**State of California**
**The Resources Agency**
**Department of Fish and Game**
**Wildlife Management Division**

# CALIFORNIA LEAST TERN BREEDING SURVEY

# 1996 SEASON

**by**

**Carolee Caffrey**

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## ABSTRACT

In 1996, 3330-3392 pairs of the endangered California least tern (Sterna antillarum browni) nested at 35 sites along the coast of California. This 29% increase in breeding population size over 1995 resumes the predominant pattern since 1987 of exponential growth of the statewide population. Fledgling-to-pair ratios at most sites increased relative to those in 1995, and terns nesting at several sites in 1996 were very successful. However, heavy predation at many San Diego County sites (including a majority of those with high pair numbers) and a local food shortage at Venice Beach compromised statewide fledgling production somewhat. Approximately 1981-2120 young terns fledged across the State, a record high and almost twice the number fledged in 1995; statewide F/P = 0.58-0.64.

Most sites experienced increases over 1995 in the number of breeding pairs present, and several sites attracted more than 200 pairs. In1996, 58% of the statewide papulation bred at only seven sites (NAS Alameda, Venice Beach, Huntington Beach, Santa Margarita River/North Beach, Mission Bay/FAA Island and Mariner's Point, Delta Beach/North), with the balance being distributed pretty evenly throughout the rest of the State. Almost half of the fledglings produced in the State came from only four sites; 45% of all potential new breeders produced this year fledged from NAS Alameda, Huntington Beach, Santa Margarita River/North Beach, and Delta Beach/North.

[1] Caffrey, C. 1998. California least tern breeding survey, 1996 season. Calif. Dep. Fish and Game, Wildl. Manage. Div., Bird and Mammal Conservation Program Rep. 98-2, Sacramento, CA. 57 pp.

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## INTRODUCTION

The California least tern (Sterna antillarum browni) is a State- and federal-listed endangered species that nests each spring and summer along the coast from the San Francisco Bay area in the north, south into Baja California, Mexico. Annual estimation of least tern breeding population size, and monitoring of breeding activities in the State of California began in 1973; estimation of total annual fledgling production was incorporated into monitoring protocol in 1978. Habitat loss due to human development and climatic events (e.g., storms and flooding), other types of human-related disturbance, predation, local food shortages, and adverse environmental conditions, including storms and El Niiio, continue to negatively affect tern reproductive success. However, the concerted efforts at identifying, enhancing, protecting, and monitoring least tern breeding areas by state and federal agencies, and the many dedicated individuals working therein, have greatly contributed to the huge increase in breeding population size from approximately 600 pairs in 1973 to a high of approximately 2792 pairs in 1994 (there were approximately 2598 pairs in 1995). These efforts were continued in 1996, and the data are summarized herein.

## METHODS

The following criteria are used to distinguish least tern breeding "sites" from "colonies" (used interchangeably prior to 1992): A site is the name of the location of a discrete and contiguous group of nesting birds. A colony is the name of the general location of a breeding area, where colony members may share the same foraging and roosting areas, and the same general nesting areas. If all pairs in the colony nest within a single, contiguous area, then colony name and site are the same. In recent years, terns have expanded nesting ranges within colonies, and particular colonies have come to comprise two or more "islands" of nesting areas, i.e., they now include two or more sites. Separate sites within the same colony appear as indentations under colony location in Table 1, except those under "San Diego Bay:" terns in this cluster of colonies may share foraging areas, yet nesting areas are distinctly separate. (Official names for military sites can be found in Appendix A; throughout this report, they are referred to as in Table 1.)

As part of the Batiquitos Lagoon Enhancement/Restoration Project, two new sites were created prior to the arrival of terns in 1996: "E-2" occurs along the shore on the northern side of the East Basin, at the eastern end of the lagoon (just west of the historical site, no longer in use, "Northeast"), and "E-3" is an island, constructed from dredge spoils, in the eastern part of the East Basin. Terns nesting at the Tijuana River expanded their ranges to form two sites on each side of the river: on the northern side, terns used the historical "north" site plus an additional site at the river mouth; south of the river, terns nested at the historical "south" site plus an additional beach site approximately 50m north of the Mexican

border. Because the permanence of this pattern is still unknown and new site names have not yet been bestowed, the data are combined for both northern sites under Tijuana River/North, and both southern sites Tijuana River/South for 1996. Three sites have been dropped from our list for various reasons. Mission Bay/Crown Point is no longer being managed for least tern nesting; an arrangement made early in the year between USFWS and the San Diego Park and Recreation Department (terns had not nested there for many years). Santa Margarita River/Saltflats Island seems to have disappeared; it is no longer visible on maps provided, and no data were received (in fact, no mention of it at all was made). Vegetation encroachment on the east side of Ormond Beach/Middle Site combined with the expansion west of terns nesting at Ormond Beach/Edison (to the east of "Middle") has obliterated "Middle;" Ormond Beach now includes only the two sites "Perkins Road" and "Edison."

Statewide censuses of known California least tern breeding sites have been conducted since 1973. A network of paid and volunteer monitors check all sites on a regular basis and compile data into final Site Reports. The present report integrates and summarizes data from all known least tern breeding sites in the state of California for 1996. The data for the two sites "Mouth" and "McGrath Lake" at Santa Clara River were combined in a single Site Report, as were the data from the two sites "Perkins Road" and "Edison" at Ormond Beach. Further details on methodology (e.g., data collection, fledgling counts, and predator-related issues) are available in the California Department of Fish and Game (CDFG) Least Tern Monitoring Packet (Caffrey 1995a). In addition, the actual final Site Reports used to prepare this survey are available through CDFG offices in Sacramento. Many new types of information regarding site characteristics and tern reproductive outcome were requested in 1996 (including summaries of the season's events: Appendix B); these reports now contain meticulous details on site fencing and vegetation characteristics, site preparation, data collection, banding information, known causes of breeding failure (including the evidence available), potential predators in the area, predator management techniques and their efficacy, and site-specific comments and recommendations regarding management issues. Readers interested in such additional information are encouraged to request copies.

Least terns breed along the coast of California from the San Francisco Bay in the north to the southern border. Breeding site characteristics vary from site to site. Nesting sites are located in areas that experience high levels of human activity to little or none. Fences may be permanent, temporary, or nonexistent. Nests may be approached closely enough for monitors to mark them and actually count eggs/chicks directly, or are simply observed from afar. Thus monitoring protocol varies from site to site as well, although at all sites the following information is determined: occupancy status (terns breeding or not), an estimate of total number of breeding pairs present, and an estimate of total number of fledglings produced. Throughout the season, attempts are also made at identifying the type and outcome of predation or other disturbance.

Given the diversity of site types, two very general monitoring approaches can be described. Type 1 sites (Table 1) are those that have historically been monitored quite closely. Monitors walk through nesting areas regularly, mark nests with numbered tongue

depressors, and record data regarding the status of nests. Monitoring of this type throughout the season provides detailed information on the timing of nesting, the number of new and active nests, clutch size, and hatching success. In contrast, monitor presence within Type 2 sites is kept to a minimum or does not occur at all. Monitors at these sites observe terns from a distance and determine the presence of nests from the location of incubating adults; many types of data are therefore unavailable, e.g., clutch sizes and actual hatching dates. Included also in Table 1 are the total number of days during the season that each site was visited for monitoring purposes (this does not include visits by ADC or other predator management personnel, or visits by people carrying out other studies, e.g., a foraging study at Venice Beach and a color marking study done at several military sites in San Diego County), and the total number of hours over the season that at least one monitor was present at the site (= mean number of hours/visit multiplied by the total number of visits, rounded to the closest hour).

Site preparation prior to the arrival of terns also varies from site to site. According to information included in final Site Reports, vegetation was cleared by hand (PGE Pittsburg, Mission Bay/FAA Island and Mariner's Point, NAS North Island), mechanically (Venice Beach, Terminal Island, Bolsa Chica, Huntington Beach, Mission Bay/FAA Island and North Fiesta Island, Naval Training Center, NAS North Island, Delta Beach/North and South, D Street Fill, Chula Vista Wildlife Reserve), or with the use of herbicides (PGE Pittsburg, NAS Alameda, Terminal Island, Mission Bay/FAA Island, Mariner's Point, and North Fiesta Island). Vegetation was also cleared at Santa Clara River and Batiquitos Lagoon/W-l and W-2, but the methods were not reported. Accumulated litter or storm debris was removed (NAS Alameda, Venice Beach, Chula Vista Wildlife Reserve), and black widow spiders were killed (NAS Alameda, Venice Beach). Sand was cleared away from fencing to expose the chick fence at Venice Beach, and added to the site as substrate at Seal Beach, Mission Bay/North Fiesta Island, NAS North Island, and Delta Beach/North and South. Oyster shells were added to the substrate at NAS Alameda, and "holes" in the substrate were covered to prevent chicks from being trapped at PGE Pittsburg. Permanent fencing at sites was modified or repaired, and/or chick fencing was repaired or erected, at NAS Alameda, VAFB Purisima Point, Ormond Beach/Edison (additional fencing was added later in response to dogs entering the nesting area), Terminal Island, Seal Beach, White Beach, and Santa Margarita River/North Beach, Mission Bay/Mariner's Point, Lindbergh Field, NAS North Island, and Tijuana River/North and South. Chick shelters were laid out and monitoring grids set up (NAS Alameda, Venice Beach, Terminal Island, Seal Beach, Huntington Beach, White Beach, Santa Margarita River/North Beach, Batiquitos Lagoon/all sites, Mission Bay/FAA Island and Mariner's Point, Naval Training Center, NAS North Island, Delta Beach/North and South, D Street Fill, Chula Vista Wildlife Reserve). As nests materialized at NAB Ocean, protective barriers were set up. Signs were posted or repaired (Mussel Rock Dunes, Ormond Beach/Edison, Terminal Island, Mission Bay/Mariner's Point, Naval Training Center, Delta Beach/North and South, D Street Fill, Chula Vista Wildlife Reserve, Tijuana River/North and South), and a construction-worker education program was inaugurated at Terminal Island. Decoys were laid out at Terminal Island, Batiquitos Lagoon/all sites, Mission Bay/Mariner's Point, NAS North Island, D Street Fill, and Chula Vista Wildlife

Reserve. Crow carcasses were placed inside the perimeter fence at Venice Beach to deter crows from entering the site. Predator control was initiated prior to the arrival of terns (and subsequently continued throughout the season) at VAFB Purisima Point, Terminal Island, Huntington Beach, White Beach, Santa Margarita River/North Beach and Saltflats, Batiquitos Lagoon/all sites, Mission Bay/FAA Island, Mariner's Point, North Fiesta Island, and Stony Point, NAS North Island, Delta Beach/North and South, and NAB Ocean. (Season-long predator control begins once terns are nesting at NAS Alameda, Seal Beach, Lindbergh Field, D Street Fill, and Tijuana River/North and South. Predator removal at Chula Vista Wildlife Reserve once terns are nesting elsewhere appears to be a last-ditch attempt to attract them to the reserve.)

Because of site-specific differences in the number of pairs present, roosting behavior and locations, and the timing of behavioral events (e.g., for how long after fledging fledglings remain at the site), fledgling estimates were arrived at in different ways. The suggested method of three-week interval counts (Massey 1989a, Caffrey 1995a) was used by monitors at Ormond Beach, Venice Beach, Terminal Island, Huntington Beach, White Beach, Santa Margarita River/North Beach and Saltflats, Batiquitos Lagoon/all sites, NAS North Island (a "modified" version), and Tijuana River/North and South. The accuracy of the above method was substantiated with banding/recapture data at NAS North Island, and by direct observation of individual fledglings at Terminal Island; direct observation was also employed by monitors at PGE Pittsburg, NAS Alameda, Mission Bay/FAA Island and Mariner's Point, Lindbergh Field, Delta Beach/North and South, NAB Ocean, D Street Fill, Saltworks, and Tijuana River/North and South. Direct observation numbers were confirmed using banding/recapture data (Mission Bay/Mariner's Point, Delta Beach/North and South, NAB Ocean), and also by determining the differences between the number of chicks hatched and those known to have died (D Street Fill) and the number of chicks banded and those known to have died (Lindbergh Field). The monitor at Seal Beach used the latter method exclusively. Monitors at VAFB Purisima Point and Bolsa Chica counted fledglings at two-week intervals and summed for the season, the monitor at Mussel Rock Dunes used maximum daily counts once/week at the end of the season, and those at Santa Clara River and NAWS Point Mugu used the maximum count observed on any one day (this method was also used at Santa Margarita River/North Beach, in conjunction with the three-week method).

Except for clear-cut cases, determining the starting date of the "second wave" has always been a bit arbitary, yet this determination is important because it directly affects estimates of total pair numbers. Historically, June 15 had been set as the statewide date that, before which, all new nests were to be counted as those of pairs in the first wave, and after which, new nests were counted as those occurring in the second wave (so including any renesting by first wave pairs, as well as latecomers making their first attempts). This system was modified over the years so as to allow monitors to examine the data from their site and adjust the date accordingly. Yet there were always those cases where there was no obvious lull between two peaks of nesting, and monitors were left to make their best guess as to when second wave nesting began. Because of the potential subjectiveness inherent to the latter method, at a meeting prior to the beginning of the 1996 season, several long-time tern people agreed to

institute the following guidelines, to be used throughout the State: (1) if new nest data demonstrate an early peak followed by a lull and a second peak, the date of the beginning of the second wave is that at the end of the lull ("yes" for occurrence of second wave, Table 2); (2) if no obvious lull occurs but nesting continues for some time, the beginning date for the second wave is four weeks after the initiation of the first nest ("minor" for occurrence of second wave, Table 2). These guidelines were used by most monitors for calculations of first and second wave nest information (Tables 3 and 4) and estimates of first and second wave pair numbers (Tables 3 and 4). However, final Site Reports for White Beach, and Santa Margarita River/North Beach and Saltflats, contained the above data using both the "6/15" and the "four week" method. June 15 was at least five weeks after the initiation of the first nests, but unfortunately, the four-week dates provided were four weeks plus three days later. For this report, I used the provided "four week" data anyway, however, examination of the final Site Reports indicate that not only does the date chosen determine nest numbers, but it dramatically affects the estimate of total pairs at Santa Margarita River/North Beach (the range of 500-557 total pairs is therefore given in Table 4).

The following distinction is made between documented and suspected predator species: a documented predator is one actually observed taking a least tern egg, chick, fledgling, or adult, or one indicated according to the following criteria: (1) identifiable tracks led to least tern remains or an empty nest where eggs were not expected to hatch for at least three more days, (2) if expected hatching date was unknown, tracks led to more than one empty nest, and (3) any evidence left had to be consistent with that expected from the indicated predator. Suspected predators are animals believed to have preyed on terns or eggs, based on substantial but not conclusive evidence (e.g., tracks throughout the site, tern remains characteristic of a particular predator, or predators observed foraging at the site).

In this report, unless otherwise cited, data for the following years were taken from the indicated sources: 1987 and 1988 (Massey 1988), 1989 (Massey 1989b), 1990 (Obst and Johnston 1992), 1991 (Johnston and Obst 1992), 1992 (Caffrey 1993), 1993 (Caffrey 1994), 1994 (Caffrey 1995b), and 1995 (Caffrey 1997).

## RESULTS

Distribution - In 1996, California least terns were reported to have nested at 35 sites from the San Francisco Bay area south to the Mexican border (Table 1). Terns settled and bred successfully at one of the two new sites at Batiquitos Lagoon ("E-3"), but passed up the opportunity at "E-2. "

Of historical sites not used by breeding terns in 1996, several have been tern-less for at least five years but are still checked at the beginning of the season for tern activity ("unl" in Table 1). For others, although they remain on our "wish" list, the combination of an

abundance of predators and/or humans in the area, vegetation overgrowth, and the lack of financial resources and effort on the part of agencies with the power to enhance, and enforce the protection of, these areas has led to their being pretty much ignored by the financially-strapped Monitoring Program ("un3" in Table 1). Others ("un2") are sites at which nesting has occurred within the last five years, yet for one reason or another (usually one or more of those mentioned above) went unused in 1996. Sites that were used by terns in 1995 but not in 1996 include Oakland Airport, Pismo Dunes, and Naval Training Center.

Breeding: Chronology - Early breeders began arriving at breeding areas from mid- to late April through mid-May (Table 2). Nesting began less than two weeks later at some sites (PGE Pittsburg, NAS Alameda, Ormond Beach, Santa Margarita River/Saltflats, Saltworks), two to three-and-a-half weeks later at others, but was delayed for a month or more at Delta Beach/South, NAB Ocean, and Santa Clara River (5 weeks!). At all four sites at Batiquitos Lagoon, terns arrived and then laid their first eggs on exactly the same days (and at W-l, W-2, and E-l, they finished laying during the same week; exact dates were not provided). Most sites had eggs in nests by mid- to late May, chicks by early to mid-June, and fledglings by late June to early July. A relatively clear-cut second wave was reported to have occurred at 19 sites; at five sites the second wave was less distinguishable ("minor"), and no second wave was evident at nine sites (this adds to 33, rather than 35, because of the combined data at the Santa Clara River and Ormond Beach sites). The duration of nest initiation across the State was variable, being fairly short at some sites (e.g., Santa Clara River, Upper Newport Bay, Batiquitos Lagoon/all sites, Mission Bay/North Fiesta Island) but extremely protracted at others (e.g., Lindbergh Field, NAB Ocean, Tijuana River/North and South). Terns began departing some breeding areas as early as early July, but many sites still had terns present through early to mid-August, while at Santa Clara River, Ormond Beach, and Tijuana River/North, terns remained until early September.

Monitors were asked to report the number of new nests each week (Saturday $\pm$1 day); Figure 1 depicts statewide data pooled as well as separated into the three "clusters" (north, central, south). Nesting began earliest at sites in Los Angeles and Orange counties. By the end of the second week of nesting, sites in these two counties accounted for 100% of the 66 nests in the State (Venice Beach: 45, Seal Beach: 20, Bolsa Chica: 1). Terns began laying eggs at other sites throughout the State the following week. Figure 2 depicts some of the diversity in the timing of nesting, and differences in "first" and "second wave" patterns at several sites.

First Wave - Relative to site-specific 1995 first wave numbers, dramatic increases and decreases occurred at several sites in 1996 (Table 3); at a few, this meant differences in many to a substantial number of pairs (e.g., increases: Batiquitos Lagoon/W-2, NAB Ocean, Huntington Beach, Santa Margarita River/North Beach (!); decreases: Venice Beach, Tijuana River/South). The increase in statewide Total first wave Pairs in 1996 over that of 1995 is real, but impossible to gauge due to the unreported 1995 numbers for Mission Bay/FAA Island (200 pairs for the season) and North Fiesta Island (12), and NAWS Point Mugu (not provided). The same is true for statewide Total Nests.

Season Totals - Approximately 3330-3392 pairs of California least terns nested statewide in 1996, an increase of 29% over the number of nesting pairs in 1995 (Table 4). Relative to 1995, some sites experienced dramatic increases in the total number of nesting pairs present; at Huntington Beach, Santa Margarita River/North Beach, and the combined sites at Batiquitos Lagoon, this translated into a considerable number of pairs. The only relatively dramatic decrease in number of nesting pairs occurred at Tijuana River, considering both the "South" sites alone, or combined with the "North" sites. In 1996, 58% of the statewide population bred at only seven sites (NAS Alameda, Venice Beach, Huntington Beach, Santa Margarita River/North Beach, Mission Bay/FAA Island and Mariner's Point, Delta Beach/North).

Approximately 1981-2120 fledglings were produced in 1996, almost twice the number produced in 1995, resulting in a statewide fledgling-to-pair ratio of 0.58-0.64. (This may be a slight overestimate, as the 150 fledglings observed at Ormond Beach include a "large jump" in numbers near the end of the season; possibly individuals fledged somewhere else. Additionally, the variety in methods for estimating fledgling numbers (Methods) notwithstanding, the count at Seal Beach was exclusively 'number of chicks banded - number known dead; ' probably a bit of an overestimate.) Many sites experienced increases in their F/Ps from 1995; some were pretty dramatic, e.g., NAS Alameda, Ormond Beach (but discussed above), Seal Beach, and Huntington Beach. Smaller but notable increases occurred at Venice Beach, Terminal Island, and the Batiquitos Lagoon complex (all sites combined, 1995 F/P=0.87). There were few real decreases, with only four warranting "dramatic" status: VAFB Purisima Point, Santa Clara River (even though 0.71 (1996) is still enviable), Mission Bay/FAA Island, and Saltworks. The fledglings produced at only four sites, NAS Alameda, Huntington Beach, Santa Margarita River/North Beach, and Delta Beach/North, comprised 45% of the State total.

Clutch Size - Clutch size at Type 1 sites ranged from 1 to 3 (Table 5), with a statewide $\bar{X}$ = 1.89 (n=3699 nests). Hatching success at Type 1 sites where it could be calculated accurately (i.e., excluding sites for which ranges were provided) ranged from 54-98%, with a mean of approximately 81.1% (n=17 sites).

Sources of Breeding Failure - Predation was the major cause of breeding failure at most sites in 1996 (Table 6); documented and suspected predators included by-now-familiar species, although two new ones must now be added to our "potential" list: a pair of roadrunners was observed taking chicks at Batiquitos Lagoon/W-l (and subsequent dissection of said roadrunners revealed tern chick USFWS bands in their stomachs), and a black-bellied plover crushed the eggs in a nest at Tijuana River/South. Monitors at VAFB Purisima Point, Bolsa Chica, White Beach, Santa Margarita River/North Beach and Saltflats, Mission Bay/FAA Island and Mariner's Point, NAS North Island, Saltworks, and Tijuana River/North and South all indicated predation as having a major impact on productivity at their sites. Although reliably attributing tern losses to predation can sometimes be difficult, the evidence provided in many final Site Reports was enlightening to numbing. Some examples: At NAS Alameda, kestrels were observed taking chicks and fledglings, and a gray fox (1st confirmed

sighting of any fox at NAS Alameda) co-occurred with a red-tailed hawk for a week or so in June; the latter were responsible for the loss of 25-30 chicks and several eggs. At VAFB Purisima Point, the 10 chick carcasses found, some still paired in their brood scrapes, suggested a great-horned owl (tracks observed) may have been taking adults. An unidentified canid got onto the site at Bolsa Chica one night and was definitely responsible for the loss of three nests, and probably 11 more. (It may also have been associated with the early end of the nesting season at that site: Figure 2.) At White Beach, 53 eggs (of 109) were eaten by predators, at least 34 of them by skunks (18-20 skunks were removed from the site over the season). Notable among impressive company (Tables 6 and 7), weasels and an immature peregrine falcon were particularly destructive at Santa Margarita River/North. Peregrine falcons and kestrels took their toll at Mission Bay/FAA Island; kestrels were observed foraging the site on every visit, and peregrine pressure kicked in after mid-June. A peregrine falcon was also observed taking chicks and fledglings at Mission Bay/Mariner's Point. A burrowing owl was responsible for the death of at least 10 chicks, six fledglings, and three adults at NAS North Island. Approximately 49 of 90 eggs at Tijuana River/North were lost to predators (19 known to have been preyed on, 30 missing prior to expected hatching date). At Tijuana River/South, at least 18 adults were killed by a barn owl, 65 eggs from 47 active nests were known to have been taken by various predators, and an additional 94 eggs from 57 nests disappeared prior to expected hatching date. Predation was also believed to underlie the majority of losses at Mussel Rock Dunes (eggs) and Mission Bay/North Fiesta Island (eggs and chicks).

A shortage of food was responsible for the dismal season at Venice Beach. Mean clutch size was only 1.42 (59% of nests contained only one egg), and 104 chick carcasses were picked up (the majority within days of hatching) over the season. There were no fledglings until almost five weeks after the first eggs began to hatch (and then there were only 32 of the more than four times that many that could have been). At NAS Alameda, too, evidence suggested that a local shortage of small prey may have contributed to the losses incurred at that site. Fifty-seven to 64 chick and fledgling carcasses were observed, the majority (53-60) being small, downy chicks. Although some (most?) of these deaths were probably the direct result of hypothermia, many lines of evidence (details in final Site Report) suggested many chicks were not well fed, making them more vulnerable to cold temperatures. Among the many lines of evidence cited by the monitor were the following: 'nests not being as well tended as expected' (regarding the 59 eggs abandoned), slowed developmental rates of some chicks, begging chicks not being fed, parents returning without food, parents eating the food they returned with, and chicks approaching and begging from adults other than their parents. Circumstantial evidence for the possibility of limited food availability early in the season at Terminal Island included abnormal courtship feeding, two unexplained adult deaths, and temporary site abandonment. Yet the successful production of fledglings at both NAS Alameda and Terminal Island demonstrated that local food shortages, if they did exist, were not enough to hamper breeding success.

Humans contributed considerably to the mortality experienced by terns in 1996; inadvertently, cluelessly, regrettably, and intentionally. Beachgoers and/or their dogs

destroyed nests at Santa Clara River (one other nest was abandoned, and no new nesting occurred after the second incident), Ormond Beach, and Tijuana River/North and South. Nests at Tijuana River/South were also destroyed by people riding horses, and people driving off-highway vehicles (OHVs) and other vehicles; their combined feet and wheels crushed 25 eggs at that site (in one case, the vehicle apparently got stuck in the sand, and the passenger(s) wandered through the site collecting and dragging the wood they used to free it). Military or airport vehicles killed fledglings at NAS Alameda (l), Lindbergh Field (l), and NAS North Island (2). A chick got caught in a trap set for ants at Delta Beach/South (the traps were subsequently modified), and the loss of adults or eggs related to a CSU Long Beach/Navy color-marking study was recorded at NAS North Island, Delta Beach/North, and NAB Ocean (a tern that had been dyed elsewhere was also found dead at Tijuana River/North). And two fledglings were beaten to death, yes, beaten to death, at Ormond Beach.

Tidal flooding washed out nests at NAWS Point Mugu ("several" nests), White Beach (2 eggs), Santa Margarita River/North Beach (34 eggs) and Saltflats (3 eggs), and Tijuana River/North (1 egg) and South (7 eggs). Heavy winds buried eggs at Mussel Rock Dunes ($n = \geq 1$), Venice Beach (n=30, all subsequently abandoned), and NAS North Island (three nests). Disease may have been related to some of the deaths at Santa Margarita River/North Beach; several chicks were found with runny yellow or green feces - one treated at Project Wildlife with antibiotics responded favorably.

Monitors at many sites also reported finding large numbers of abandoned eggs and intact chick carcasses. Forty-four of 112 eggs were abandoned at Terminal Island. At Huntington Beach, 43 carcasses (most only a few days old) were found, and 69 eggs were abandoned. One hundred and eighty-one carcasses and 100 abandoned eggs were picked up at Santa Margarita River/North Beach, as were 30 carcasses and 106 abandoned eggs at Mission Bay/FAA Island, and 33 carcasses and 28 eggs at Mission Bay/Mariner's Point. Forty-six eggs were abandoned at Delta Beach/North. At NAB Ocean, seven carcasses and 19 abandoned eggs were picked up. At D Street Fill, seven carcasses and eight abandoned eggs were found, as was one carcass and 17 abandoned eggs at Tijuana River/North, and eight chick carcasses and 104 abandoned eggs at Tijuana River/South.

Sources of Disturbance - Sources of site disturbance (Table 7) were believed to either underlie the abandonment of nests, or to otherwise contribute directly or indirectly to egg or chick mortality, although unequivocal evidence of the connection was lacking. Because the presence of all tern predators causes disturbance and may cause abandonment, all potential predators observed by monitors within 100m of tern nesting areas should be listed here. However, for the sake of unclutteredness, species known or suspected to have preyed on terns (so listed in Table 6) are not included in Table 7.

Disturbance resulting from human presence in or near nesting areas continues to ill-affect terns (the day-to-day disturbance from surrounding public beaches (Ormond Beach, Venice Beach, Huntington Beach, Mission Bay/Mariner's Point) and that associated with nearby

active airfields (NAS Alameda, VAFB Purisima Point, Lindbergh Field, NAS North Island) not included here, although it is certainly present). Pedestrians and/or their pets cause disturbance/flushing, if not direct mortality. OHV riders drive near or through nesting areas. Monitors reported many other types of human-generated problems, including low-flying helicopter disturbance (Terminal Island, Huntington Beach, D Street Fill), jetskiers close to the nesting area (Mission Bay/FAA Island), nocturnal "partying" in the nesting area (as evidenced by litter found by monitor: Tijuana River/North), beligerent equestrians ignoring signs and monitor urgings (Tijuana River/South: one couple was caught riding into the nesting area again, after having just been spoken to a half hour earlier), and even teenagers shooting at stilts and avocets near nesting terns (Ormond Beach; a public beach). Construction activities, jetblast from nearby planes, a broken floodgate, military training exercises, July 4th festivities, and monitoring-associated activities were all also reported to cause disturbance to nesting terns in 1996.

One additional inclusion: at Tijuana River/North, a week-old chick was found caught within the projections extending from the seedpods of a sand verbena (Abronia sp.); its head was gripped by the projections, and its feathers were sticky from plant secretions. Monitors were able to free the chick, which survived, but would not have without human intervention.

## DISCUSSION

The steep yearly increase in the size of the California least tern breeding population that had been the predominant pattern of the last decade, except for a small dip in 1989 and a larger one in 1995, resumed in 1996 (Figure 3). The estimate of 3356 pairs (midpoint of range) is 29% larger than the size of the 1995 breeding population, and almost twice the size of the the population in 1990, only six years ago. Despite the low breeding success experienced at many sites, including several large ones (in terms of number of pairs), fledgling numbers were also up: approximately 2051 fledglings were produced, technically a record high (approximately 2028 were produced in 1993), and almost twice the number produced in 1995 (admittedly a very bad year for terns). The statewide fledgling-to-pair ratio of approximately 0.61 thus represents the splendid success experienced at some sites, compromised by the disheartening breeding failure at others.

The number of sites used by nesting terns throughout the State fluctuates from year to year, as potential nesting areas become either suitable, available, or more attractive (naturally or through site preparation efforts), or unsuitable or unavailable, as a function of human, predator, or other environmental disturbance. The decrease to 35 active sites in 1996 from 37 in 1995 reflects terns choosing not to nest at Oakland Airport, Pismo Dunes (three pairs and zero fledglings since 1993), and Naval Training Center (NTC). Their nesting at Oakland Airport in 1995 was a bit of a fluke; predator presence was (and still is) unyielding, yet the combination of disastrous forces acting at NAS Alameda (Caffrey 1997) may have driven the

1-6 pairs (0 fledglings) to try anywhere else. Their abandoning NTC (for good reason: construction activities at adjacent Lindbergh Field, including massive amounts of human disturbance and the provision of predator-friendly habitat aplenty (details in final Site Report), were allowed to continue into the tern season) is particularly discouraging given their rewarding return, in 1993, to this struggling site after years of diligent site preparation by several tenacious tern people, and their (the terns') incredible success since then (21 pairs, 19 fledglings; 1993-1995 combined). On the flip side, the 83 pairs that nested on the new island ("E-3") at Batiquitos Lagoon were wonderfully successful.

As has been the case since 1994 (the first year nesting-pattern data were requested), terns began nesting earliest in Los Angeles and Orange counties (Figure 1). Through Saturday May 4, 100% of all nests in the State (n=66) were located at sites from Bolsa Chica north to Venice Beach (where nesting had been going on for two weeks). By the following Saturday, terns were nesting throughout the State. Interestingly, first-nest dates do not track arrival dates (Table 2), nor do departure dates track last nest dates (e.g., a pair initiated a nest within days of leaving the site at Tijuana River/South). With regard to the timing of nesting and questions regarding patterns of peaks, lulls, oscillations, and gradual declines (Caffrey 1997), Figure 2 demonstrates that California least terns exhibit a wide range of nesting patterns. Clearly, the issue of nesting "waves," and who's doing what, when, is wide open for further investigation. Better-than-nothing approaches, such as using June 15 or the four-week method to distinguish between different groups of nesters do not appear to be capturing the essence of whatever is really going on. This is not a trivial matter; it directly affects our estimates of pair numbers.

Throughout the State, most sites experienced an increase in the number of breeding pairs present over that of 1995, some notably more than the across-the-board 29% increase in statewide population size (Terminal Island, Huntington Beach, Santa Margarita River/North Beach and Saltflats, Batiquitos Lagoon/all sites combined, Lindbergh Field, Delta Beach/South, NAB Ocean). This was a bit surprising for Santa Margarita River/North Beach (and Saltflats), given that virtually every predator known to terns appears on the "Potential Predators in Area" list for those sites, and many of those predators did, in fact, prey on the eggs and young of the terns that nested there. For Delta Beach/South, 15 pairs equals the high of 1994 (terns first nested at this site in 1992), and is reassuring after their near abandonment of that site last year in response to the ubiquitous ants (effectively controlled in 1996). The steady increase in number of pairs at NAB Ocean (from one in 1994, its first year, to 22 and 72) is encouraging (they have been very successful) yet a bit problematic, given that this beach is essential for military training purposes.

Only three colonies declined in pair numbers enough to warrant concern; in all cases the decline is to some extent understandable. The two sites at Ormond Beach have long suffered from human disturbance problems; given a choice, terns experienced with those sites should nest elsewhere (although clothing the monitor in a CDFG uniform this year seemed to extract a bit more respect from the humans doing the disturbing). The same reasoning applies for the two sites at Tijuana River with regard to both human disturbance and predation; these

beleaguered sites, too, have virtually every tern predator known on their lists. Combined with the continual intrusion of people, successful breeding has been tough to accomplish. At Venice Beach, the local food shortage that began near the end of the 1994 season and apparently continued through 1996 has resulted in dropping pair numbers, presumably in response to dropping (and abysmal) fledgling-to-pair ratios.

Sites where dramatic increases in fledgling-to-pair ratios occurred included two where reproductive success was rebounding back to very successful status after a bleak 1995 season (NAS Alameda, Seal Beach). The monitor at Seal Beach suspects that nesting may have even been more successful if the encroachment of vegetation could have been quelled. At Terminal Island, hatching success was low but chick survival was high; the fledgling-to-pair ratio at that site was the highest in at least a decade. Combined with the increase in the number of breeding pairs present, a hefty number of potential breeders fledged. Huntington Beach, with its record number of pairs and high F/P, fledged its record number of potential breeders. The Batiquitos Lagoon group, with their increasing pair numbers, large clutch sizes, high hatching success, and high chick survival, have become one of the bright spots in predator-plagued San Diego County, Against the backdrop of predator presence, terns at Lindbergh Field, Delta Beach/North (and South), NAB Ocean and D Street Fill all managed a successful season (with lots of help from ADC). All of the above notwithstanding, the success of the intrepid pairs at San Elijo Lagoon may have been the sweetest of all.

Predation is the major factor constraining the fledging of terns across California, and the low-to-dismal success experienced at many sites in 1996 was attributable directly to the take by predators of eggs, chicks, and adults. From the combined sites at Camp Pendleton south to the Mexican border, San Diego County was hit hard, despite the Herculean efforts of ADC. Over 1000 eggs were laid at sites in Mission Bay; using the midpoints of the hatching success ranges provided (Table 5), not many more than half of those hatched. But even then, there may have been more than 500 chicks produced, from which only 133 individuals (again, midpoints of ranges) fledged. Similarly, at Camp Pendleton, 1511 eggs produced 1250 chicks, of which only 244 fledged. Those frightening relationships scream for ideas regarding predator management.

In 1996, terns were also lost to at least one local food shortage (Venice Beach), tidal flooding, heavy winds, and possibly disease. The abandoned eggs and chick carcasses found at sites where predation was intense may have been the consequence of parents either being taken themselves or opting for their own survival by abandoning the site, but the eggs abandoned at Terminal Island, and the carcasses found at Huntington Beach, appear to beg some other explanation. Interestingly, Venice Beach (57 abandoned eggs, not including those buried by wind, and 104 chick carcasses), Terminal Island, and Huntington Beach had among the lowest clutch sizes in the State (Table 5); could there be some connection?

Humans, too, remain a major constraint on tern breeding success. Foot, vehicular, and pet traffic in and around nesting areas cause the loss of eggs and chicks directly through trampling or predation, and indirectly through disturbance, resulting in nest or site

abandonment, or exacerbation of predation pressure. The attitudes and behavior of the horse and OHV riders at Tijuana River/South, and especially the various teenagers at Ormond Beach, make it clear that despite how far we've come, we still have a long, long way to go.

## RECOMMENDATIONS

Funding - Underlying many of the limits on tern reproductive success is the lack of funds available for site preparation, site maintenance, site enhancement, monitoring, and predator control. Sites throughout the State need new fencing, fencing repair, vegetation control, lagoon water level control, educational signs, predator control, and above all, monitor presence, as it is monitors who are familiar with tern breeding requirements as well as the particulars and weaknesses of individual sites. The more often monitors are present, the greater the chance we have of mediating negative influences. To wit, increased monitor presence (as a function of increased funding) was associated with decreased human-related disturbance in 1996 at Ormond Beach; this would likely be the case at the Tijuana River sites as well. Sources of funding must be found to simply maintain the status quo, to say nothing of increasing monitor presence, enhancing current sites, and establishing new sites. Sources of funding for predator management would also help to alleviate some of the predation pressure at CDFG sites without usual access to ADC.

Nesting. Sites - Enhancement of well-established, incipient, and potential sites remains a priority. Human-related threats to terns are ostensibly mollifiable; educating the public is one solution. Efforts to educate the public at Mussel Rock Dunes, including signs depicting nesting terns along with educational information, in both English and Spanish, plus information dispensed at the kiosk upon entering the preserve, **and** the exclusion of dogs during the tern breeding season, have all greatly reduced the number of nests lost to human-related disturbance. The worker education program (for construction workers in the vicinity of the nesting area) at Terminal Island likely contributed to tern reproductive success in 1996, in that trash was properly disposed of, decreasing crow and raven presence. Enclosing nesting areas within fencing so as to exclude humans, in addition to educating the public, would appear one solution (in appropriate situations). With an eye toward approaching that ideal, fencing repair or better fencing, better enforcement, and/or bilingual signs are badly needed at Ormond Beach, Venice Beach, Huntington Beach, San Elijo Lagoon, and Tijuana River. A fox-proof fence is still badly needed at Oakland Airport, and chicken wire along the base of the gate at Chula Vista Wildlife Reserve might help to exclude mammals from tern nesting areas. In addition, some new kind of chick enclosure is needed at Lindbergh Field (the fencing is blown down regularly). In addition, finding a way to put a brake on local development was deemed increasingly important at Ormond Beach and San Elijo Lagoon.

Because terns seek flat, open, sandy areas with little vegetation as nesting sites, overgrown vegetation can constrain, or even prohibit, breeding at otherwise suitable sites.

Oakland Airport, Venice Beach, Seal Beach, White Beach, San Elijo Lagoon, Mission Bay/FAA Island and North Fiesta Island, and Chula Vista Wildlife Reserve are all in need of help clearing vegetation as part of site preparation. Clearing all vegetation in a buffer zone around nesting areas decreases the attractiveness to predators, and is strongly recommended in appropriate situations. Adding some sand to the known nesting levees at Saltworks would increase the available substrate; the same was requested for Mission Bay/North Fiesta Island. And (I say this every year), despite the success of the 1-2 pairs that nested there in 1996, we are losing control of San Elijo Lagoon; getting a handle on the lagoon water level, people-related problems, and especially predation is absolutely required in order to maintain this area as a California least tern nesting site.

In the past, terns have returned to breed in areas unused for variable periods of time (e.g., Santa Clara River, Terminal Island, Batiquitos Lagoon/Park and Ride, and Naval Training Center in 1993, Guadalupe Dunes and Lindbergh Field in 1994, Oakland Airport and Tijuana River/North in 1995); this underscores the importance of continued protection and enrichment of such sites. The use of decoys has been successful in efforts to attract terns back to previously used areas, such as the Naval Training Center, as well as to new sites, for example Mission Bay/Mariner's Point and Delta Beach/South in the past, and Batiquitos Lagoon/E-3 in 1996. Their use at sites used year after year can direct terns to particularly suitable areas.

Monitoring - Because monitors not only collect data but serve as the direct link between recovery efforts and tern life during the breeding season, it is crucial that monitoring continue at least at current levels, and **recommended that those levels increase.** It is a given that the more closely a site is monitored, the better the troubleshooting and problem intervention/solving. As often as possible, and for as long as possible, monitors should visit sites, assess the impact of all things that impinge on breeding success and, when possible, respond to negative influences in ways that promote tern survival and reproduction. Increased monitor presence (pending funding) was requested at Bolsa Chica, San Elijo Lagoon, Mission Bay/North Fiesta Island, and both Tijuana River sites.

Predator Control - Predation on least tern eggs, chicks, fledglings, and adults has been, and will continue to be, a major problem at most sites. Wiping out all potential predators prior to the onset of nesting would clearly benefit terns, but is unnatural, unacceptable, and not possible anyway. Presently, at CDFG-contract managed sites, predator management consists mostly of "crisis control," where predators are removed only after damage is done and the predator(s) can be identified. Sometimes, even after predators have been identified, predator removal is not attempted. The decision as to the fate of the offender(s) is based on several criteria, including the status of the predator (e.g., "endangered" or "species of special concern"), the estimate of its potential effects on tern breeding success, the site history, and financial and local residential considerations. All of these are important variables, and in most cases, the ultimate decision is neither easy nor straightforward. Yet the time, and additional terns, lost in the decision-making process, and the frustration and helplessness felt by monitors with no control over the situation are issues that can be addressed directly.

Thus, some sort of ecologically- and ethically- sound predator management program must be worked out, and soon.

With an eye toward such a program, we have attempted to improve our base of information on predator behavior and effects, and site histories, by standardizing the reporting of actual or potential predation, and requesting the filling out of Predator Sighting Sheets (Caffrey 1995a) by all monitors, when appropriate. In the future, these will contribute to the establishment of a predator management program where site histories and documented predator effects dictate a more standardized approach to predator control than exists now.

In the meantime, increased ADC assistance at sites severely affected by predators in the past and at sites experiencing intense predation pressure during any particular breeding season is desperately needed. At Chula Vista Wildlife Reserve, ADC presence prior to tern arrival would alleviate some of the predation pressure at that site. Huntington Beach (re ground squirrels), San Elijo Lagoon, Saltworks, and the Tijuana River sites are all in need of increased predator-management help. The peregrine falcon situation in Mission Bay would appear to require a change in approach, and ADC needs easier access to FAA Island there. Additionally, crow carcasses work so well at Venice Beach (and at Batiquitos Lagoon/W-l in 1996) at keeping live crows out of the nesting area that I strongly recommend we pursue this means of non-lethal intervention at sites plagued by crows. Monitors at D Street Fill (where crow and raven carcasses were used in 1994) and VAFB/Purisima Point (crow carcassess used in 1995) also reported that crow (and raven, at D Street Fill) presence on site appeared much reduced compared to previous years. I repeat (from the last three years): Can we get some stuffed ones made, so we can determine whether or not **they** work, and so that, if so, we can re-use them year after year?

Future Research and a Better Understanding of Demographic Mechanisms - Resumption of a large-scale banding program and the compilation of data on marked individuals would go a long way toward increasing our understanding of nesting patterns, survivorship patterns, the mechanisms underlying population growth, and maybe even breeding decisions made by individuals (e.g., choice of mate and/or breeding site). A coordinator for such a program, a necessary first step, is much needed.

## ACKNOWLEDGEMENTS

This report marks the end of my tenure of five years as Administrator and Principle Investigator of the CDFG California least tern Monitoring Program. It was an admirable program when I arrived, and I believe it has steadily gotten better and better. That continuing excellence is the accomplishment of the agencies and organizations, but especially the people, whose names appear below. The people associated with this program have been some of the nicest and most compassionate people I am privileged to know, Their work, their care, their

ideas, their generosity, their tireless dedication, and their sense of responsibility have been overwhelming. I am proud to have worked with all of you, and honored to acknowledge your contributions.

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Field monitors remain the vital link between us and the terns, and the terns and their survival as a species. Monitors pull vegetation, erect fencing, shovel sand, pilot boats, wade through water, trudge through mud, educate the public, and endure whitewashing as they watch and walk to keep data up to date; moreover, they are forced to become coroners of sorts, like it or not, and are our first step in predator crisis management. Through it all, they somehow manage to remain open-minded, level-headed, and upbeat in the face of uncontrollable mortality, human recklessness, and that sometimes nightmarish phenomenon we call bureaucracy. Thanks to all of you (from north to south, in 1996): Laura Collins, Leora Feeney, Anne Marie Tipton, Robert Burton, Wendy Thomlinson, Mary Perry, Karen Bronner, Sandra Schultz, Tom Applegate, Phil Persons, Don Davis, Mary Jane Davis, Linda O'Neill, Terry O'Neill, Jan Lewison, Art Marshall, Jaimie Jackson, D. Reischel, Tom Keeney, Denise Woods, Elisa Graham, Phil Takata, Kathy Keane, Wally Ross, Mike Taylor, Nick Liberato, Nathan Mudry, Brian Collins, Charlie Collins, Michael Mitchell, Jeff Johnson, Gary Gillis, Lara Ferry-Graham, James McClister, Doreen Stadtlander, Carol Roberts, Madonna Young, Brian Foster, Linda Belloumini, Tricia Hobell, Margaret McIntosh, Dennis Parker, Robert Patton, Kim Taylor, Mark Tucker, Adam Welchel, Susan Welker, Tricia Campbell, Tim Dillingham, Ginger Johnson, Marit Evans-Lang, John Konecny, Elizabeth Copper, Kenneth Andrecht, Melissa Mailander, Y. Sachiko Kohatsu, Patricia Baird, Bonnie Peterson, Jill Terp, and Jennifer Price.

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Table 1. Type, Primary Contact, total number of Days during the breeding season that sites were visited, and total number of Hours over the season that at least one monitor was present at sites in the state of California, 1996. Type 1 sites are monitored from inside; Type 2 from the outside (see Methods). An asterisk next to site name indicates it is a new site in 1996. "Un" indicates historically-used site unoccupied by nesting terns in 1996 (1: site unused for at least five years, 2: site used within the last five years, 3: site unused for many years and no longer monitored). The new site "E-2" was not used by nesting terns in 1996. NP indicates data were not provided. Primary contacts can be reached through CDF&G office in Sacramento.

**Table 1.**

| | Type | Primary Contact | Days | Hours |
|---|---|---|---|---|
| **San Francisco Bay Area** | | | | |
| PGE, Pittsburg | 1&2 | Laura Collins | 18 | 29 |
| Port Chicago (Allied) | un1 | Laura Collins | | |
| NAS Alameda | 1&2 | Laura Collins | 109 | 556 |
| Oakland Airport | un2 | Leora Feeney | | |
| **San Luis Obispo/Santa Barbara Counties** | | | | |
| Pismo Dunes | un2 | Ann Marie Tipton | | |
| Santa Maria River Mouth: | | | | |
| Guadalupe Dunes | un2 | Walter Wehtje | | |
| Mussel Rock Dunes | 1 | Wendy Thomlinson | 35 | 111 |
| San Antonio Creek | un1 | Nancy Read | | |
| Vandenberg AFB: Beach 2 | un2 | Nancy Read | | |
| Purisima Point | 2 | Nancy Read | 62 | 186 |
| Santa Ynez River Mouth | un1 | Nancy Read | | |
| **Ventura County** | | | | |
| Santa Clara River: Mouth | 1 | Don Davis | 30 | |
| McGrath Beach | un2 | Don Davis | | 195 |
| McGrath Lake | 2 | Don Davis | 18 | |
| Ormond Beach: Perkins Rd | 2 | Morgan Boucke | 68 | 299 |
| Edison | 2 | Morgan Boucke | | |
| Point Mugu | 1 | Tom Keeney | 14 | NP |
| **Los Angeles/Orange Counties** | | | | |
| Venice Beach | 1 | Carolee Caffrey | 60 | 210 |
| Terminal Island | 1 | Kathy Keane | 115 | 288 |
| Seal Beach | 1 | Brian Collins | 60 | 90 |
| Bolsa Chica | 1 | Carolee Caffrey | 35 | 105 |
| Huntington Beach | 1&2 | Doreen Stadtlander | 66 | 188 |
| Newport Slough | un2 | Brian Collins | | |
| Upper Newport Bay | 2 | Carolee Caffrey | 39 | 39 |
| **San Diego County** | | | | |
| MCB Camp Pendleton: | | | | |
| White Beach | 1 | Brian Foster | 62 | 91 |

| | | | | |
|---|---|---|---|---|
| Santa Margarita River: | | | | |
| North Beach | 1 | Brian Foster | 62 | 241 |
| Saltflats | 1 | Brian Foster | 49 | 83 |
| Buena Vista Lagoon | un3 | Elizabeth Copper | | |
| Aqua Hedionda | un3 | Elizabeth Copper | | |
| Batiquitos Lagoon: | | | | |
| W-1 | 1&2 | Adam Whelchel | 80 | 60 |
| W-2 | 1&2 | Adam Whelchel | 80 | 80 |
| E-1 | 1&2 | Adam Whelchel | 80 | 80 |
| E-2* | un* | Adam Whelchel | 40 | 40 |
| E-3* | 1&2 | Adam Whelchel | 80 | 80 |
| San Elijo Lagoon | 2 | Robert Patton | 20 | 20 |
| San Diequito Lagoon | un3 | Elizabeth Copper | | |
| Los Penasquitos | un3 | Elizabeth Copper | | |
| Mission Bay: | | | | |
| Mariner's Point | 1 | Ginger Johnson | 40 | 113 |
| FAA Island | 1 | Elizabeth Copper | 7 | 33 |
| North Fiesta Isl | 1 | Elizabeth Copper | 16 | 45 |
| Stony Point | un3 | Elizabeth Copper | | |
| South Shores | un3 | Elizabeth Copper | | |
| Cloverleaf | un3 | Elizabeth Copper | | |
| San Diego Bay: | | | | |
| Lindbergh Field | 1 | Kenneth Andrecht | 90 | 50 |
| Naval Training Center | un2 | Elizabeth Copper | 46 | 125 |
| NAS North Island | 1 | Robert Patton | 116 | 342 |
| Delta Beach: North | 1 | Elizabeth Copper | 95 | 380 |
| South | 1 | Elizabeth Copper | 61 | 244 |
| NAB Ocean | 1 | Elizabeth Copper | 68 | 275 |
| Grand Caribe Island | un3 | Elizabeth Copper | | |
| D Street Fill | 1 | Kenneth Andrecht | 34 | 25 |
| Chula Vista Wldlf Res. | un2 | Kenneth Andrecht | 38 | 11 |
| Saltworks | 1 | Jennifer Price | 31 | 47 |
| Tijuana River: North | 1 | Robert Patton | 19 | 27 |
| South | 1 | Robert Patton | 30 | 96 |

Table 2. Chronology of California least tern reproductive activities, 1996. For date of arrival, "less than (=earlier than) or equal to" indicates terns present on that date, but may have arrived earlier (similarly for departure date, terns gone on that date, but may have left earlier). "Later than" for departure indicates last day monitor present; terns still there. Second wave occurrence was determined for each site (see Methods): if "yes" or "minor," beginning date is provided; if no, date provided is that through which "lack of" determination was made. For Saltworks and Tijuana River/North and South (*), second wave beginning date reflects date when renesting of failed pairs was believed to have begun. First Egg, Chick, and Fledgling dates indicate actual date, if known, or the first date observed ("earlier than or equal to"). First Egg date for San Elijo Lagoon (*) is an estimate based on backtracking from first chick observed. Last Nest date is the actual date the last new nest was initiated, or the first date observed. NA indicates data were not available, NP indicates data were not provided.

**Table 2.**

| | Activity Period | | | Date of First | | | |
|---|---|---|---|---|---|---|---|
| | **Arrive** | **Depart** | **Second Wave?** | **Egg** | **Chick** | **Fledgling** | **Last Nest** |
| PGE, Pittsburg | 5/3 | 8/23 | yes,5/31 | ≤5/10 | ≤6/7 | ≤6/21 | ≤7/12 |
| NAS Alameda | 4/25 | 8/20 | yes,6/4 | 5/6 | ≤6/2 | 6/20 | ≤7/12 |
| | | | | | | | |
| Mussel Rock Dunes | ≤4/28 | <8/16 | minor,6/15 | ≤5/17 | ≤6/12 | ≤7/5 | ≤7/15 |
| VAFB: Beach 2 | 4/29 | 8/13 | | | | | |
| Purisima Point | 4/29 | 8/13 | yes,6/20 | ≤5/14 | NA | ≤6/25 | NP |
| St Clara Rv: Mth & McG | 5/2 | 9/6 | no,9/6 | ≤6/7 | 6/20 | 7/14 | 7/5 |
| Ormond Bch: Ed & Prk | 5/10 | 9/3 | yes, 7/8 | 5/19 | 6/11 | 7/5 | 7/22 |
| NAWS Point Mugu | 5/3 | 7/30 | no,9/11 | ≤5/23 | ≤6/19 | NP | 7/16 |
| | | | | | | | |
| Venice Beach | ≤4/10 | >7/28 | yes,6/12 | 4/27 | 5/22 | ≤6/20 | 7/7 |
| Terminal Island | 4/12 | 8/15 | yes,6/10 | 5/4 | 6/7 | 6/28 | 7/15 |
| Seal Beach | ≤4/9 | 7/9 | no,7/30 | ≤5/2 | ≤5/21 | ≤6/18 | NA |
| Bolsa Chica | ≤4/23 | 7/15 | no,7/21 | 5/3 | 5/26 | ≤6/22 | 6/11 |
| Huntington Beach | ≤4/19 | 8/13 | minor,6/25 | 5/10 | 5/31 | 6/20 | 7/12 |
| Upper Newport Bay | ≤4/30 | ≤8/1 | no,8/1 | ≤5/11 | ≤6/3 | ≤6/29 | 6/5 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| White Beach | 4/28 | 8/11 | yes,6/11 | 5/11 | 6/1 | 6/22 | 7/2 |
| SM River: North Beach | 4/21 | 8/20 | yes,6/5 | 5/5 | 5/30 | 6/23 | 7/20 |
| Saltflats | 4/30 | 7/16 | yes, 6/9 | 5/9 | 6/4 | 7/4 | 6/27 |
| Batiquitos Lagoon: W-1 | 4/15 | NP | no,9/1 | 5/10 | 6/2 | 6/23 | NP |
| W-2 | 4/15 | NP | no,9/1 | 5/10 | 5/31 | 6/20 | NP |
| E-1 | 4/15 | NP | no,9/1 | 5/10 | 6/1 | 6/22 | NP |
| E-3 | 4/15 | NP | yes,6/15 | 5/10 | 6/1 | 6/22 | NP |
| San Elijo Lagoon | ≤4/28 | 7/31 | no,8/15 | 5/20? | ≤6/11 | ≤7/2 | NA |
| Mission Bay: FAA Isl | NA | 7/10 | yes,6/12 | NA | ≤5/29 | 6/26 | 7/3 |
| Mariner's Point | ≤4/23 | 7/29 | yes,6/3 | 5/6 | 5/29 | 6/18 | 7/13 |
| N Fiesta Isl | ≤5/13 | 7/24 | yes,6/14 | ≤5/29 | 6/5 | 6/30 | ≤7/12 |
| Naval Training Center | 4/23 | 5/10 | | | | | |
| Lindbergh Field | 4/19 | 8/7 | yes,6/19 | 5/6 | 5/28 | 6/18 | 7/22 |
| NAS North Island | 4/18 | 8/16 | minor,6/13 | ≤5/10 | 5/31 | 6/24 | ≤7/7 |
| Delta Beach: North | 4/19 | 9/9 | minor,6/7 | 5/10 | 6/3 | 6/23 | ≤7/22 |
| South | 4/16 | 7/24 | yes,6/5 | 5/14 | 6/5 | 6/28 | 6/29 |
| NAB Ocean | ≤4/8 | 8/23 | minor,6/10 | 5/13 | 6/3 | 6/24 | 8/1 |
| D Street Fill | 4/19 | 8/9 | yes,6/14 | 5/10 | 6/3 | ≤6/24 | 7/19 |
| Saltworks | 5/7 | ≤7/30 | yes,5/28* | 5/13 | 6/7 | 7/11 | NA |
| Tijuana River: North | 4/24 | 8/29 | yes,5/30* | ≤5/8 | < 6/13 | ≤7/5 | ≤8/9 |
| South | 4/24 | 8/16 | yes,6/7* | ≤5/13 | ≤6/7 | ≤6/28 | ≤8/16 |

Table 3. First wave totals for 1996 California Least Tern breeding season; included are all sites with nesting terns in 1996 or 1995. Total Nests includes any suspected renests of first wave pairs. Total Pairs are followed by numbers of first wave pairs at each site in 1995 (in parentheses). Percent Change 1995 indicates increase or decrease in 1996 first wave pairs relative to 1995 numbers (for both years, if ranges were given, midpoints of ranges used in calculation). NA indicates data were not available, NP indicates data were not provided. Total Eggs generally not available at Type 2 colonies, thus statewide Total Eggs not included.

| | **Total Pairs** | **% Δ 1995** | **Total Nests** | **Total Eggs** |
|---|---|---|---|---|
| PGE, Pittsburg | 2 (2) | 0 | 2 | 4 |
| NAS Alameda | 132 (130) | +2 | 137 | 257 |
| Oakland Airport | 0 (2.5) | | | |
| | | | | |
| Pismo Dunes | 0 (1) | | | |
| Mussel Rock Dunes | 29 (43) | -33 | 30 | 59 |
| VAFB Purisima Point | 50 (26) | +92 | 50 | NA |
| St Clara Rv: Mth & McG | 28 (16) | +75 | 28 | 54 |
| Ormond Bch: Ed & Perk | 74 (39) | +90 | 74 | NA |
| NAWS Point Mugu | 69 (NP) | | NP | 109 |
| | | | | |
| Venice Beach | 241 (295) | -18 | 311 | 463 |
| Terminal Island | 37 (11) | +236 | 37 | 70 |
| Seal Beach | 150 (117) | +28 | 167 | 312 |
| Bolsa Chica | 147 (125) | +18 | 147 | 263 |
| Huntington Beach | 275 (171) | +61 | 275 | 502 |
| Upper Newport Bay | 55 (24) | +129 | 55 | NA |

| | | | | |
|---|---|---|---|---|
| White Beach | 38 (28) | +36 | 38 | 79 |
| Santa Margarita River: | | | | |
| North Beach | 500 (294) | +71 | 500 | 1013 |
| Saltflats | 77 (41) | +88 | 77 | 156 |
| Batiquitos Lagoon: W-1 | 39 (50) | -22 | 45 | 90 |
| W-2 | 46 (3) | +1433 | 47 | 97 |
| E-1 | 37 (29) | +28 | 37 | 80 |
| E-3 | 57 | | 57 | 122 |
| San Elijo Lagoon | 2 (.5) | +300 | 2 | NA |
| Mission Bay: FAA Island | 188 (NP) | | 188 | 367 |
| Mariner's Point | 200 (210) | -5 | 222 | 435 |
| N. Fiesta Island | 6 (NP) | | 6 | 13 |
| Naval Training Center | 0 (5) | | | |
| Lindbergh Field | 53 (18) | +194 | 53 | 110 |
| NAS North Island | 48 (54) | -11 | 48 | 91 |
| Delta Beach: North | 159 (134) | +19 | 159 | 311 |
| South | 9 (1) | +800 | 9 | 19 |
| NAB Ocean | 59 (13) | +354 | 59 | 111 |
| D Street Fill | 19 (22) | -14 | 19 | 37 |
| Saltworks | 10 (18) | -44 | 10 | 19 |
| Tijuana River: North | 23 (2) | +1050 | 24 | 42 |
| South | 114 (273) | -58 | 114 | 204 |
| | | | | |
| **Total** | 2973<br>(>>2198) | | 3096<br>(>>2362) | |

Table 4. Totals for 1996 California least tern breeding season; included are all sites with nesting pairs in either 1996 or 1995. Total Pairs and Fledglings/Pair numbers are followed by 1995 data (in parentheses; in cases where ranges were given for 1995, midpoints used here). Percent Change 1995 indicates increase or decrease in 1996 total pairs relative to 1995 number (midpoints of ranges used in calculation). Any discrepancy between 1996 Total Pairs and Total Nests reflects renesting attempts by pairs. Fledgling numbers, and thus F/Ps also, for Ormond Beach and Seal Beach (*) may be overestimates (see text). NP indicates data were not provided.

**Table 4.**

| | Total Pairs | % Δ 1995 | Total Nests | Total Fledglings | Fledglings/ Pair |
|---|---|---|---|---|---|
| PGE, Pittsburg | 4 (3) | +33 | 5 | 4 | 1.0 (0.67) |
| NAS Alameda | 208 (150) | +39 | 250 | 233 | 1.12 (0.49) |
| Oakland Airport | 0 (4) | | | | (0) |
| | | | | | |
| Pismo Dunes | 0 (1) | | | | (0) |
| Mussel Rock Dunes | 45-50 (52) | -8 | 54 | 25-30 | 0.50-0.66 (0.44) |
| VAFB Purisima Point | 62 (38) | +63 | 62 | 11 | 0.18 (0.45) |
| Santa Clara Rv: Mouth | 7 28 (17) | 7 +65 | 7 28 | 7 20 | 7 0.71 (1.0) |
| McGrath Lake | | | | | |
| Ormond Beach: Perkins | 7 85 (7-15) | 7 -17 | 7 85 | 7 155* | 7 1.82* (0.53) |
| Edison | (92) | | | | |
| NAWS Pt Mugu | 69 (NP) | | NP | 11 | 0.16 (NP) |
| | | | | | |
| Venice Beach | 271 (310) | -13 | 361 | 92 | 0.34 (0.14) |
| Terminal Island | 56 (15) | +273 | 68 | 45-50 | 0.80-0.89 (0.6) |
| Seal Beach | 150 (117) | +28 | 167 | 100* | 0.67* (0.03) |
| Bolsa Chica | 147 (134) | +10 | 147 | 20 | 0.14 (0.11) |
| Huntington Beach | 300 (171) | +75 | 300 | 255 | 0.85 (0.33) |
| Upper Newport Bay | 55 (38) | +45 | 55 | $\geq$14 | $\geq$0.26 (0) |

| | | | | | |
|---|---|---|---|---|---|
| White Beach | 38 (28) | +36 | 56 | 5-10 | 0.13-0.26 (0.3) |
| SM River: North Beach | 500-557 (294) | +80 | 631 | 220-240 | 0.40-0.48 (0.36) |
| Saltflats | 83 (41) | +102 | 84 | 2-10 | 0.02-0.12 (0.16) |
| Batiquitos Lagoon: W-1 | 39 (50) | -22 | 45 | 132 | 1.55 (0.74) |
| W-2 | 46 (3) | +1433 | 47 | | |
| E-1 | 37 (29) | +28 | 37 | 20 | 0.54 (1.1) |
| E-3 | 83 | | 83 | 76 | 0.92 |
| San Elijo Lagoon | $\geq$2 (2) | 0 | $\geq$2 | 3 | $\leq$1.50 (0.5) |
| Mission Bay: FAA Isl | $\geq$188 (200) | -6 | 255 | 0-5 | $\leq$0-0.03 (0.3) |
| Mariner's Point | 250 (210) | +19 | 294 | 100-150 | 0.40-0.60 (0.61) |
| N Fiesta Isl | 11 (12) | -8 | 17 | 4-5 | 0.36-0.46 (0.33) |
| Naval Training Center | 0 (5) | | | | (0.6) |
| Lindbergh Field | 63 (26) | +142 | 71 | 100-120 | 1.59-1.91 (1.95) |
| North Island NAS | 49 (54) | -9 | 53 | 21 | 0.43 (0.44) |
| Delta Beach: North | 190 (150) | +27 | 224 | 200 | 1.05 (0.83) |
| South | 15 (1) | +1400 | 21 | 10 | 0.67 (2.0) |
| NAB Ocean | 72 (22) | +227 | 84 | 60 | 0.83 (0.77) |
| D Street Fill | 25 (26) | -4 | 28 | 15-35 | 0.60-1.40 (0.95) |
| Saltworks | 22 (23) | -4 | 29 | 2 | 0.09 (0.44) |
| Tijuana River: North | 23 (2) | +1050 | 57 | 3 | 0.13 (0) |
| South | 114 (273) | -58 | 246 | 23 | 0.20 (0.26) |
| | | | | | |
| **Total** | $\geq$3330-3392 (2598) | | | 1981-2120 (1069) | 0.58-0.64 (0.41) |

Table 5. Clutch sizes and hatching success at Type 1 sites, 1996. "Unsure" denotes either the number of nests abandoned or preyed upon possibly prior to completion at Type 1 sites (thus actual clutch size unknown), the total number of nests at Type 2 sites (thus Total Number of Eggs not available), or some combination of the above (at NAS Alameda, both Type 1 and Type 2 methods are used to monitor). Mean clutch size provided for known clutch sizes only. Total Eggs for NAS Alameda includes those of "unsure" clutch size, and thus represents the minimum at that site. Ranges provided for hatching success indicate difference between eggs known to have hatched and those that "probably" hatched (not found broken, predation unlikely, and egg gone after appropriate incubation period). NA indicates hatching success data were unavailable: either a Type 2 site so unknown, observation limitations (e.g., days/week present, overgrown vegetation), or not enough information in final Site Report to distinguish between knowns and probables. NP indicates data were not provided.

**Table 5.**

**Clutch Size**

| | 1 | 2 | 3 | Unsure | Mean | Total Eggs | % Hatch |
|---|---|---|---|---|---|---|---|
| PGE, Pittsburg | | 3 | 1 | 1 | 2.25 | 10 | NA |
| NAS Alameda | 38 | 192 | 7 | 13 | 1.87 | 456 | 85 |
| | | | | | | | |
| Mussel Rock Dunes | 6 | 46 | 2 | | 1.93 | 104 | 23-40 |
| VAFB Purisima Point | | | | 62 | | | NA |
| St Clara Rv: Mth & McG | 2 | 26 | | | 1.93 | 54 | 89 |
| Ormond Bch: Ed & Pk Rd | | | | 85 | | | NA |
| Point Mugu | NP | NP | NP | | | 109 | NP |
| | | | | | | | |
| Venice Beach | 213 | 145 | 3 | | 1.42 | 512 | 81 |
| Terminal Island | 26 | 40 | 3 | | 1.67 | 112 | 54 |
| Seal Beach | 27 | 135 | 5 | | 1.87 | 312 | NA |
| Bolsa Chica | 37 | 104 | 6 | | 1.79 | 263 | 42-88 |
| Huntington Beach | 72 | 225 | 3 | | 1.77 | 531 | 86 |
| Upper Newport Bay | | | | 55 | | | NA |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| White Beach | 7 | 45 | 4 | | 1.95 | 109 | 38 |
| SM River: North Beach | 73 | 513 | 45 | | 1.96 | 1234 | 86 |
| Saltflats | 5 | 74 | 5 | | 2.00 | 168 | 88 |
| Batiquitos Lagoon: W-1 | 5 | 35 | 5 | | 2.00 | 90 | 90 |
| W-2 | 3 | 38 | 6 | | 2.06 | 97 | 94 |
| E-1 | | 31 | 6 | | 2.16 | 80 | 98 |
| E-3 | 11 | 60 | 12 | | 2.01 | 167 | 87 |
| San Elijo Lagoon | | | | 2 | | | NA |
| Mission Bay: FAA Isl | 33 | 214 | 8 | | 1.90 | 485 | 27-76 |
| Mariner's Point | 36 | 253 | 5 | | 1.89 | 557 | 41-91 |
| N Fiesta Isl | 3 | 12 | 2 | | 1.94 | 33 | 30-70 |
| Lindbergh Field | 7 | 57 | 7 | | 2.00 | 142 | 47-88 |
| NAS North Island | 10 | 42 | 1 | | 1.83 | 97 | 75 |
| Delta Beach: North | 36 | 185 | 3 | | 1.85 | 415 | 85 |
| South | 2 | 17 | 2 | | 2.00 | 42 | 93 |
| NAB Ocean | 11 | 72 | 1 | | 1.88 | 158 | 87 |
| D Street Fill | 7 | 20 | 1 | | 1.79 | 50 | 40-82 |
| Saltworks | 5 | 23 | 1 | | 1.86 | 54 | 63 |
| Tijuana River: North | 24 | 33 | | | 1.58 | 90 | NA |
| South | 64 | 150 | 2 | | 1.71 | 430 | NA |

Table 6. Causes of California least tern breeding failure, as reported, 1996. Documented and suspected avian and mammalian predators are indicated, as well as other sources of mortality. Birds: BbP - Black-bellied Plover, BcNH - Black-crowned Night Heron, BO - Barn Owl, BwO - Burrowing Owl, CG - California Gull, CH - Cooper's Hawk, Cr - American Crow, Gl - Gull species, GBH - Great Blue Heron, GbT - Gull-Billed Tern, GhO - Great Horned Owl, Ks - American Kestrel, NH - Northern Harrier, Ow - owl species, PF - Peregrine Falcon, Rr - Roadrunner, Rv - Raven, RtH - Red-Tailed Hawk, WG - Western Gull, WM - Western Meadowlark. Mammals: Bc - Bobcat, Cn - Canid species, Ct - Domestic Cat, Cy - Coyote, Dg - Domestic Dog, FC - Feral Cat, FD - Feral Dog, GF - Gray Fox, Rc - Raccoon, Sk - Skunk species, Ws - Weasel. Other: An - Ant, Ds - Disease, Fl - Flooding, FS - Food Shortage, Hpo - Hypothermia, Hu - Human-related mortality (1: pedestrians and/or their dogs crushed eggs, 2: fledglings beat to death by teenagers, 3: vehicles killed fledglings, 4: loss of eggs or adults related to color-marking study, 5: chick caught in ant trap, 6: people riding OHVs and other vehicles crushed eggs, 7: people riding horses crushed eggs), Sn - Snake species, Wd - Wind.

**Table 6.**

| | Predation | | | | |
|---|---|---|---|---|---|
| | Documented | | Suspected | | Other |
| | **Bird** | **Mammal** | **Bird** | **Mammal** | |
| PGE, Pittsburg | | | GBH | | |
| NAS Alameda | Ks,NH,Rv | | RtH | GF | Hpo,Hu3,FS? |
| | | | | | |
| Mussel Rock Dunes | | Cy,Rc | Gl | | Wd |
| VAFB Purisima Point | WG | | PF,GBH | | |
| St Clara Rv: Mth & McG | | | | | Hu1 |
| Ormond Bch: Ed & Pk | | | WG,CG | | Hu1,Hu2 |
| NAWS Pt Mugu | | | Ks | FD,Cy | Fl |
| | | | | | |
| Venice Beach | | | Ks | | FS,Wd |
| Terminal Island | PF,Ks,Cr | FC | Rv,WM | | FS? |
| Seal Beach | | | | | |
| Bolsa Chica | | Cn | | | |
| Huntington Beach | | | Cr | | |
| Upper Newport Bay | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| White Beach | Rv | Sk | Ks,BO,GhO,NH | Bc | An,Fl |
| SM River: North Beach | PF,BO,BwO,Rv, CH,GBH,GhO | Bc,Ws, Sk | Ks | | Sn,Fl,Ds? |
| Saltflats | RtH | | Ks,NH,Ow | | An,Fl |
| Batiquitos Lagoon: W-1 | Rr,Cr | | Rv,BO,GBH,GhO | | |
| W-2 | | | BO,GhO,Ks,Rv, RtH | | |
| E-1 | RtH | | BO,GhO,Ks,Rv,Cr | | |
| E-3 | Ks | | BO,GhO | | |
| San Elijo Lagoon | | | | | |
| Mission Bay: FAA Isl | PF,Ks,Gl | | GBH | | An |
| Mariner's Point | PF,WG | | Ks | | An |
| N Fiesta Isl | | | Ks | | An |
| Lindbergh Field | | | | | Hu3 |
| North Island NAS | Ks,BwO | | | | Hu3,Hu4,Wd,An? |
| Delta Beach: North | BcNH,RtH | | Ks,PF | FC | Hu4 |
| South | | | Ks,PF,RtH | FC | Hu5 |
| NAB Ocean | Ks,WG | | RtH,PF,GbT | Sk | Hu4 |
| D Street Fill | | | | | |
| Saltworks | | | Ow,PF,Ks | Dg | |
| Tijuana River: North | Rv | Ct | GbT,WG,Ow,WM | Dg | Hu1,Hu4,Fl |
| South | NH,BO,BwO,WM, BbP | Dg,GF | GbT,WG,Ks, PF,Ow | | Hu1,Hu6, Hu7,Fl |

Table 7. Sources of nesting site disturbance: there was no direct evidence of actual predation or other mortality caused by indicated sources, however, sources were believed to cause some undetected mortality, underlie nest abandonment, or to exacerbate sources of mortality. All sources of breeding failure (Table 6) are relevent here (predators and humans in nesting areas cause disturbance), but are not included because of space considerations. Thus predators listed here were observed by monitors or ADC personnel in or near nesting areas, but were not known to have caused any mortality directly: BsK - Black-shouldered Kite, CT - Caspian Tern, LS - Loggerhead Shrike, Os - Osprey, RsH - Red-shouldered Hawk, RwB - Red-winged Blackbird, RD - Rock Dove, SN - Snowy Egret, BtJ - Black-tailed Jackrabbit, GS - Ground Squirrel, Op - Oppossum, Rc - Raccoon, Rt - Rat, Tr - Turtle spp, BWS - Black Widow Spider, Cb - Crab spp. Human-related disturbance: J4 - July 4th activities, Mlt - Navy training operations or recreational use often in area near nesting terns, Rec1 - pedestrians in nesting areas, Rec?2 - teens shooting at avocets and stilts near nesting terns, Rec3 - tracks indicate vehicles in/near nesting areas, Rec4 - surfers walking through nesting area, Rec5 - low-flying helicopters and/or planes in area, Rec6 - jetskiers close to nesting area, Rec7 -nocturnal "partying," Rec8 - public events on nearby beach drew huge crowds and caused gulls to relocate toward terns, Rec9 - fledgling found with fishing line wrapped around bill and feet (monitor removed and tern survived), UP - presence of unauthorized people in vicinity of tern site (base closed 7/1), Vd - vandalism (tampering with electric fence). Other: Abr - chick caught in Abronia sp. almost died, Cs (construction) - increased vehicular activity on adjacent taxiway associated with paving projects on airfield (terns seen flying or running in response to passing vehicles), Jb - jetblast from nearby taxiing planes repeatedly undermined chick fence (which repeatedly required maintenance), MP (management problems) - broken floodgates, encroaching vegetation, and ample perching opportunities for predators continue to constrain successful nesting by terns, RE1 (recovery effort) - fine grain size of sand deposited on site resulted in increased drifting against chick fence, allowing chicks to escape (they were successfully returned) and requiring increased maintenance, RE2 - 47 nests required moving/elevation; only 3 abandoned. All other abbreviations as in Table 6.

| | Human | Animal | Other |
|---|---|---|---|
| PGE, Pittsburg | | | |
| NAS Alameda | UP,Vd | PF,FC,Op,Sk,Dg | |
| | | | |
| Mussel Rock Dunes | Rec1 | NH,PF,CT,GS | |
| VAFB Purisima Point | | GhO,NH,Ks,LS,RtH,CH | |
| St Clara Rv: Mth & McG | Rec1 | | |
| Ormond Bch: Ed & Prk | Rec?2 | | |
| NAWS Pt Mugu | Rec3,Rec4 | | |
| | | | |
| Venice Beach | J4,Rec9 | Cr,Dg | |
| Terminal Island | Rec5 | LS,Op,Gl,GBH,An,BWS | |
| Seal Beach | | Cr,Ks,LS,PF,BO | |
| Bolsa Chica | | | |
| Huntington Beach | Rec5 | Ks,Ow | |
| Upper Newport Bay | | GBH,Cr,Ks,CT,Rv,Gl,RtH,BsK | |

| | | | |
|---|---|---|---|
| White Beach | | | |
| SM River: North Beach | Rec5 | | |
| Saltflats | | | |
| Batiquitos Lagoon: W-1 | | | |
| W-2 | | | |
| E-1 | | PF,Rc,Sk,Op,Bc | |
| E-3 | | PF,NH | |
| San Elijo Lagoon | | Cr,Ks,CT,Rv,GBH,Gl, RtH,RwB,WM,Ow,RsH,Bc, Cy,GF,Op,Rc,Sk,Ws,Tr | MP |
| Mission Bay: FAA Isl | Rec6 | Cb | |
| Mariner's Point | Rec1,Rec8 | GBH,Rt,Ow | |
| N Fiesta Isl | | GBH,LS,NH,WG,WM,BtJ | |
| Lindbergh Field | | FC,PF,Ks,WG | Jb |
| North Island NAS | | WG,PF,Rv | Cs,RE1 |
| Delta Beach: North | | BO,BwO,CT,Rv,GBH,GhO,Gl, GbT,LS,NH,Os,RD,BtJ,GS, Ct,Op,Sk,Dg,Ws,An,BWS,Cb | RE2 |
| South | | Cr,BcNH,CT,Rv,GBH,Gl,GbT, LS,NH,Os,RD,SE,BtJ,GS,Ct, Dg,FC,Op,Sk,An,BWS | |
| NAB Ocean | Mlt | BwO,CT,Rv,GBH,Gl,NH,Os, BtJ,GS,Ct,Dg,FC,Op, Sk,Ws,An | |
| D Street Fill | Rec5 | Op,Sk,GS,Cy,LS,BtJ | |
| Saltworks | | Rv,CT,Gl | |
| Tijuana River: North | Rec1,Rec7 | Cr,Ks,CT,GBH,Gl,NH, Os,PF,GS,FC,An,Cb | Abr |
| South | | Cr,BsK,Rv,GBH,Gl,LS,Os, BtJ,GS,Cy,FC,Op,Rc,Sk,An,Cb | |

Figure 1. Number of new nests initiated during the week ending on each Saturday (± 1 day) of the breeding season, 1996. Data from the following sites: North: NAS Alameda, Mussel Rock Dunes, Santa Clara River. Central: Venice Beach, Terminal Island, Seal Beach, Bolsa Chica, Huntington Beach, Upper Newport Bay. South: White Beach, Santa Margarita River/North Beach and Saltflats, Batiquitos Lagoon/W-l, W-2, E-l and E-3, Mission Bay/ Mariner's Point and North Fiesta Island, Lindbergh Field, NAS North Island, Delta Beach/North and South, NAB Ocean, D Street Fill, Saltworks, Tijuana River/North and South.

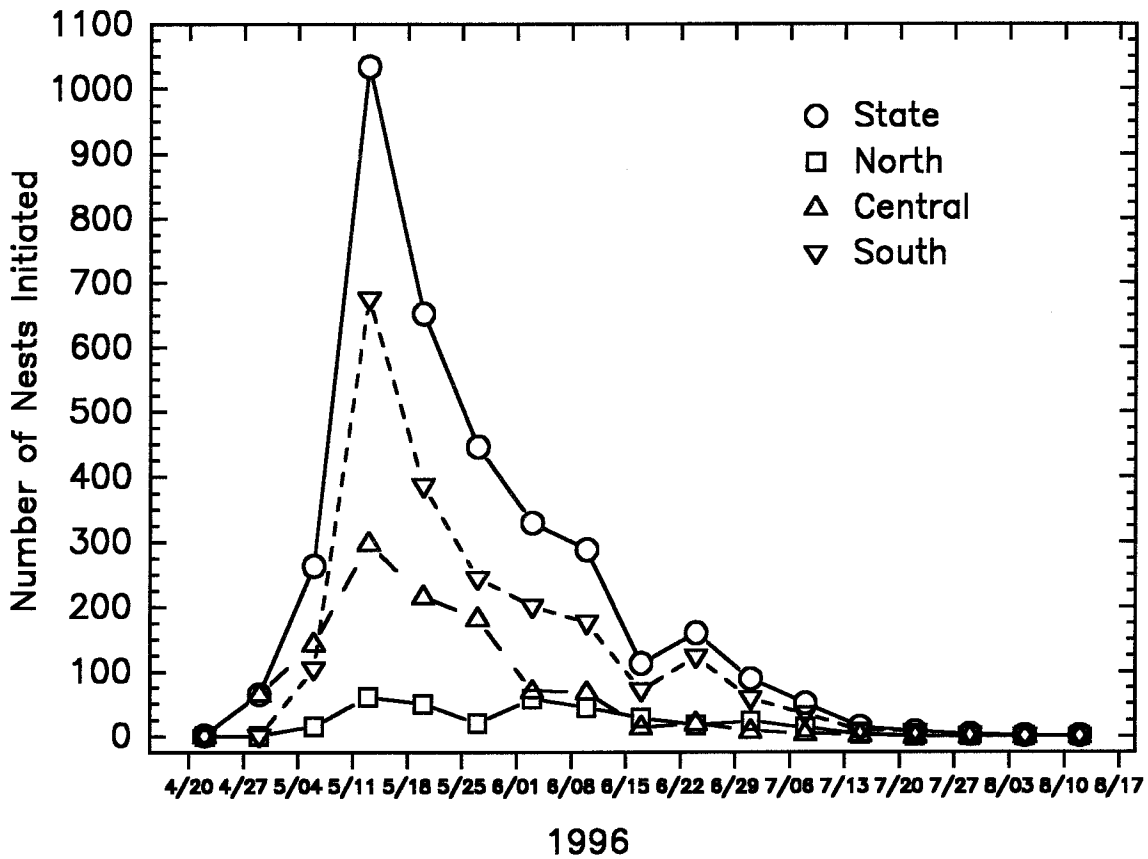
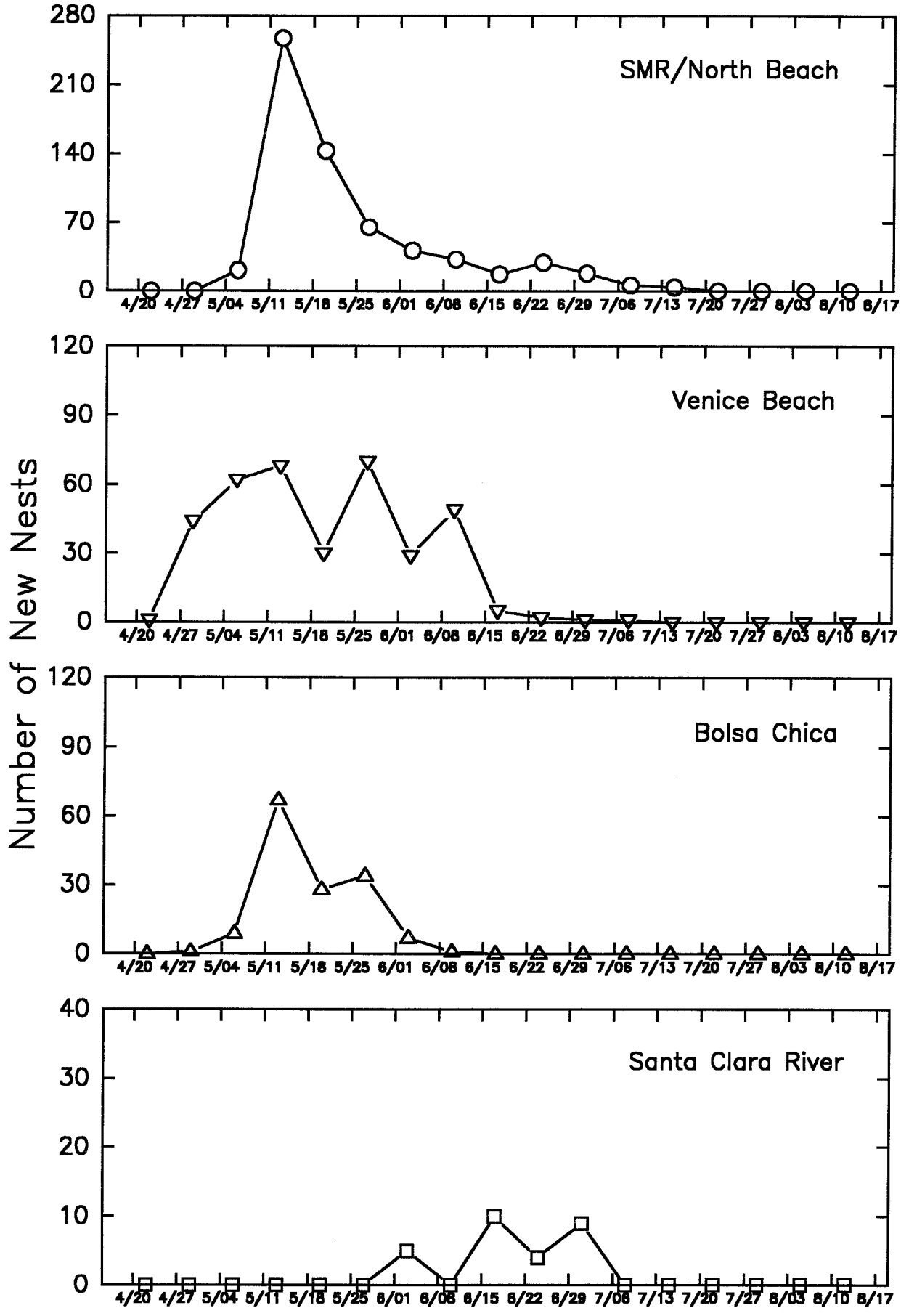

1100
1000
900
800
700
600
500
400
300
200
100
0
Number of Nests Initiated
State
North
Central
South
4/20 4/27 5/04 5/11 5/18 5/25 6/01 6/08 6/15 6/22 6/29 7/06 7/13 7/20 7/27 8/03 8/10 8/17
1996

Figure 2. Differences in the timing of nesting and nesting patterns: number of new nests initiated during the week ending each Saturday ($\pm$1 day) at Santa Margarita River/North Beach, Venice Beach, Bolsa Chica, Santa Clara River, Mussel Rock Dunes, NAB Ocean, White Beach, Tijuana River/North. Note that differences exist in Y-axes.


Number of New Nests
SMR/North Beach
Venice Beach
Bolsa Chica
Santa Clara River
280
210
140
70
0
120
90
60
30
40
20
10
4/20 4/27 5/04 5/11 5/18 5/25 6/01 6/08 6/15 6/22 6/29 7/06 7/13 7/20 7/27 8/03 8/10 8/17

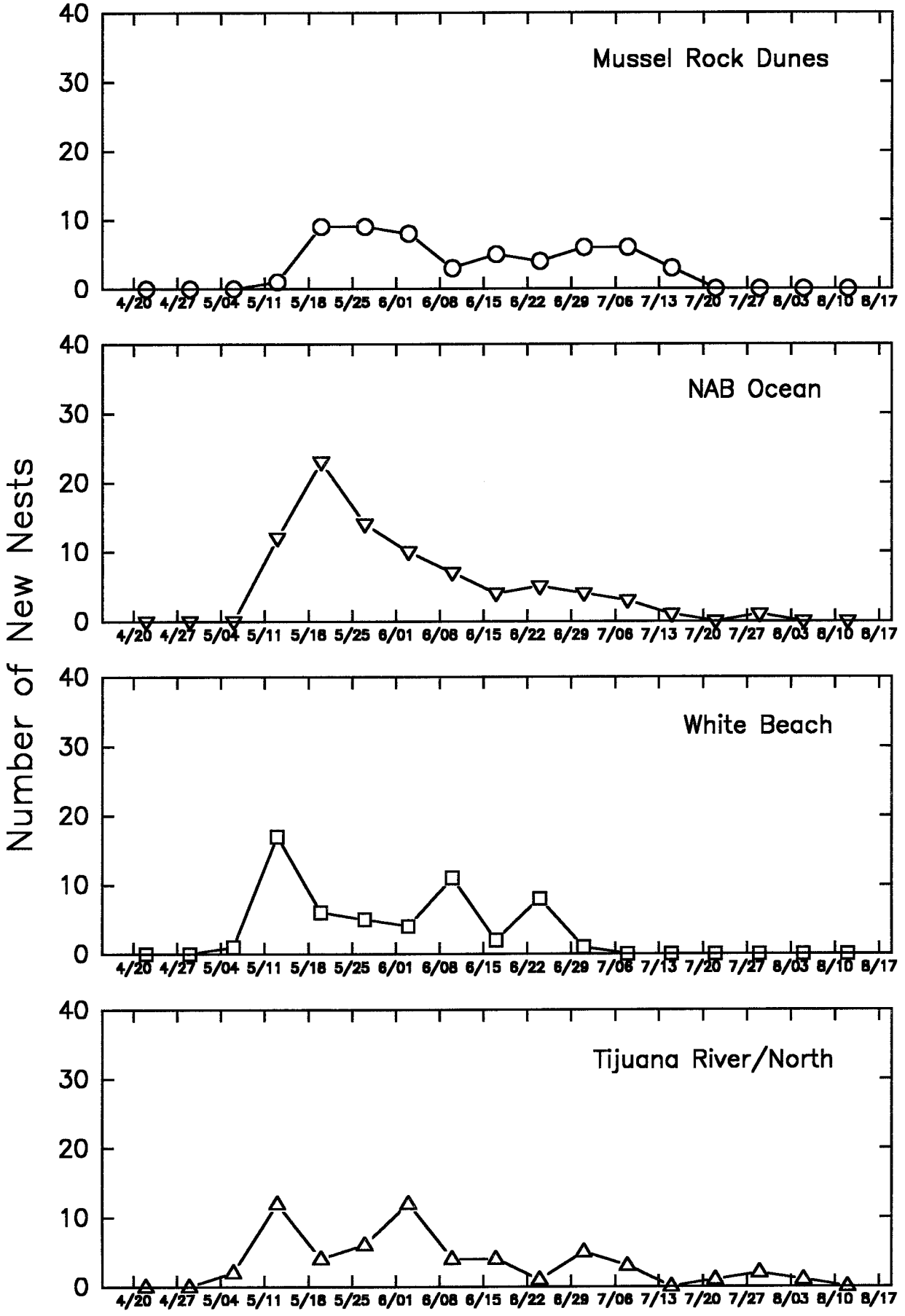
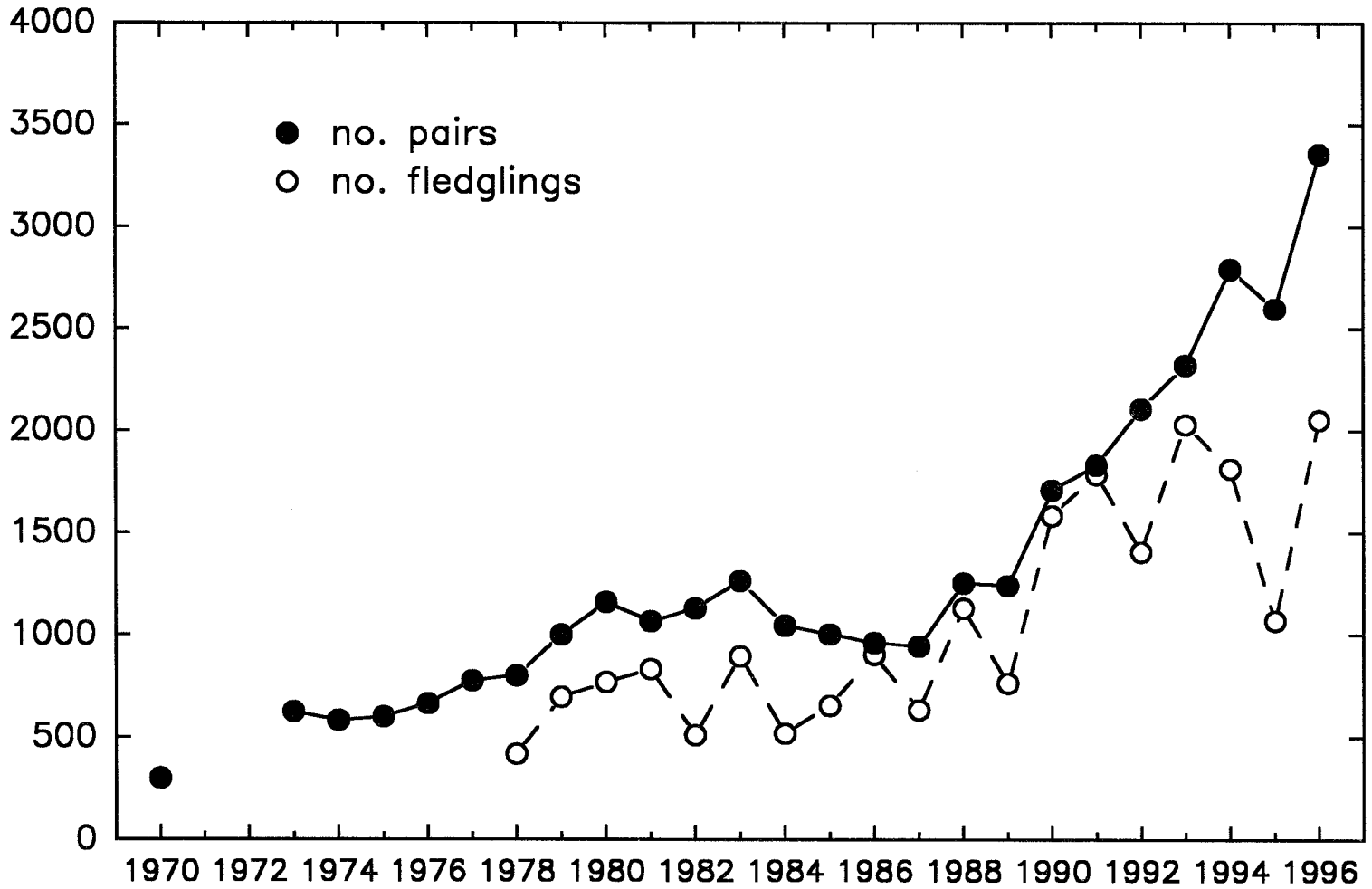

Number of New Nests
Mussel Rock Dunes
NAB Ocean
White Beach
Tijuana River/North
0
10
20
30
40
4/20 4/27 5/04 5/11 5/18 5/25 6/01 6/08 6/15 6/22 6/29 7/06 7/13 7/20 7/27 8/03 8/10 8/17

Figure 3. Statewide numbers of pairs and fledglings, 1973-1996. Data for 1973-1990 from Fancher 1992.


4000
3500
3000
2500
2000
1500
1000
500
0
no. pairs
no. fledglings
1970 1972 1974 1976 1978 1980 1982 1984 1986 1988 1990 1992 1994 1996

## APPENDIX A: MILITARY SITES

Naval Air Station, Alameda (NAS Alameda)
Vandenberg Air Force Base (VAFB Beach 2, and Purisima Point)
Naval Air Weapons Station, Point Mugu (NAWS Pt. Mugu)
Marine Corps Base, Camp Pendelton (White Beach, and Santa Margarita River/North Beach, Saltflats, and Saltflats Island)
Naval Training Center, San Diego (Naval Training Center)
Naval Air Station, North Island (NAS North Island)
Naval Amphibious Base, Coronado (Delta Beach/North and South, and NAB Ocean)

## APPENDIX B: SITE SUMMARIES (those received)

### PG&E Pittsburg

This little colony experienced good reproductive success with four fledglings produced by two of the four nesting pairs. It was still the most northern California least tern colony. Aside from the Alameda Naval Air station colony, PG&E has the only other nesting site in northern California that has continued to host terns on a yearly basis (with appreciable success). PG&E maintained a formidable fence at the entrance to the nesting berm to discourage larger mammalian predators. Human activity in the area was restricted while the terns were present. Vegetation control provided an adequate substrate for tern nests and young. The Plant also provided for a monitor. The only disappointment was my inability to detect the somewhat locally famous right banded male. This bird visits each year to breed or patiently spend time waiting for a mate. It has appeared that when he eventually finds a mate somewhere, they breed at PG&E. He visited last year, early in the season. We hope he found a mate in 1996 and that she will follow him to PG&E by 1997, assuming that they did not breed undetected this year.

### NAS Alameda

The colony experienced a remarkable 28 percent increase in the number of breeding pairs, from 150 pairs in 1995 to 208 pairs in 1996. This huge increase was probably due in part to the "excellent" reproductive success that occurred at NAS in both 1992 and 1993. Once again, comprehensive monitoring and management measures included vegetation control, other substrate preparations, maintenance of a partially electrified fence that surrounds a 4 acre nesting enclosure, almost daily monitoring designed to track each family unit as long as possible, demographic, behavioral and ecological observations, comprehensive but sensitive animal damage control, and the minimization of problems associated with humans, aircraft and ground vehicles. An unusually high number of predators were observed or obviously involved in depredations of tern young and some eggs. Those predators included the common raven, a gray fox, a male northern harrier, and 4 American kestrels. A pair of nonbreeding red-tailed hawks were likely suspects. The peregrine falcon may have at least caused some abandonments of nests in incubation. Various methods were employed to control all but the ravens, whose depredations were limited to the eggs in several of the first nests, and the peregrine falcons. However, the last tern chicks and young fledglings were allowed to escape the enclosure at the end of the season, so some survived the inevitable encroachment and depredations of certain avian predators. Food availability did not appear as good as expected during much of the nesting season. However, the colony still experienced good reproductive success since it was estimated that 233 of the fledglings left the colony successfully. The Base will be closed in April of 1997. Due to various considerations involving the least tern, it is critical to structurally and otherwise secure the entire western portion of NAS from unauthorized human related intrusions prior to the 1997 nesting season. There are other important issues that must also be addressed.

### Mussel Rock Dunes

The California Least Tern colony located on Guadalupe-Mussel Rock Dunes, within the preserve managed by The Nature Conservancy, has continued to increase the number of nests laid over the last five years. A total of 54 active nests were observed in 1996, an increase from 1995. The colony site lacked predator exclusion devices leading to the loss of a significant number of eggs, and potentially chicks and fledglings. The largest disappointment this season was the documentation of raccoon predation. Losses to burial or human disturbance were mmimal. Continued education of the pubhc entering the Preserve has helped reduce human and domestic dog disturbance over the years of the study.

Monitors visited the colony on average 3 times per week during the height of breeding and egg laying. This provided adequate sighting of new nests, hatchings, predated nests, and fledglings. The two monitors developed a system of using compass bearings to determine nest locations and to reduce duplicate nest

sightings. Toward the end the of the season, four attempts were made to locate the tern evening roost to assess fledgling production. All attempts failed, so fledglings were counted as they loafed during the day. Overall, the estimated fledgling number appears to have increased from previous years.
The colony of least terns on Guadalupe-Nipomo Dunes PreseIve has benefited from the protection afforded from a preserve system. Tern production this year was likely adequate to sustain the population in coming years. Predation must continue to be closely monitored. Increased predation this year may affect future population stability ofthe least tern colony and should be examined closely in 1997.

**VAFB Purisima Point**

**Site preparation at the Purisima Point site** involved activating electric fences; USFWS recommended that decoys and chick shelters not be deployed at Purisima or at Beach 2, as they apparently **attract** the attention of predators. Purisima was the only site used for nesting in 1996, although 6 terns were observed in courtship behavior near San Antonio Creek early in the season. **Monitoring at Purisima** was **conducted three days per week, as usual.** Monitoring technique was modified this year. Although this is a Type 2 site, a minimal number of entries were made into the colony to identify and monitor nests, as there are several areas used by terns that are impossible to observe from outside the colony. Bi-weekly coordination meetings between the least tern monitor, USDA-ADC, USFWS, and VAFB ensured that monitoring and predator control activities achieved maximum results with minimum intrusion into the colony. Occasional night monitoring proved quite valuable; this is when gull predation on tern eggs (and possibly a snowy plover chick) was directly observed. Gull numbers and activity in the colony at night far exceeded that observed during the day. The highest **adult tern population** observed at the Purisima colony was 98 on May 19. 62 nests were located, 24 more than in 1995. 11 chicks fledged in 1996; as in 1995, fledging success was greater for second wave nests. **Predator Monitoring and Control** was conducted as in prior years, emphasizing non-lethal control measures. Successful measures implemented included use of gull carcasses to deter gull predation, in a manner similar to that used for crows; and live-capture and holding of two great horned owls. Other **significant events** included: 2 adult and 10 nestling least terns were found dead; 8 chicks and 1 adult showed no obvious signs of injury, one chick was a scavenged skeleton, and one chick had a wound in its side which could have occurred before or after death. Six of the dead chicks were found in paired brood scrapes. Carcasses of 1 adult and 9 chicks were collected and turned over to USFWS (Jim Watkins, Ventura office). The cause of death was not deterrnined for any of these birds, excepting 1 adult which was predated. No food shortage was indicated; we suspect abandonment due to harassment of adult terns by predators. Although the electric fence effectively excluded mammalian predators, there was an unusually high diversity of avian predators this year, including two species not previously documented as least tern predators on VAFB (great blue heron and a juvenile peregrine falcon). Attempts to trap the peregrine were delayed due to conflicting feedback from USFWS regarding the appropriateness of trapping. Trapping was finally attempted by the Santa Cruz Predatory Bird Research Group in mid-July, but this effort was not successful. We wish to thank the USFWS Carlsbad office (Loren Hayes and Doreen Stadtlander) for helping us to clarify both the peregrine issue and the importance of VAFB to least tern recovery.

**Venice Beach**

Vegetation overgrowth has become a huge problem. For the last few years, it has been getting more and more difficult to clear enough vegetation by hand, and it would have been impossible this year. Chanelle Davis came to the rescue and arranged with Beaches and Harbors to have a plow pulled around the site, scraping all of the vegetation from the surface (it looked really weird). She also made the arrangements to have the sand moved away from the fence, so as to expose the chick fence (which had been buried over the winter). Being 9 months pregnant and then immediately post-partum in March and April, I was more grateful for her help than I can put into words.
As usual lately, nesting began earlier at Venice than anywhere else, providing hope that last year's horrible failure (as the result of a local food shortage) was in our past. That was not to be the case. Chicks began

dying as soon as they began hatching, and that continued for the rest of the season. At our first fledgling count, 7 weeks after the first week of nesting, there were 0 fledglings (98 nests should have fledged by then; even if things were slow due to a shortage of food, lots of early nests failed). We ended up picking up 104 dead chicks and 87 abandoned eggs (including the 30 mentioned below). It was noticeably windier this year than ever before (several monitoring attempts were aborted because of the intense wind), and 30 eggs in 24 nests buried for l-2 days were abandoned. A kestrel present on site was live-trapped within 24 hours. We had 361 nesting attempts, including an estimated 90 renests, and produced 92 fledglings (F/P =0.34). Nesting ended really early - it was essentially over by June 20...a pretty dismal year, by any criterion.

**Terminal Island**

Least Terns were first observed over the 15-acre Terminal Island nesting site on April 12 and were first seen landing on the site on April 26. Up to 20 terns were present on the site by May 16, and a total of 28 nests was present by May 28. By June 12, 44 nests had been initiated (already exceeding the nest total for 1995), and 19 chicks had hatched from ten nests. The first fledging was seen June 24. By July 1, 25 nests had hatched a total of 44 chicks, five nests were abandoned, six had eggs overdue for hatching, and two had been lost to predators. Sixty-eight nests had been initiated by July 15, the total for the season. An estimated 36 fledglings was present by July 26, and terns were roosting on the site at night and on the dredge pipes east of the site during the day, where fledglings were learning foraging skills. Five chicks and eight unhatched nests were still present by August 1 but were abandoned by August 3. Hatching success was low (53.5%) because of abandonment or inviability because of contaminants (which is still being examined) or inattendance due to predation, and six eggs were lost to predators. However, survival of the 60 hatched chicks was high; a total of 45 to 50 fledglings were produced from the site this year by an estimated 56 nesting pairs. Such productivity at this site has not been observed since 1986.

**Seal Beach**

The California least tern breeding colony at NASA Island, Seal Beach National Wildlife refuge experienced a productive year in 1996 with about 100 least tern fledglings being produced. The site was utilized by approximately 150 pairs of terns. Some predation did occur, but not enough to cause a wholesale failure of the colony. Food availability seemed good and the overall health of the population was good. No evidence of disease outbreaks was observed. No visible deformities or other abnormalities were observed in the population. Substrate preparation was attempted with mixed results. Vegetation cover of undesirable plant species was a significant factor that affected the colony. This may have caused a limitation of “second wave” nesting at this site. Predator control was established on site and no doubt had a positive effect on least tern breeding output. A team of talented and qualified individuals was recruited to assist in the monitoring of this site. This also produced a positive effect on the colonies’ breeding output and helped to gather data relative to growth rates and contaminants loads of chicks and eggs respectively. The site was also utilized as an educational outreach tool to visitors to the Refuge who can now observe the colony from a distance and become better informed on conservation issues that are present in the region.

**Bolsa Chica**

Bolsa Chica was monitored 3 times per week from April 23 to July 21. A few terns were present at the site upon my arrival on April 23, but the first egg did not appear until May 3. The site had much of its vegetation removed prior to April 23, providing nesting access on a larger portion of the island than had been available last year. A total of 147 nests were found over the course of the season. 25% of nests had 1 egg (37 nests), 71% had 2 eggs (104 nests), and 4% had 3 eggs (6 nests). Nesting rate reached a peak in mid May, (67 new nests appeared between May 12 and May 18), and slowly decreased **until the last new** nest was found on June 11. There was no second wave of nesting, so I assumed that each of the 147 nests represented its own nesting pair, hence I estimated 147 nesting pairs this year. In mid June, a mammalian predator (probably a coyote, possibly a feral or domestic dog) left tracks all over the island, and dug up 3-14

nests (probably nearer the latter). This predator appeared to get onto the island only once, so actual damage was relatively minimal, although its presence may have precluded further nesting by some pairs. 20 dead chicks and 2 dead adults were also found during the course of the season, with no apparent sign of being killed by a predator. These animals probably were killed by food limitation or possibly by overheating (the younger chicks). Only 20 fledglings were observed at this site, which is relatively low, but fledgling counts at this site are typically relatively low. Overall, the season was relatively short, and it is unclear if this was due to the predator's visit to the island in mid-June, or whether the season was short throughout California.

**Huntington Beach**

Nest monitoring at the Huntington Beach tern colony was conducted via a mobile blind inside the enclosure twice/week with additional observations taken from outside the colony. This site has been plagued in the past by either crow or kestrel predation. Although several eggs were believed to be depredated, no full clutches were lost. Egg laying was relatively synchronous and the large number of terns (300 pairs) reacted together to successfully drive out individual crows which occasionally entered the site. In addition, this years' removal of the female kestrel and one fledgling from the palm trees across from the colony just as tern eggs began to hatch was believed to be critical in this years' reproductive success. An estimated 255 fledglings were produced resulting in a fledgling/pair ratio of 0.85, the highest fledgling to pair ratio since 1983.

**Upper Newport Bay**

The Newport Site did very well considering that very few adults actually nest there. In contrast to last year, chicks and fledglings were observed this year, although being a type 2 site, it is difficult to be certain of the exact success rate. Food seems abundant, and predation low.

**Camp Pendleton Sites**

Data from the three sites that were monitored on Camp Pendleton during 1996 are as follows:

The first egg was laid on May 5; the first chick hatched on May 30; the last nest was initiated on 20 July (and abandoned shortly thereafter). The first fledgling was observed on June 22.

There were 678 nest established during the 'first wave' and 93 during the 'second wave.' There were 678 pairs nesting. Hatching success at the three sites ranged from 38 to 88 percent. An estimated 157 to 270 fledglings were produced.

Predation was a significant factor in the low fledgling production despite daily intervention by the local Animal Damage Control Field Specialist . Known predators included ravens, stripped skunks, Cooper's and red-tailed hawks, barn owls, burrowing owls, great horned owls, great blue heron, long-tailed weasels, bobcats, and peregrine falcons.

**San Elijo Lagoon**

Monitoring of California least terns at San Elijo Lagoon Ecological Reserve was not specifically funded in 1996, however, San Diego County Parks Department staff were in the area daily, checked potential nesting areas at least monthly, and noted tern activity incidental to other duties. Nesting areas were not entered, but viewed from the periphery.

Nesting habitat was limited due to prolonged freshwater inundation of the East Basin saltpamre related to lagoon closure to the ocean and a broken flood control dike floodgate. At least two pairs nested on the saltpanne and appear to have fledged three chicks. No other nesting attempts were documented. The abandonment of San Elijo by nesting snowy plovers and the majority of its tern colony reflects long-term predation and unresolved site management issues relating to predator control, colony site designation and preparation, and water level management.

**Mission Bay/FAA Island**

FAA Island was monitored weekly from 29 May to 10 July. A total of 255 nests were identified, over 188 nesting pairs were estimated, and between zero and 3 fledglings were produced. Due to heavy predation from Americcn Kestrel and Peregrine alcon, colony abandonment occurred during the second week of July. Subsequent to colony abandonment, gulls began roosting on the site resultiny in large scale depredation of unattended nests (106 eggs were consumed). Personnel from Animal Damage Control and The Peregrine Fund attempted to trap and relocate kestrels and peregrines from the area but as in previous years were unsuccessful.

FAA Island continues to be an important site for a large number of breeding Least Terns (over 188 pairs in 1996). However, the colony also continues to be plagued with severe avian predation, ants, and vegetation all resulting in heavy losses and consequently little to no reproductive success. Lack of adequate transportation hinders our ability to properly manage the site from both c monitoring and predator control perspective. Although vegetation can be a benefit by providing cover for chicks, this year the site was covered with dead low cover vegetation that resulted in reduced nesting substrate and inadequate chick protection from foraging falcons. Ants, as in past years, remain a problem for both chicks and eggs and need to be addressed. FAA Island needs serious attention. The site has in the past been very productive for Least Terns and still offers important reproductive potential.

**Mission Bay/Mariner's Point**

This fenced site adjoining a public beach in Mission Bay was still in excellent condition following last year's improvements (riprap to control erosion and chick fence around the entire site). Fall and spring clean-ups and clearing of non-native vegetation were done by local volunteers. The site was monitored two to three times a week from 23 April to 5 August for a total of 40 visits. 250 pairs of Least Terns laid 557 eggs (294 nests) of which about 400 hatched (343 chicks were banded). Only l00-150 chicks survived to fledge, however, due to persistent predation by a Peregrine Falcon and by Western Gulls working the site. Efforts made by ADC to control these predators were helpful but not always successful. 33 dead chicks and two dead adults were found on the site. 49 eggs were abandoned and/or preyed upon. Without the pressure from predators this site would be relatively problem-free. It has potential for being a highly successful and productive breeding site for Least Terns.

**Mission Bay/North Fiesta Island**

This was a season with some successes, but the numbers remain low. relative to historical use and to the potential of the site. lntensified monitoring and predator management should allow the site to support populations equal to or greater than those found at Mariner's Point and F.A.A. Island.

**NAS North Island**

Vegetation was graded off, sand was deposited, decoys and tiles were placed prior to arrival of the terns. Monitoring was conducted April through August one to seven days per week.

California Least Terns were observed at the central Mat nesting site at Naval Air Station, North Island from 18 April through 16 August. At least 49 pairs established 53 nests with 97 eggs. All nests occurred on the modified substrate of sand-filled cracks or depressions in the asphalt and on deposited expanses, mounds, and strips of sand.

Seventy-five percent of the eggs hatched, two eggs were depredated, two eggs were broken during handling for adult color-marking, 11 eggs failed to hatch, and eight eggs from seven nests were abandoned or nonviable. One chick hatched and died after the nest was abandoned and its sibling died while hatching. Three chicks were found dead with no apparent signs of trauma. One fledgling was found dead on the taxiway, apparently run over by a vehicle, and another was observed killed as it flew through an aircraft propeller. One chick was observed to have been preyed on by a kestrel, and Burrowing Owls preyed on at least 10 chicks, six fledglings, and three adults. Remains of five chicks and fledglings and two adults

indicated avian predation, as well. However, 21 young are estimated to have fledged from the colony this season.

American Kestrels were observed foraging within the colony. Burrowing Owls, Western Gulls, and Common Ravens were observed within the colony and tracks and feathers were found within the site on multiple occassions. Peregrine Falcons were also observed over the site and landed within and adjacent to the site several times. Feral cats and a striped skunk were observed outside the fence prior to any losses and following departure of the last terns from the site.

**Delta Beach/North**

In addition to the grading of the site, some additional sand was imported to attempt to reduce the number of nests vulnerable to flooding. Decoys were placed on site and tiles were distributed within the nesting area. Monitoring began on 8 April and continued into September. Terns were present at North Delta Beach from 19 April through 24 August. The first nests were found on 10 May and the last nest was found on 22 July and the last hatch was on 26 July. A record 224 nests were established with a total of 415 eggs for an everage clutch size of 1.85. Of the 224 nests, 196 (88%) hatched young, with 351 chicks produced (85% hatching rate) and an estimated 200 young fledged. One nest with two eggs was preyed upon apparently by a black-crowned night-heron; six chicks were found in a red-tailed hawk removed after it was observed taking a chick. Twenty nests were abandoned pre-term (9%). Three of the abandoned nests had been recently moved or elevated to avoid flooding. Nineteen eggs were incubated to term but did not hatch, one died while hatching, and 27 were abandoned pre-term. Forty-seven nests (21 %) were moved and/or elevated to avoid flooding by high tides with all but three successfully hatching young. Three hundred thirty chicks were banded (94% of those hatched) and 26 adults were trapped and banded. Twenty-seven chicks, eight fledglings, and two adults were found dead on site with the cause of mortality unknown. An estimated 200 young were fledged.

**Tijuana River/North**

USFWS refuge staff repaired fencing and posted signs prior to the terns' arrival. Additional signs were posted as needed when nesting occurred outside the limit of signs at the river mouth. Monitoring was conducted April through August one to two days per week.

California Least Terns were observed from 24 April through 29 August. At least 23 pairs established 57 nests northeast of the mouth of Tijuana River and at the fenced "north site" south of Seacoast Drive. The majority of nests were initiated relatively late in the season and were assumed to be renesting attempts from failed nests at the river mouth and elsewhere around the estuary and south San Diego Bay. Forty nests with 65 eggs were established at the river mouth and 17 nests with 25 eggs were established at the north site.

Only 23 percent of the eggs hatched, at least 19 eggs were depredated, two nests were destroyed by human activity, one nest was lost to high tides, and 17 nests were abandoned. The fate of 30 eggs from 19 nests is unknown. Though predation seems most likely, it is possible that many were lost to human destruction. One chick and two adults were found dead with no apparent signs of trauma. Remains of two chicks and two fledglings indicated avian predation. Only three young are estimated to have fledged from the colony this season, and they came from later nests at the north site.

At least one nest was depredated by a raven and one chick by a cat. At least one gull-billed tern was observed over or adjacent to the colony each visit from late May through mid-July. Beachgoers and their dogs were observed disturbing the river mouth subcolony several times a day despite signs and contact by monitors and USFWS personnel. Western gulls, western meadowlarks, kestrels, and California ground squirrels were observed within the colony, and tracks of a large owl were found.

**Tijuana River/South**

USFWS refuge and State Parks staff replaced fencing and posted signs prior to the terns' arrival. Addidonal signs were posted as needed once nesdng was underway. Monitoring was conducted April through August

one to three days per week.

California Least Terns were observed from 24 April through 16 August. At least 114 pairs established 237 nests southeast of the mouth of Tijuana River. An additional nine nests were established just north of the international border and are believed to have been renesting attempts in response to predadon.

Only 29 percent of the eggs hatched, at least 65 eggs from 47 nests were depredated, 25 eggs from 16 nests were destroyed by human activity, four nests were lost to high tides, and 104 eggs from 72 nests were abandoned. The fate of 94 eggs from 57 nests was uncertain, but age of nests and lack of hatching or chick presence makes predadon most likely. Eight chicks and five adults were found dead with no apparent signs of trauma. Predation was documented for five chicks, three fledglings, and nineteen adults, but an addidonal 84 to 97 young are estimated to have been preyed on. Only 23 young are estimated to have fledged from the colony this season.

A northern harrier was observed taking eggs and is believed responsible for the loss of up to 20 percent of the nests. Barn owls preyed on at least 18 adult least terns and one nest. A burrowing owl, western meadowlark, gray fox, and dog took additional eggs. Gull-billed terns are suspected in taking eggs and kestrels and a peregrine falcon are suspected of taking chicks, as well. A great blue heron, western gulls, kite, ravens, crow, and loggerhead shrike were observed within the nesting area. Black-bellied plovers apparently opportunistically preyed on the last remaining eggs.