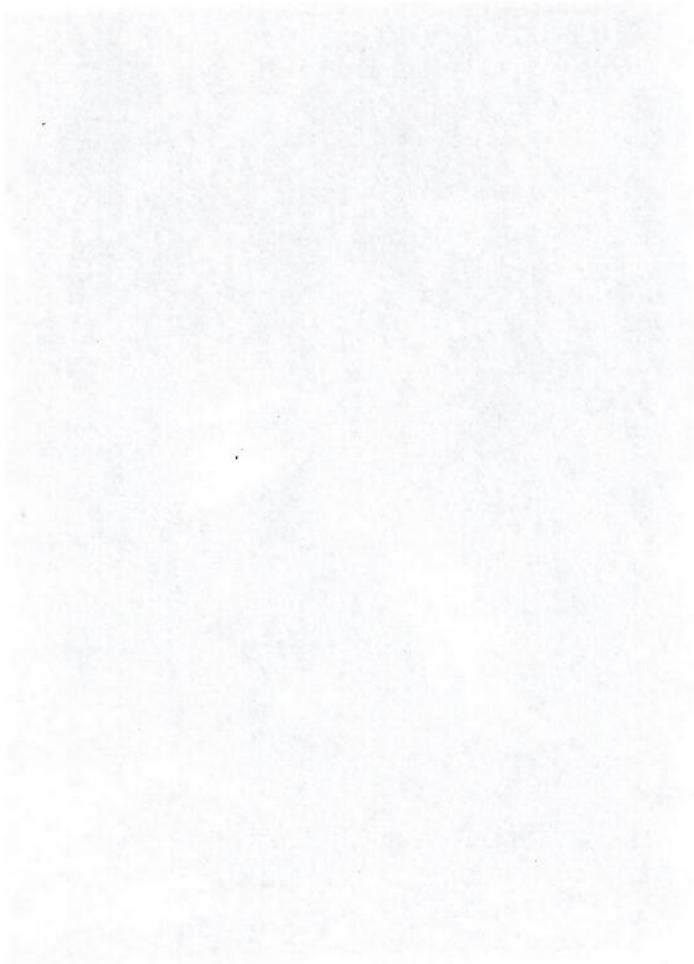




Juvenile Snowy Plover photo by Peter Knapp

Western Snowy Plover Nesting at Bolsa Chica, Orange County, California 1997

Jack Fancher, author
Fish and Wildlife Service
Carlsbad Field Office
April 1998



Faint, illegible text, possibly a title or header.

Faint, illegible text, possibly a date or reference.



Introduction

In February 1997, the study area was acquired into public ownership and that marked the beginning of a multi-agency effort to design and implement a plan for restoring the fish and wildlife habitats of Bolsa Chica. This study, among others, was implemented to improve the level of knowledge about a sensitive species that utilizes existing Bolsa Chica and which must be considered in the design of the "restored" Bolsa Chica.

Background and Current Status

The western snowy plover, *Charadrius alexandrinus nivosus*, is a small, pale-colored shorebird with dark patches on either side of the upper breast. It is one of two recognized North American subspecies, out of twelve subspecies worldwide. The Pacific coast population of the western snowy plover is reproductively isolated from the interior populations. 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 western snowy plover extends along coastal beaches from the southern portion of Washington State to southern Baja California, Mexico. Larger concentrations of breeding birds occur in the south than the north, suggesting that the center of the plovers' coastal distribution lies closer to the southern boundary of California (Page and Stenzel 1981). Prior to 1970, snowy plovers were known to breed at 53 locations along coastal California (Page and Stenzel 1981). By the early 1990's, breeding occurred at only 20 locations representing a 62 percent decline in breeding sites. The greatest losses of habitat have occurred in southern California where breeding western snowy plovers have vanished from parts of San Diego, Ventura and Santa Barbara counties, most of Orange County, and all of Los Angeles County. In all these areas the plovers' absence can be correlated with industrial or residential development and/or heavy recreational use of former beach nesting areas (Page and Stenzel 1981).

In addition to the loss of nesting habitat, the breeding population of the western snowy plover in California, Oregon, and Washington has experienced a 17 percent decline between 1977 and 1989 (Page *et al.* 1991). The breeding population in California has declined from an estimated 1565 adults in 1980 (Page and Stenzel 1981) to 1386 adults in 1989 with a 55 percent decline occurring in north San Diego County and a 41 percent decline at San Diego Bay (Page *et al.* 1991). Survey data also indicate a decline in wintering western snowy plovers, particularly in southern California. Christmas Bird counts conducted from 1962 to 1984 show a significant decrease in the number of western snowy plovers in southern

California despite increased observer participation (Page *et al.* 1986). The coastal population of the western snowy plover consists of both resident and migratory birds with some birds wintering in the same areas used for breeding (Warriner *et al.* 1986, Powell and Collier 1994).

Western snowy plovers breed in loose colonies with the number of adults at coastal breeding areas ranging from 2 to 318 (Page and Stenzel 1981). Sand spits, dune backed beaches, sparsely to unvegetated beach strands, open areas around estuaries, and beaches at river mouths are the preferred coastal nesting areas of the western snowy plover (Page and Stenzel 1981, Wilson 1980). Other areas utilized by nesting western snowy plovers include dredge spoil fill, dry salt evaporation ponds, and salt pond levees (Wilson 1980, Page and Stenzel 1981). Nest sites typically occur in flat, open areas with sandy or saline substrates with little or no vegetation (Wilson 1980, Stenzel *et al.* 1981). The majority of western snowy plover breeding adults are site faithful, returning to the same breeding location in subsequent breeding seasons.

The breeding season of the western snowy plover extends from March 1 through September 15. Egg laying begins in mid-March and continues through mid-July. Generally, 3 eggs are laid in a nest which consists of a shallow depression scraped in sandy or saline substrates. Incubation does not begin until the full clutch is laid and continues for 27-33 days with an average of 27 days before eggs are hatched (Warriner *et al.* 1986). Both sexes incubate the eggs.

Snowy plover chicks are precocial and leave the nest within hours of hatching in search of food. Broods rarely remain within the nesting territory (Warriner *et al.* 1986). Birds are able to fly within approximately 31 days of hatching. Snowy plovers will renest after loss of a clutch or brood (Wilson 1980, Warriner *et al.* 1986). Double brooding and polygamy have been observed in snowy plovers along coastal California (Warriner *et al.* 1986). If polygamous, snowy plover females may abandoned chicks as young as 6 days old to find another mate. This leaves the male as the only adult to care for the brood (Warriner *et al.* 1986). Males attend their young for 29-47 days (Warriner *et al.* 1986). Renesting may occur within the initial colony or snowy plovers may move to another nesting site (Warriner *et al.* 1986, Powell and Collier 1994).

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. Page *et al.* (1981) observed western snowy plovers moving between salt pans, tidal flats, and beaches indicating these areas function together in providing habitat for the species.

Human activities which have a detrimental effect to nesting snowy plovers include unintentional disturbance and destruction of eggs and chicks, off-road vehicle use, horse-back riding, and beach raking. Intensive beach use by humans can preclude snowy plover breeding altogether and has resulted in abandonment of nesting sites and reductions in nesting success.

Human disturbance can interfere with normal western snowy plover behavior. Disturbances to incubating adults can leave nests exposed to extreme temperatures resulting in non-viable eggs or blowing sand which buries the eggs. Western snowy plover chicks which are separated from their attending adult as a result of human disturbances or predators may become more susceptible to hypothermia since young chicks are unable to thermoregulate. It has been shown that increased human disturbance forces piping plover (*Charadrius melodioides*) chicks to expend more energy avoiding disturbances and less time foraging (Fleming *et al.* 1988). Frequently disturbed piping plover chicks fed less often and at a reduced rate with fewer chicks surviving to 17 days in areas heavily disturbed by humans (Fleming *et al.* 1988).

Areas which receive significant off-road vehicle activity support lower densities of western snowy plover nests (Page and Stenzel 1981). Powell and Collier (1994) reported a shift in beach usage by western snowy plovers from areas of heavy vehicular traffic to more protected sites. Direct mortality to western snowy plovers, as a result of vehicular activity on beaches, has been documented (Persons 1994). Research has shown a decrease in piping plover chick survivorship with as little as 10 vehicular passes per day (Melvin *et al.* 1994). Western snowy plovers, especially the flightless young, are particularly vulnerable to being run over or trampled since crouching in depressions such as footprints and tire tracks appears to be a behavioral characteristic.

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 the 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** species on March 5, 1993 (58 Federal Register 12864).

The proposal to designate western snowy plover critical habitat was published on March 2, 1995 (60 FR 11768). Proposed critical habitat designation considers those physical and biological attributes that are essential to the conservation of the species and that may require special management considerations or protection. Primary physical and biological features which are essential for the conservation of the western snowy plover are provided by intertidal beaches (between mean low water and mean high tide), associated dune systems, and river estuaries. Important components of the beach/dune/estuarine ecosystem include surf-cast kelp, sparsely vegetated foredunes, interdunal flats, spits, intertidal flats, and salt flats. Functional suitability is also contingent upon isolation from human disturbance and predation. Activities that could adversely affect proposed critical habitat include human associated disturbance of beaches including the operation of off-road vehicles, vehicles driven at night, actions which promote unnatural rates of predation, actions that would promote the invasion of non-native vegetation, shoreline erosion projects, and contamination events. In southern

California, a few sections of beach have not been subjected to the intense human uses found elsewhere. They include military installations such as the Naval Amphibious Base-Coronado and Marine Corps Base-Camp Pendleton, and are significantly used by breeding western snowy plovers. A few others, in protected status, such as a Batiquitos Lagoon State Ecological Reserve, Tijuana Estuary and Sweetwater National Wildlife Refuges, are managed to benefit western snowy plover breeding activity. Bolsa Chica was not proposed as western snowy plover Critical Habitat because such designation could impede the preparation of a plan that would further the recovery of another endangered species, the light-footed clapper rail. At this writing, there has been no determination of Critical Habitat for the coastal population of the western snowy plover.

Southern California Western Snowy Plover Breeding Activity 1994-1997

From a variety of sources and study methods, a compilation of western snowy plover breeding activity in San Diego County was prepared over the last four years (Powell *et al.* 1994-1997). Probably due in part to the increased vigilance and monitoring, but also to increased nesting area protection and management, the number of snowy plover nests in San Diego County since it was listed as Threatened in 1993, has increased at least 126 percent. The recent, seven-fold increase in snowy plover nests at Batiquitos Lagoon is a direct result of the construction of nesting areas that were not vulnerable to flooding, and were managed and protected for snowy plover breeding (Welchell and Keane 1997 & 1998). On average, in San Diego County, about half the nests are destroyed, abandoned, or eliminated by predators every year (Powell *et al.* 1994-1997). Predation is predominantly by crows (*Corvus brachyrhynchos*).

No western snowy plover breeding sites have been identified in Los Angeles County in the last 10 years. Incidental observations of western snowy plover breeding in Orange County have been noted. For example, a single nest was observed inside the California least tern nesting area at Huntington State Beach in 1993 (Stadtlander, pers. comm.). A 1995 inventory of western snowy plover breeding in Orange County (Powell 1995) detected no such activity other than the anecdote about Bolsa Chica related below for that year.

Site	94	95	96	97
Camp Pendleton	43	88	81	61
Batiquitos Lagoon	5	15	39	38
Mariner's Pt.	-	1	-	-
North Island	3	-	4	-
Coronado Beach	9	16	23	38
Coronado Bay	2	0	3	4
Silver Strand St. Bch.	?	4	7	7
Navy RRF, Coronado	1	-	2	1
Sweetwater NWR	8	11	7	10
Western Salt Works	1	?	1	4
Tijuana Slough NWR	5	11	16	11
Total	79	146	179	174

Bolsa Chica Study Area

Bolsa Chica, while under full tidal influence 100 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). An oil field has operated there since the late 1940's. Its soils and groundwater are very influenced by the salt of ocean origin and most of the study area remains below mean sea level. Today, the study area, of about 900 acres, with its criss-crossing 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 now are not actively disturbed. This has resulted in three principle surface conditions within the cells of the study area, heavily vegetated, unvegetated, and flooded. Many cells (roughly 400 acres) have areas that are always vegetated, primarily with the perennial salt marsh plant, pickleweed (*Salicornia virginica*). Many cells are largely unvegetated and have annually varying extent of ponded water or exposed flat (also roughly 400 acres). A few areas are always covered with water year-round. Thus, in March of 1997, as in most years, all the cells contained extensive ponded water with very little unvegetated flats exposed. With the end of the rainy season, the water levels began to drop slowly and the areas of unflooded salt flats grew larger. By April 1997, some small salt flat areas were exposed but relatively little suitable nesting area was available for the snowy plover at Bolsa Chica. By July 1997, most of the cells had much smaller or no areas of ponded water and very extensive areas of dry pickleweed flats or unvegetated salt flats.

Bolsa Chica Breeding Activity

While surveys for migratory bird use had been conducted at Bolsa Chica, no systematic search for western snowy plover nests are known to have been completed before 1996. The 1995 Biological Assessment prepared pursuant to section 7 of the Endangered Species Act for the Corps of Engineers, for the now-defunct wetland development project, cited a bird survey (Guthrie *et al.* 1993) and concluded that the western snowy plover was a common visitor to Bolsa Chica and "occasionally" nested there. During a one-day visit to Bolsa Chica in June 1995, eight breeding pairs were estimated (Lee Jones memo 1995). Western snowy plovers were thought to have nested in low numbers on the nesting islands within the Bolsa Chica Ecological Reserve in 1995 and 1996, but no documentation or citation was recorded. In 1996, a weekly surveillance of western snowy plovers, between April and August, at Bolsa Chica established a significantly larger breeding presence than ever before reported (Guthrie 1996). Guthrie's study, which assumed that an immobile adult, exhibiting incubation behavior on consecutive surveys constituted a nest, identified 33 such "nests" and included maps depicting their locations. The largest number of western snowy plovers seen at any one time during that study was 27, in September of 1996. While the nesting islands within the Bolsa Chica Ecological Reserve were not completely surveyed for snowy plover as part of that

1996 study (visible parts of the south island were observed from a distance), one nest was noted there.

Methods of This Study

Beginning April 4, 1997, observers began surveying for nesting western snowy plovers twice a week until August 15, 1997. In the morning hours, usually between 8 am and noon, the observer(s) would drive in an automobile slowly along the roads that subdivide Bolsa Chica. Typically, frequent stops were made to examine specific areas through binoculars without exiting the vehicle. The large majority of Bolsa Chica that was suitable for western snowy plover nesting, is visible from the road net. In a relatively few cases, the observer(s) 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. Some nests, upon first discovery were marked with tongue depressors stuck in the substrate about 15 feet from the nest to facilitate relocation during subsequent visits. Most of the time, a nest was evident when an adult is incubating. On the rare occasion when an adult would move away from the nest when the vehicle approached on the nearby road, they usually would reoccupy the nest after a few moments. Sometimes the adult was foraging near the nest. In either case, these were opportunities for the number and condition of eggs in the nest scrape to be observed with binoculars or spotting scope.

In this manner, it was possible to discover most nests within several days of their having been formed. Also noted were the gender of the incubating adult, number of eggs in the clutch, condition of the nest (e.g. signs of disturbance), and some idea of 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.

A second method for determining the total number of snowy plovers in the study area was also employed. The first method, as discussed above, simply involved adding up the cumulative total snowy plovers observed during each day of the monitoring of breeding activity and nests. The second method involved a skilled volunteer making more frequent (sometimes several days a week) and faster paced observations (not attempting to determine status of nests) throughout the study area of the total presence and distribution of snowy plovers, usually in the early morning hours. Very often the observations from these two methods were not made on the same day, and when they were on the same day, were at different hours of the day. No banding of western snowy plover chicks or adults was conducted at Bolsa Chica, and there was little effort or ability to monitor the activity of broods once the eggs had hatched.

The study area was physically delineated into relatively discrete parcels (cells) by the net of slightly elevated roads constructed for access to the oil wells in the lowland. These cells were numbered and formed the basis for observer navigation, nest location, and data

recording (Figure 2). Some areas of Bolsa Chica were not surveyed in this study, although western snowy plovers are likely to have used the habitats for foraging or loafing. Those areas are the ocean beach to the west at Bolsa Chica State Beach, the tidal mudflats of outer Bolsa Bay, or the tidal flats or nesting islands of Inner Bolsa Bay within the Bolsa Chica Ecological Reserve. The study area included all the numbered cells, except cells 47 and 64, which are in private ownership. The cells are of uniquely different configuration and area, but the gross area of some of those 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, such as cells 41 through 50. Some cells that were completely or largely covered by water during most of the breeding season, such as cells 3, 5, 23, 30, and 38, were only occasionally checked for nesting western snowy plover because ponded water is not suitable nesting substrate, either.

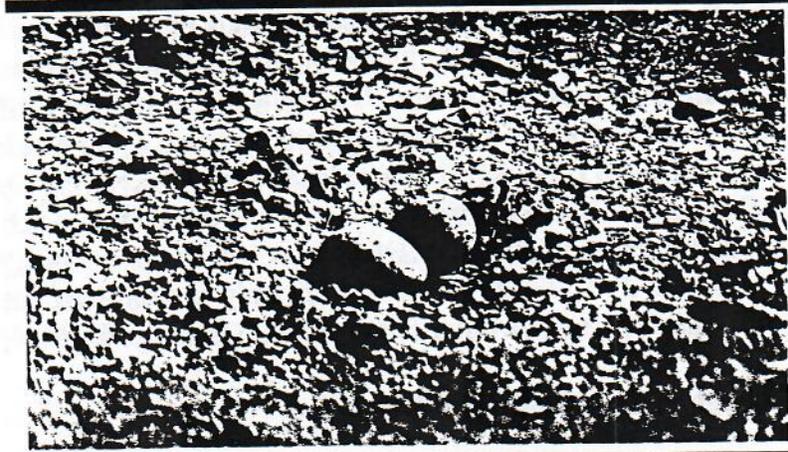
Findings of This Study and Discussion

In early April, one area that was suitable and available for western snowy plover nesting (e.g. not under water) was the south nesting island in the Bolsa Chica Ecological Reserve. Two such islands were created in 1977 by building up areas with sand to make them above the reach of the tides, primarily for the benefit of the California least tern. In recent years, other species have begun nesting at Bolsa Chica (elegant tern, *Sterna elegans*; Caspian tern, *Sterna caspia*; black skimmer, *Rynchops niger*; Forster's tern, *Sterna forsteri*), forcing the least tern entirely off of the north island. The density of nests of these other species apparently precludes California least tern and western snowy plover nests. Our observer(s) did not go onto the nesting islands, as least tern nesting was monitored by a seasonal aide of the Department of Fish and Game on the south island and university researchers monitored the nesting birds on the north island. Even though outside our study area, we observed that the western snowy plover appeared to have established two nests in April 4 on the south island, before the least tern began nesting in earnest. The fate of these nests is unknown. Western snowy plovers were not observed by us to be nesting there after April, but some parts of the south island are not visible without walking out onto it. The California least tern started nesting there in late April but western snowy plover and least tern are able to nest in the same vicinity. It is possible that the least tern nesting monitor may have considered any observed western snowy plover eggs to be those of the least tern since the eggs are very similar and adults of both species leave the nest scrape when a human approaches on foot.

The first western snowy plover nest observed in our study area was April 25th. The latest nests initiated at Bolsa Chica were between July 6th and 9th and were hatched or abandoned in early August. In total, 30 nests were identified during that time period within the study area (two additional nests were thought to have been attempted on the Ecological Reserve nesting island). The locations of the nests identified in 1997 are depicted in Figure 3. The largest number of nests within any particular cell was in cell 11, with seven total nests. Cells 10 and 4 each supported a total of five nests during the entire breeding season, and cell 8 supported a total of four. Nests within cells 4 and 11 were initiated throughout the breeding

season. However, all five of the nests in cell 10 were initiated before May 20th. All of the nests in cell 8 were initiated after June 20th.

All nests were located within a cell, usually on sandy barren areas that were slightly elevated above ponded water or in salt flat, with the exception of two nests located on top of filled dirt. One of these nests was at the edge of a turnout area contiguous with a connecting oil well access road beside cell 23. The other nest was at the top of a low berm of dirt, also next to cell 23. Most nests were simple scrapes in soft substrate, on open flats, away from most vegetation.



Nest 17, Cell 4, substrate dry, flaky, light-colored mud

The appearance of the substrate within one foot of the nest scrape usually matched very closely the coloration of the snowy plover eggs. The substrate character where the nests were placed was quite variable from moist mud, fine, light-colored sand, dried algae, and occasionally salt crust over moist mud. Nests did not appear to be placed near where surface water was present, although, early in the nesting season when water levels were high, the few suitable nesting areas were all “near” water. Later, when more of the flats were exposed and the extent of surface water reduced, nests were found placed on largely featureless flats without surface water within many tens of yards.

The number of active nests existing at any one time within the study area fluctuated as nests were initiated, hatched, preyed upon, or abandoned (Figure 4). The peak number of active nests at any one time was eight. This peak was reached three different times, in late May, late June, and early July. The first peak of active nests appears shifted about one month later than the peak of active nests reported for all western snowy plover nests in San Diego County in 1997 (Powell *et al.*). This shift in nest initiations to later in the breeding season at Bolsa Chica is probably due to the high water levels in April that rendered most of Bolsa Chica unsuitable for western snowy plover nesting.

Three nests were initiated in the second half of April, four nests were started in the first half of May, eight in the second half of May, three in the first half of June, eight in the second half of June, and four in the first half of July (Figure 5). An estimated 16 nests of the total 30 nests hatched, while 14 failed to be incubated long enough to reach hatching (Figure 6). Abandonment of eggs was relatively low. One nest (#27) was incubated for about 47 days before being abandoned. Another nest (#18) had two eggs abandoned after one egg hatched.

Twenty-seven nests were observed closely or frequently enough to confirm the number of eggs present with twenty-one nests having three eggs, six having two eggs, and three nests were preyed upon before the clutch was completed, for a total of about 78 eggs. Four of the two egg nests were initiated last in the breeding season, in July. The 16 nests that reached hatching stage produced an estimated total of 44 chicks.

The total number of western snowy plover individuals present at Bolsa Chica fluctuated over time. At the peak of the first nesting attempts in May, the highest number of males observed was 20 and of females was 14 (Figure 7). This is assumed to be the "breeding" population of western snowy plovers at Bolsa Chica at the beginning of the 1997 season. This estimate assumes that failed nest attempts at Bolsa Chica probably were reinitiated at Bolsa Chica, that females successfully nesting at Bolsa Chica probably attempted subsequent nests at Bolsa Chica, and that breeding western snowy plovers may have arrived from other localities after a failed nesting attempt. However, none of this can be quantified because no banded western snowy plovers were ever observed at Bolsa Chica in this study.

It is also assumed that some of the snowy plover chicks that hatched at Bolsa Chica survived to fledge and were observed as juveniles. The number of observed juveniles seemed to have two peaks, the first in early June of about 12 individuals and the second in mid-July of about 15 individuals. It cannot be concluded that these were the products of two waves of nesting since the broods were not followed after hatching to determine their fate, and it is simply unknown how long a juvenile will remain in the area of its rearing. Interpretation of these observations is further confounded by the arrival of migrating western snowy plovers, juveniles among them, in late July and early August.

The total number of western snowy plovers at Bolsa Chica (referred to as "cumulative" from the nesting survey, and "total" from the area survey, Figure 8) were under 30 individuals until late May when juveniles first began to augment the group total. The total fluctuated between 20 and 40 individuals from May until mid-July when more juveniles were produced or migrants began to arrive at Bolsa Chica. In late July and early August, the total number of snowy plovers at Bolsa Chica was between 40 and 70 individuals, presumably due to the arrival of migrating western snowy plovers.

Both male and female western snowy plovers were seen incubating nests. On some occasions, western snowy plover broods and both adults were seen in the general vicinity of the nest for many days after hatching. Usually, however, the chicks and adults were not seen after hatching as the chicks are highly mobile within days of hatching. An entire brood can move the length of a cell and into other cells fairly readily. The chicks may also be led to seek cover in the abundant pickleweed vegetation as well, making them harder to observe. As a result, it became impossible to determine whether any particular chick survived to fledge, or whether any particular female adult left the brood in order to reneest. An estimate of the number of fledglings produced by each nest attempt cannot be made from these incomplete observations.

Neither western snowy plover broods or loafing adults were observed on the oil well access roads. Many of the roads are traveled several times a day by vehicles and that may habituate plovers to avoid the roads. Western snowy plovers were quite tolerant of vehicles moving along those roads while they themselves were foraging, loafing, and nesting within the cell as close as a few tens of feet away. On the other hand, some snowy plovers did move off their nest when approached by a human outside of a vehicle as near as a couple hundred feet.

Western snowy plover foraging was sometimes observed for brief periods during the nesting survey. These limited observations suggest that snowy plovers run after, and peck from mid-air, small flying insects found while walking over the unvegetated flats and very shallow surface water of the flats. These same areas were often the location where snowy plovers would loaf in groups, sometimes associated with other bird species, particularly semipalmated plovers (*Charadrius semipalmatus*) which appeared at Bolsa Chica in large numbers in the late summer. Cells 4, 8, and to a lesser degree cell 11, were most frequently used, and they were used by more loafing snowy plovers than all other cells, particularly in June and July.

Few snowy plover interactions with other nesting bird species at Bolsa Chica were observed with the exception of black-necked stilt (*Himantopus mexicanus*). The black-necked stilt is omnipresent at Bolsa Chica and nests in many of the same places that snowy plovers would nest. It was not uncommon to see adult black-necked stilts briefly chasing western snowy plover adults and chicks, apparently to clear the stilt's domain of the intruders. Black-necked stilt nest locations were not marked, therefore it was not possible to determine if black-necked stilts were a significant factor in determining where western snowy plovers nested at Bolsa Chica.

No predation of snowy plovers was directly observed during this study but about 43 percent of nests (13 of 30) were estimated to have been lost to egg robbing predators (only one nest was totally abandoned). In a few cases, canid tracks were seen in the vicinity, suggesting a feral dog or coyote may have been the culprit. In most cases, little physical evidence was observed. The most likely suspect is the American crow which is also omnipresent and occasionally very abundant in the Bolsa Chica. A flock of 51 crows were seen to settle into cell 11 in June, apparently devouring eggs and chicks of several ground nesting species nesting there, probably including western snowy plovers, American avocet (*Recurvirostra americana*), and Forster's tern (*Sterna forsteri*). Common raven (*Corvus corax*) is frequently present in low numbers at Bolsa Chica and will take snowy plover eggs and chicks. American kestrel (*Falco sparverius*) is a major chick predator and frequent, perennial problem for the California least tern which nests on the south island of the Bolsa Chica Ecological Reserve. Western snowy plover chicks are likely prey for kestrels as well.

In 1996, western snowy plover activity was monitored weekly at Bolsa Chica and nest locations were indicated on maps (Guthrie 1996). Not all "nests" from the 1996 survey (e.g. apparently incubating adult) would be considered a nest in this study (e.g. presence of eggs),

nor were nests marked or plotted on a map in a manner to specifically identify a nest in that survey. However, by assuming that an incubating adult that was seen on several weekly visits and in the same area constituted a single nest, a cumulative total nest location map similar to this study's 1997 nest location map (Figure 3) is possible for 1996 western snowy plover nests (Figure 9). It can be seen from that map that several cells that supported western snowy plover nests in 1997, had also supported nests in 1996 as well. In particular, cells 4, 10, and 11 provided conditions for 16 out of 24 nests in 1996.

In conclusion, the western snowy plover nests at Bolsa Chica at a significant level for southern California, ranking fourth (total nests) among all sites from Pt. Mugu to the Mexican border and about 15 percent of all nests in 1997. The large majority of the western snowy plover nests at Bolsa Chica were found in the interior areas of cells that are largely unvegetated seasonal pond/salt flats, once the cell dried out enough to expose the salt flat.

Acknowledgments

The completion of this study was made possible only by the efforts of Dick Zembal, Doreen Stadlander, Loren Hays, Patrice Ashfield, Annie Hoecker, Kathy Linder, Bob James, Jeanette Mar, Christine Moen, John Konecny, and Mark Pavelka. Very frequent and caring visits to Bolsa Chica, coupled with a sharp eye for seeing snowy plovers made Peter Knapp's volunteer efforts particularly valuable. Thanks to Mark Pavelka for critical review of the draft report and to Stacy Love for preparing the map figures.

Figures

1. Bolsa Chica Vicinity
2. Cell Numbering Map
3. 1997 Western Snowy Plover Nest Location Map
4. Active Nests Over Time
5. Nest Initiation, Hatching, Loss by Period
6. Individual Nest Histories
7. Males, Females, Juveniles, Identified During Nesting Surveys
8. Total Western Snowy Plover at Bolsa Chica 1997
9. 1996 Western Snowy Plover Nest Location Map

Literature Cited

- Fleming, S.P., R.D. Chiasson, P.C. Smith, P.J. Austin-Smith, and R.P. Bancroft. 1988. Piping plover status in Nova Scotia related to its reproductive and behavioral responses to human disturbance. *J. Field Ornithol.* 59(4):321-330.
- Guthrie, D., R. Feldmuth, R. Clements, J. Sugden, K. Macdonald, and J. Gendron. 1993. Preliminary analysis of Bolsa Chica Lowland Bird Census Data: March 1992 through February 1993. A Report for the Bolsa Chica Company. 65pp. with appendices.
- Guthrie, D. 1996. Snowy Plover (*Charadrius alexandrinus*) Survey in the Bolsa Chica Wetlands, April - August, 1996. Unpubl. report for the Koll Real Estate Group. 34pp.
- Melvin, S.C., A. Hecht, and C.R. Griffin. 1994. Piping plover mortalities caused by off-road vehicles on Atlantic coast beaches. *Wildl. Soc. Bull.* 22:409-414.
- Page, G.W. and L.E. Stenzel (eds.). 1981. The breeding status of the snowy plover in California. *Western Birds* 12(1):1-40.
- Page, G.W., F.C. Bidstrup, R.J. Ramer, and L. Stenzel. 1986. Distribution of wintering snowy plovers in California and adjacent states. *Western Birds* 17(4):145-170.
- Page, G.W., L.E. Stenzel, W.D. Shuford, and C.R. Bruce. 1991. Distribution and abundance of the snowy plover on its western North American breeding grounds. *J. Field Ornithol.* 62(2):245-255.
- Persons, P. 1994. Western Snowy Plover Monitoring in 1993 at Vandenberg Air Force Base, California. Unpub. report prepared for U.S. Air Force 30th Space Wing/ET Vandenberg Air Force Base, CA. 22pp.
- Powell, A. 1995. Western snowy plover use of State-managed lands in southern California. Cal. Dept. Of Fish and Game Bird and Mammal Conservation Program Report 96-03. 14 pp.
- Powell, A., and C. Collier. 1994. The status of Western Snowy Plovers (*Charadrius alexandrinus nivosus*) in San Diego County, 1994. Report to the California Dept. of Fish and Game and U.S. Fish and Wildlife Serv. 23pp.
- Powell, A., C. Collier, and B. Peterson. 1995. The status of Western Snowy Plovers (*Charadrius alexandrinus nivosus*, in San Diego County, 1995. Report to the California Dept. of Fish and Game and U.S. Fish and Wildlife Serv. 25pp

- Powell, A., B. Peterson, and J. Terp. 1996. The status of Western Snowy Plovers (*Charadrius alexandrinus nivosus*, in San Diego County, 1996. Report to the California Dept. of Fish and Game and U.S. Fish and Wildlife Serv. . 25pp.
- Powell, A., J. Terp, C. Collier, and B. Peterson. 1997. The status of Western Snowy Plovers (*Charadrius alexandrinus nivosus*, in San Diego County, 1997. Report to the California Dept. of Fish and Game and U.S. Fish and Wildlife Serv. 34pp.
- Warriner, J.S., J.C. Warriner, G.W. Page, and L.E. Stenzel. 1986. Mating system and reproductive success of a small population of polygamous snowy plovers. *Wilson Bull.* 98(1):15-37.
- Welchell, A. W. and K.M. Keane. 1997. Western Snowy Plover Breeding Survey for Batiquitos Lagoon, San Diego County, 1996 Season. A report from Wetland Research Associates and Keane Biological Consulting for the Batiquitos Lagoon Enhancement Project. 19pp.
- Welchell, A. W. and K.M. Keane. 1998. Western Snowy Plover Breeding Survey for Batiquitos Lagoon, San Diego County, 1997 Season. A report from Wetland Research Associates and Keane Biological Consulting for the Batiquitos Lagoon Enhancement Project. 17pp.
- Wilson, R.A. 1980. Snowy plover nesting ecology on the Oregon coast. MS Thesis, Oregon State Univ., Corvallis. 41pp.

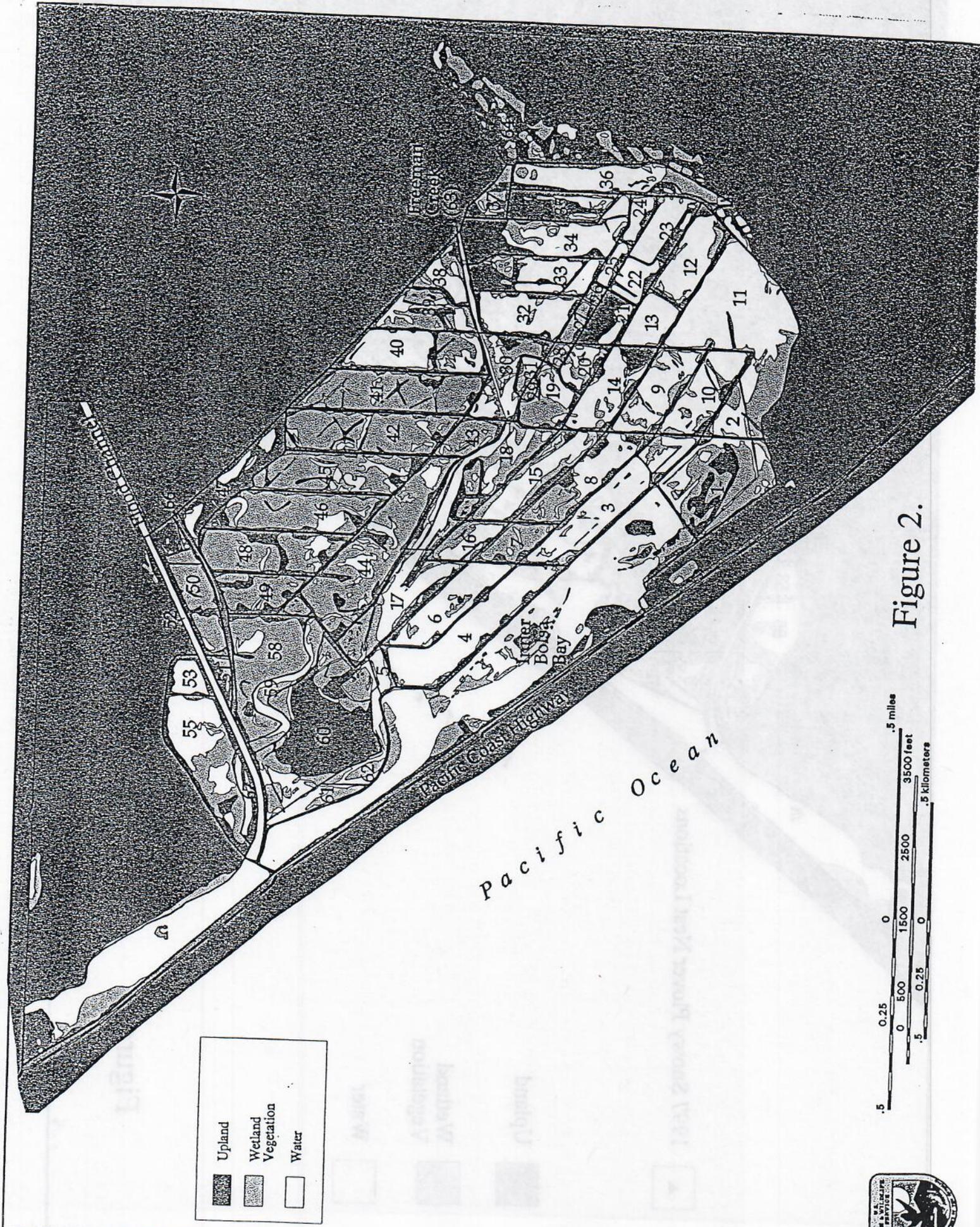
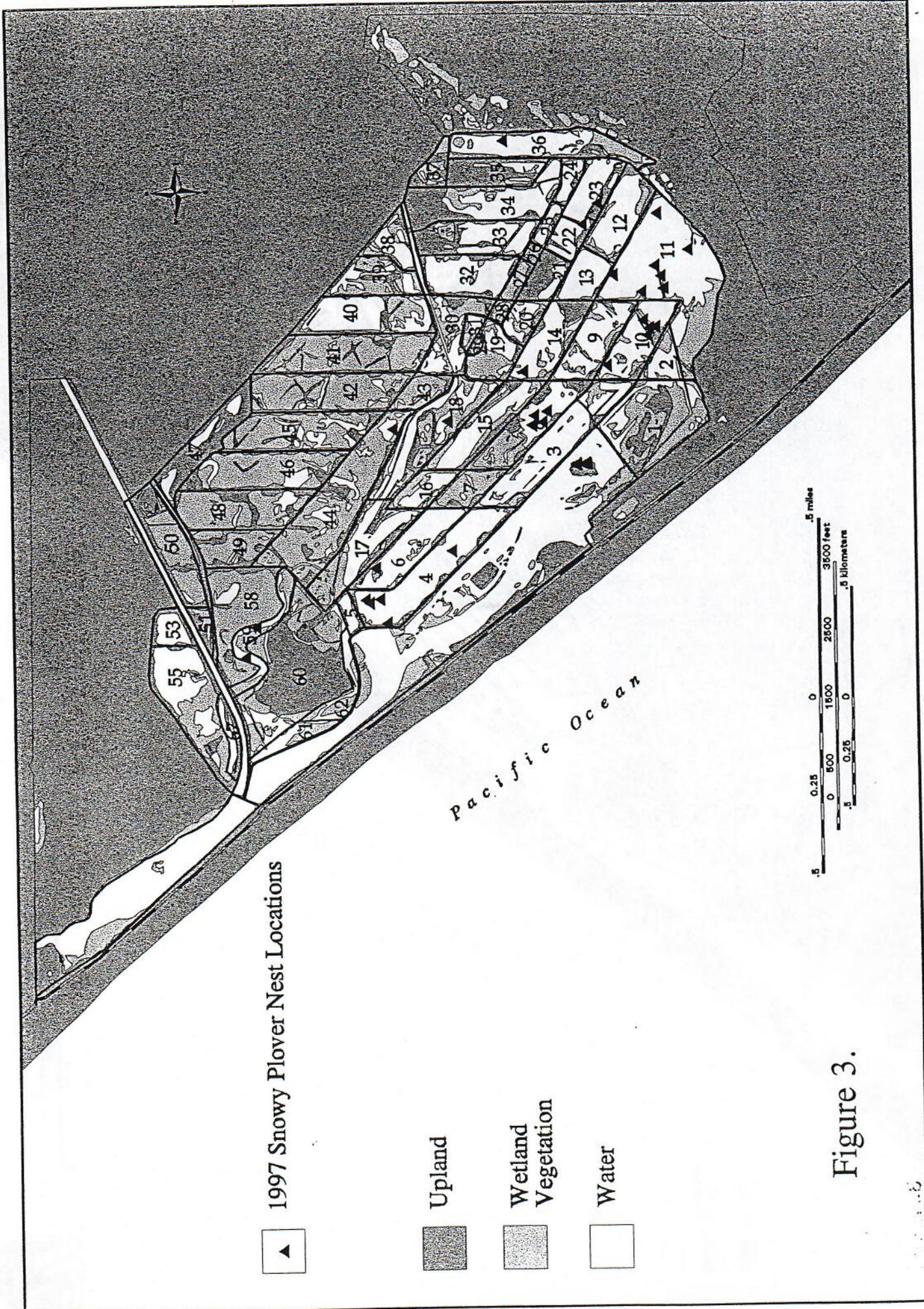


Figure 2.





▲ 1997 Snowy Plover Nest Locations

Upland

Wetland
Vegetation

Water

Pacific Ocean

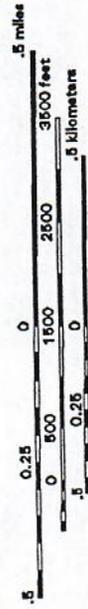


Figure 3.

Western Snowy Plover

Bolsa Chica 1997 Survey

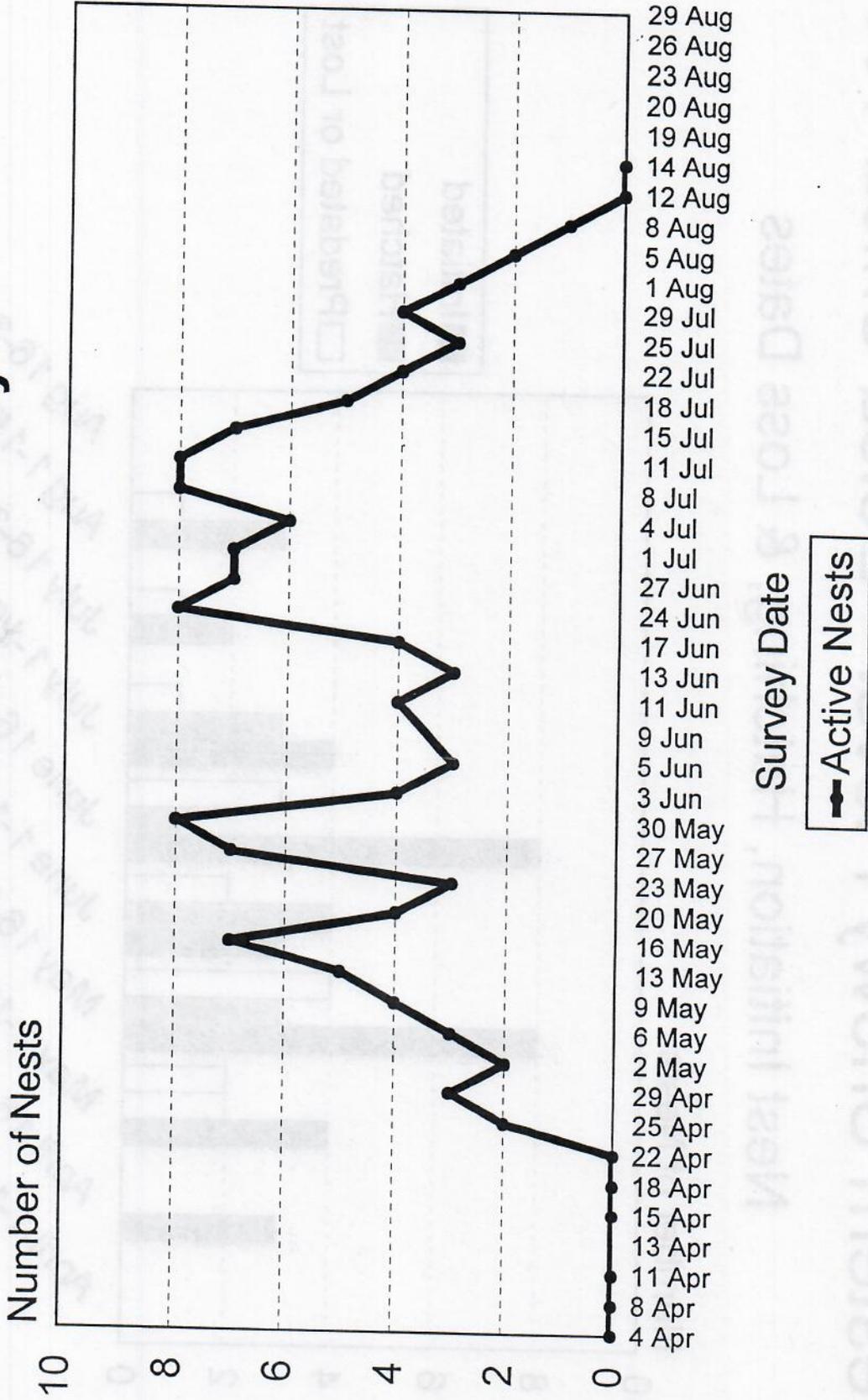
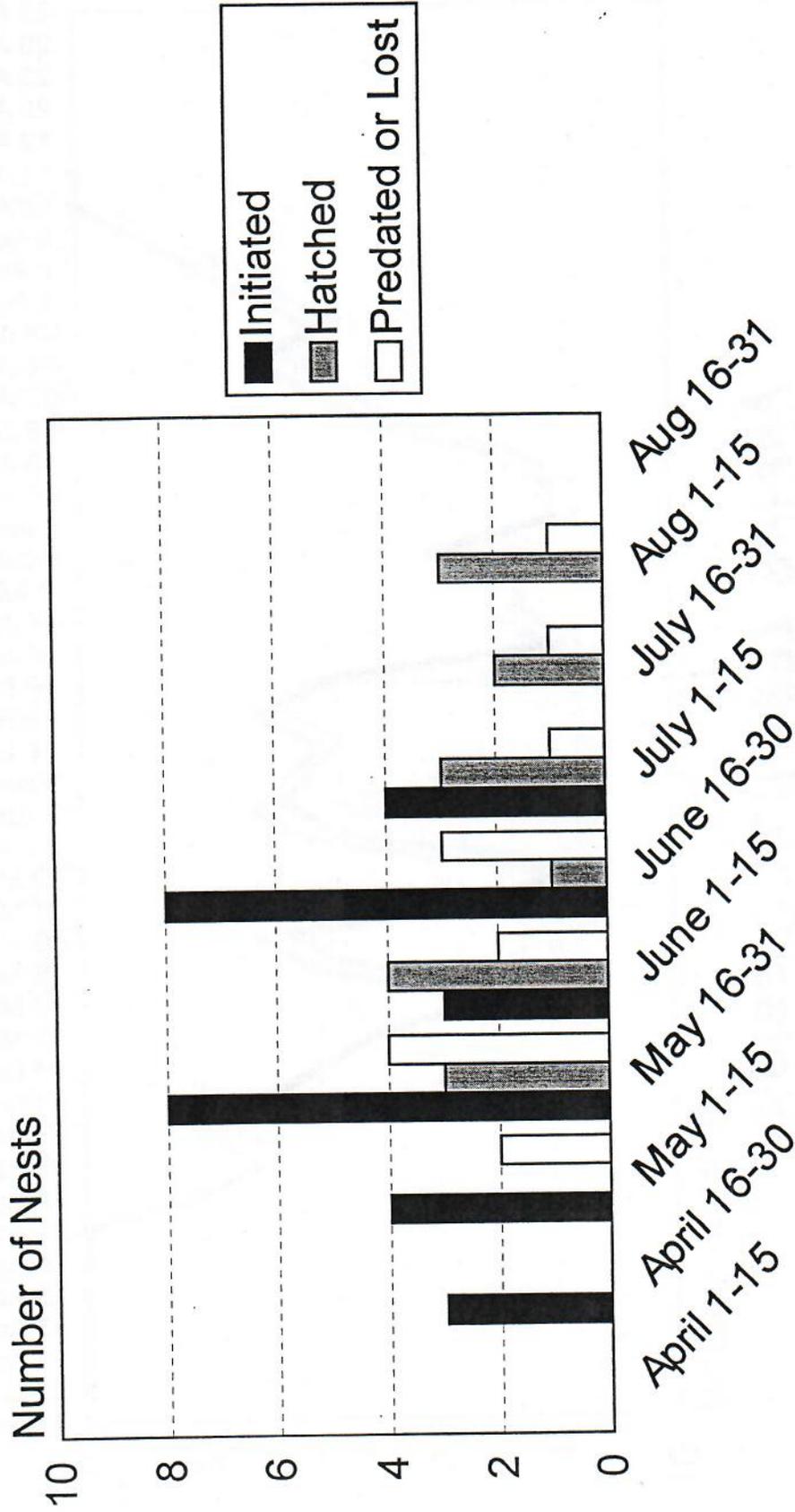


Figure 4.

Western Snowy Plover - Bolsa Chica 1997

Nest Initiation, Hatching, & Loss Dates



Survey Time Period

Figure 5.

Western Snowy Plover

Bolsa Chica 1997 Survey

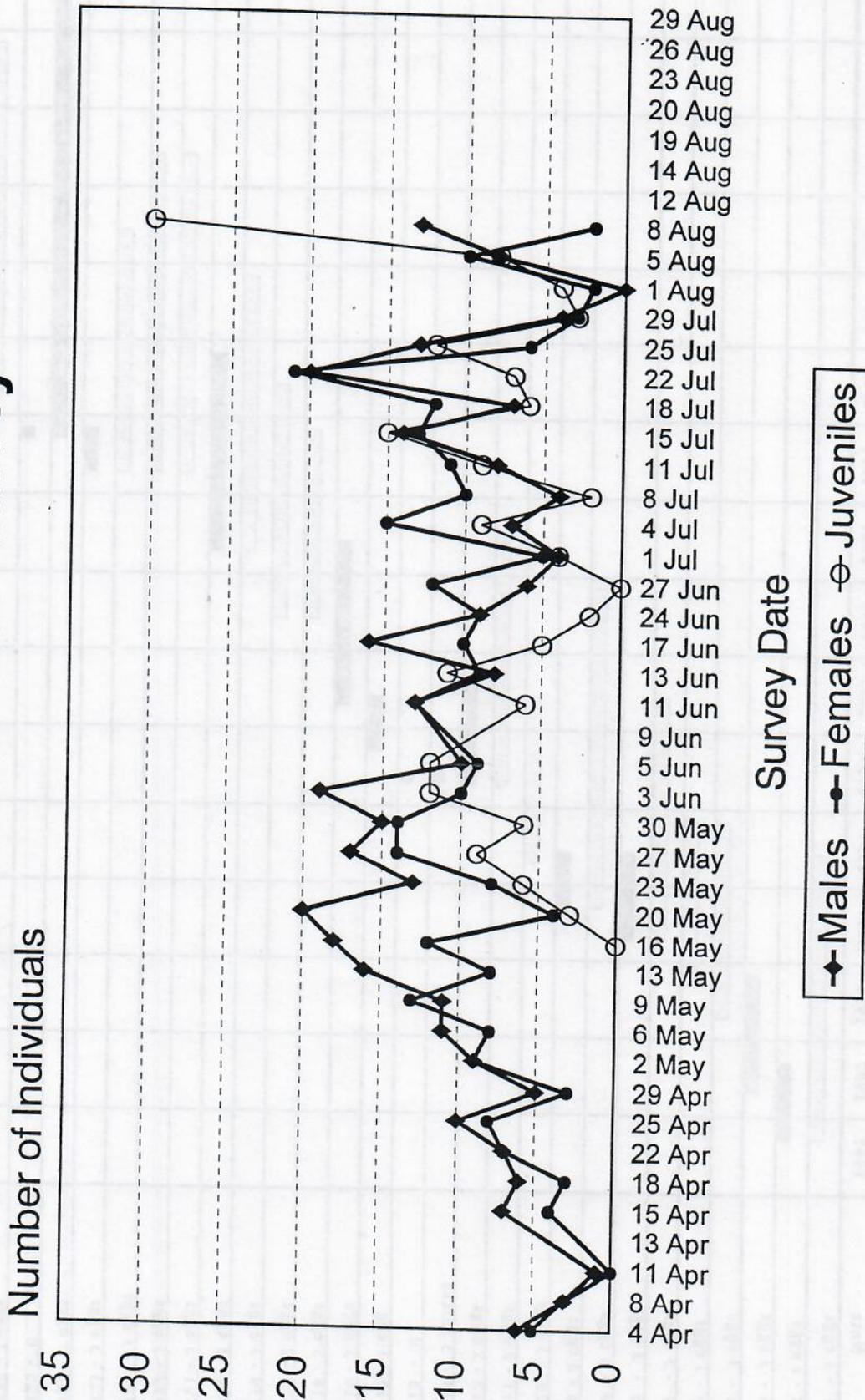


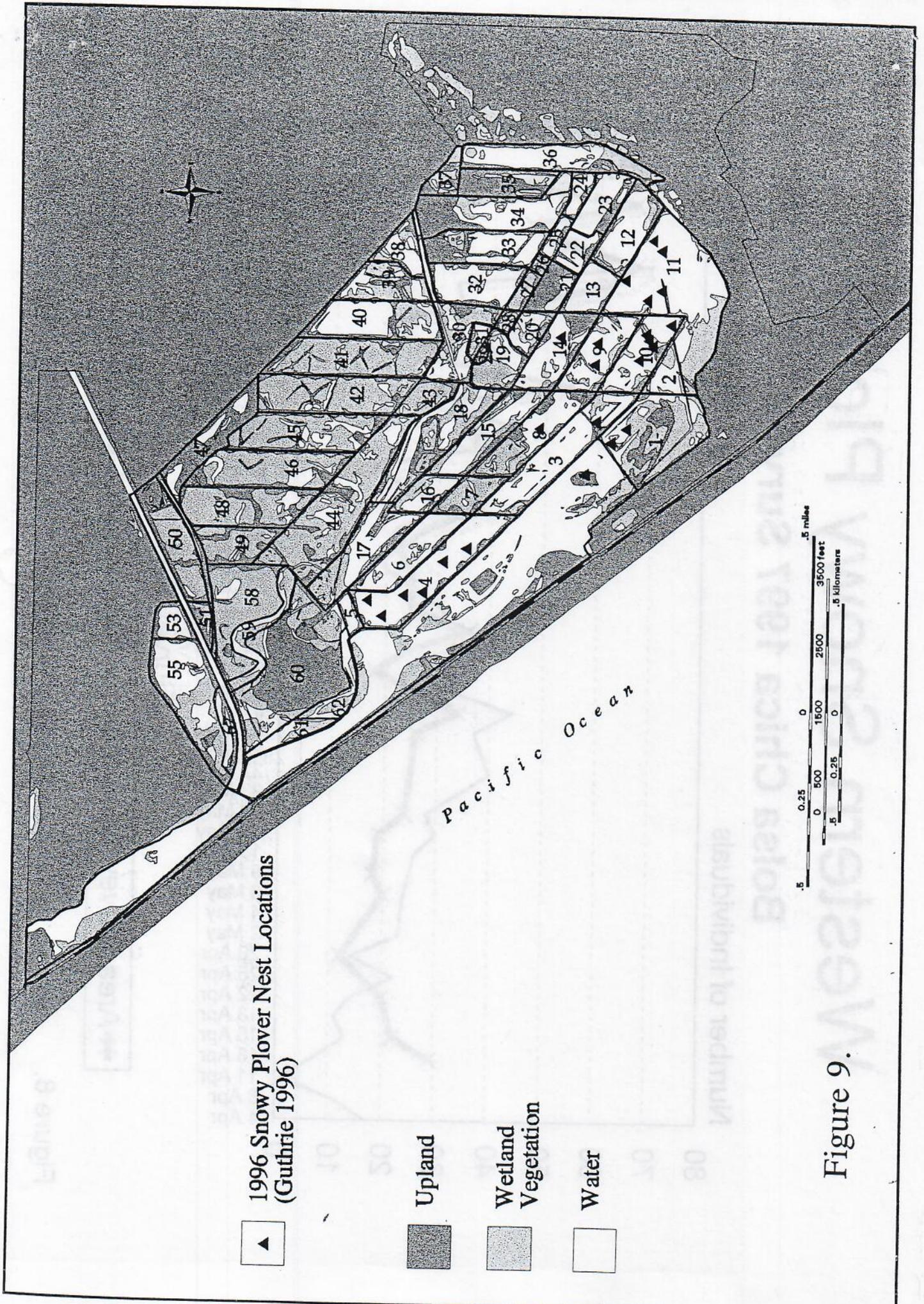
Figure 7.

Bolsa Chica Snowy Plover Nest History

Note	4/20 1997	4/27 1997	5/4 1997	5/11 1997	5/18 1997	5/25 1997	6/1 1997	6/8 1997	6/15 1997	6/22 1997	6/29 1997	7/6 1997	7/13 1997	7/20 1997	7/27 1997	8/3 1997
Nest #1 - 3 eggs																
Nest #2 - 3 eggs																
Nest #3 - 3 eggs																
Nest #4 - 3 eggs																
Nest #5 - 3 eggs																
Nest #7 - 3 eggs																
Nest #6 - 3 eggs																
Nest #9 - 3 eggs																
Nest #8 - 3 eggs																
Nest #10 - 3 eggs																
Nest #11 - 3 eggs																
Nest #12 - 2 eggs																
Nest #14 - 3 chicks																
Nest #13 - 0																
Nest #15 - 1 egg																
Nest #16 - 3 eggs																
Nest #18 - 3 eggs																
Nest #17 - 2 eggs																
Nest #19 - 3 eggs																
Nest #20 - 3 eggs																
Nest #21 - 3 eggs																
Nest #22 - 3 eggs																
Nest #24 - 3 eggs																
Nest #23 - 3 eggs																
Nest #27 - 3 eggs																
Nest #25 - 0																
Nest #28 - 2 eggs																
Nest #29 - 2 eggs																
Nest #30 - 2 eggs																
Nest #31 - 2 eggs																

Nest Hatched
 Nest Predated or Abandoned

Figure 6.



▲ 1996 Snowy Plover Nest Locations
(Guthrie 1996)

- Upland
- Wetland
- Water

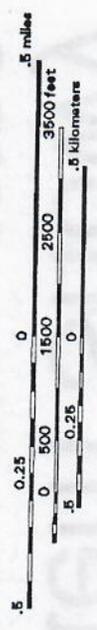


Figure 9.

Western Snowy Plover

Bolsa Chica 1997 Survey

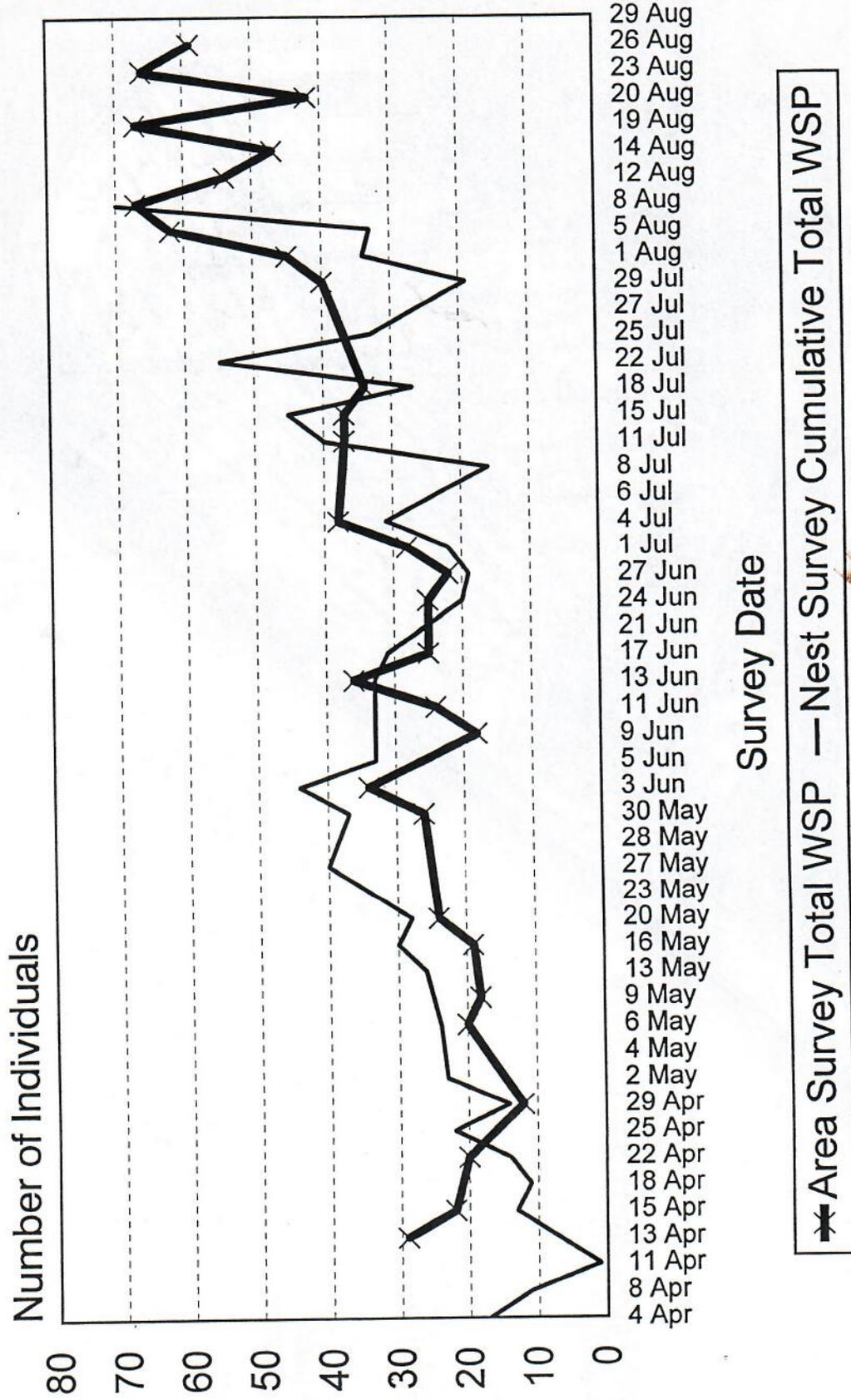


Figure 8.