

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

**CALIFORNIA LEAST TERN  
BREEDING SURVEY  
1993 SEASON**

by  
Carolee Caffrey

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Nongame Bird and Mammal Section Report, 94-07

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### **ABSTRACT**

In 1993, a minimum of 2,400 pairs of the endangered California least tern (*Sterna antillarum browni*) nested at 35 sites along the coast of California, and produced approximately 1848-2009 fledglings. This 14% increase over 1992 breeding population size continues the trend since 1987 of continued growth of the population, and is directly attributable to the efforts of people working on behalf of recovery of the species. The statewide total of 2,400 pairs is the highest number recorded since systematic monitoring began in 1973, and represents a four-fold increase over the estimated 600 pairs of that year.

Predation on tern eggs, chicks, fledglings, and adults, and abandonment of eggs and chicks as a function of predation pressure, were the major causes of breeding failure in 1993. Monitors at 15 of 22 sites with low fledgling production (<0.9 fledglings/pair) attributed the lack of success to predation. The adverse effects of predation were manifested at all stages of breeding. Many types of human-related disturbance also constrained fledgling production in 1993. Breeding success and failure were strikingly localized; successful (>0.9 fledglings/pair) and unsuccessful sites were distributed throughout the State. Seven sites were particularly successful at fledging high numbers of tern chicks: NAS Alameda, Venice Beach, Seal Beach, Mission Bay/Mariner's Point, and Delta Beach North combined produced approximately 82% of the total fledglings produced statewide.

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<sup>1</sup>Caffrey, C. 1994. California least tern breeding survey, 1993 season. Calif. Dep. Fish and Game, Wildl. Manage. Div., Nongame Bird and Mammal Section Rep. 94-07, Sacramento, CA. 39 pp.

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**1993 SEASON**

**CONTRACTOR**

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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, and adverse environmental conditions, particularly El Niño, continue to dampen recovery of the species. 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 three-and-a-half-fold increase in breeding population size from approximately 600 pairs in 1973 to approximately 2106 pairs in 1992. These efforts were continued in 1993, and the data are summarized herein.

## METHODS

The following criteria are used to distinguish least tern breeding "sites" from "colonies" (used interchangeably in the past): A site is the name of the location of a discrete and contiguous group of nesting birds. A colony is the name of the location of a breeding area, where colony members 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 several sites.

Statewide censuses of known California least tern breeding areas have been conducted since 1973. A network of paid and volunteer monitors check all sites on a regular basis and compile data into mid-season and final Site Reports. The present report integrates and summarizes data from all known least tern breeding sites in the state of California for 1993. 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 1993a). Additionally, the actual final Site Reports used to prepare this survey are available through CDFG offices in Sacramento. These reports often contain many more details regarding site preparation, data collection, predation and disturbance problems and procedures than can be included here; readers interested in such additional

information are encouraged to request copies.

For 1993, data were collected and are reported here for individual sites, with the following exceptions: Total Fledglings and Fledglings/Pair are pooled for the two sites at Ormond Beach, as are 1992 Total Pairs (for comparison) for the then three sites at Ormond Beach (Table 4). No reports were received from Pt. Mugu personnel for 1993, although breeding terns were present, thus data for this site are indicated as "not available." Official names for military lands housing tern breeding sites can be found in the Appendix; throughout this report they are referred to as in Table 1.

Least terns breed along the coast of California from the southern border north to the San Francisco Bay. 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 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, estimates of total number of breeding pairs present, and estimates of total number of fledglings produced. Fledgling counts are generally made at nocturnal roosting areas at three-week intervals, and summed for the season (Massey 1989, Caffrey 1993a). 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 are those that have historically been monitored quite closely. Monitors walk through nesting areas regularly, mark nests with 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 active nests, clutch size, hatching success, and the number of chicks produced. 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; therefore many types of data are unavailable, e.g., clutch sizes and actual hatching dates.

Site preparation prior to the arrival of terns also varied from site to site. From information included in mid-season and final Site Reports, vegetation was cleared by hand (PGE Pittsburg, NAS Alameda, Oakland Airport, Seal Beach, San Elijo Lagoon, Mission Bay/Mariner's Point), mechanically (Terminal Island, Huntington Beach, Newport Slough, Mission Bay/FAA Island, Mariner's Point, North Fiesta Island, Crown Point and Stoney Point, Naval Training Center, NAS North Island, Delta Beach North and South, D Street Fill, Chula Vista Wildlife Reserve), or with the use of herbicides

(NAS Alameda). Accumulated litter or storm debris was removed (NAS Alameda, McGrath Beach, Venice Beach), ceramic roofing tiles were placed on site for chick shelter and/or grid marking (VAFB Beach 2, Ormond Beach/Perkins Rd, Venice Beach, Mission Bay/Mariner's Point, NAS North Island, D Street Fill, Chula Vista Wildlife Reserve), dried tumbleweed was placed against the chain link fence around the perimeter of the site to prevent chick escape (Seal Beach), water level control was attempted at San Elijo Lagoon, and sand was cleared away from fencing to expose chick fence (Venice Beach, Delta Beach North) or pushed into berms to restrict human access (Tijuana River North and South). Permanent fencing at sites was erected (PGE Pittsburg) or repaired (VAFB Purisima Point, Venice Beach, Terminal Island, Seal Beach, Mission Bay/FAA Island, Tijuana River North and South), or temporary fencing was erected once terns chose particular nesting areas within sites (Santa Clara River, White Beach, Santa Margarita River/North Beach, Mission Bay/Mariner's Point). A railroad-car barricade was erected and signs were posted at Ormond Beach/Edison to deter pedestrian and ORV traffic; signs were also posted at Mussel Rock Dunes, Batiquitos Lagoon/Park and Ride, San Elijo Lagoon, and Tijuana River North and South. Trees were trimmed at Terminal Island to discourage nesting by kestrels. Crow heads (yes, crow heads) were laid out at Venice to deter crows from entering the site. Sand was provided to enhance the site at Santa Clara River, Mission Bay/North Fiesta Island, and NAS North Island, and decoys were laid out to attract terns to particular areas at Pismo Dunes, VAFB Beach 2, Terminal Island, Newport Slough, Mission Bay/North Fiesta Island and Crown Point, Naval Training Center, NAS North Island, Delta Beach North and South, D Street Fill, and Chula Vista Wildlife Reserve.

Site preparation also included predator removal at several sites. All military sites have permanent Animal Damage Control (ADC) personnel who trap and relocate, or exterminate, a majority of actual or potential predators from least tern nesting areas prior to and throughout the breeding season. In 1993, these sites included NAS Alameda, Vandenberg AFB Beach 2, VAFB Purisima Point, White Beach, Santa Margarita River/North Beach, Saltflats and Saltflats Island, Naval Training Center, NAS North Island, and Delta Beach North and South. ADC was also on site at Mission Bay/FAA Island, Mariner's Point, North Fiesta Island and Crown Point, and D Street Fill prior to tern arrival. Pre-season predator removal occurred at Terminal Island as well.

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 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).

The methodology used to determine Total Fledglings for Seal Beach (Table 4) was inconsistent with that employed at all other sites, and inappropriate (Total Eggs - number of abandoned eggs - number of dead chicks found), thus the number provided (and therefore Fledglings/Pair as a consequence) is likely a substantial overestimate.

## **RESULTS**

Distribution - In 1993, 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 returned to Santa Clara River, Terminal Island, and Batiquitos Lagoon/Park and Ride after a hiatus of one year, and to Naval Training Center after several years. Resettlement of three of these sites was attributed to site restoration via sand deposition at Santa Clara River (this site had suffered storm damage in the winter of 1992), the removal of several crows and kestrels (the major predators at Terminal Island) prior to tern arrival, and to years of persistence at site preparation and the use of decoys finally paying off at Naval Training Center. The underlying reason(s) for their return to Batiquitos Lagoon/Park and Ride was not obvious.

Of sites known to have been used by nesting terns in the past, several have been tern-less for several years (Table 1) for various reasons, including an abundance of predators (e.g., Mission Bay/Stoney Point) and/or humans (e.g., Mission Bay/South Shores) in the area, vegetation overgrowth (Mission Bay/Cloverleaf), or all of the above (Mission Bay/Crown Point). In 1993, seven nesting sites used in 1992 also went unused by breeding terns (Tables 1 and 3). For the latter sites, lack of nesting by terns was attributed to (1) all of the above reasons (San Diequito Lagoon), (2) most of the above plus a domestic waterfowl glut (Buena Vista Lagoon), (3) persistent on-shore winds early in the season prohibiting nesting (Pismo Dunes), (4) alteration of the site by storm damage prior to the breeding season (McGrath Beach), and (5) prohibitive levels of human-related disturbance (recreationists with and without pets at Ormond Beach/Middle Site, and vegetation still being cleared as terns arrived at Newport Slough) and/or perceived predator pressure (Newport Slough, Oakland Airport).

Breeding Chronology - First-wave breeders began arriving at breeding areas from mid- to late April through mid-May; nesting began 1-2 weeks later (Table 2). Most sites had eggs in nests by

mid-May, chicks by early June, and fledglings by the end of June. Definitive second wave nesting was reported at 24 sites; at four sites the second wave was minimal, and no second wave was evident at 8 sites. Two sites apparently had only second wave nesters (Ormond Beach/Perkins Rd, Batiquitos Lagoon/Northeast). Terns began departing some breeding areas in early July, but remained at others until late August/early September.

First Wave - An estimated 2053 pairs nested in the first wave of breeding in 1993 (Table 3), although this is likely a conservative estimate due to the lack of data from Pt. Mugu. Throughout the State sites experienced increases, relative to 1992, in the number of first wave nesters, with relatively dramatic increases occurring at Mussel Rock Dunes, VAFB Beach 2, Batiquitos Lagoon/Mouth, Mission Bay/Mariner's Point, Delta Beach North and South, Chula Vista Wildlife Reserve, and Tijuana River North and South. Dramatic increases can also be said to have occurred at the sites used in 1993 but not in 1992 (Santa Clara River, Terminal Island, Batiquitos Lagoon/Park and Ride, Naval Training Center).

The dramatic decreases, relative to 1992, in the number of pairs settling to breed in the first wave at San Elijo Lagoon and D Street Fill were attributed to prohibitive predator presence at both sites (including a nearby pair of nesting peregrines at D Street Fill), as well as water level problems at San Elijo Lagoon.

Season Totals - Excluding data from Pt. Mugu, 2305-2337 pairs of California least terns nested statewide in 1993 (Table 4). The estimate for statewide Total Fledglings of 1998-2059 may be inflated by anywhere from 50-150 birds due to the methodology employed at Seal Beach. Thus, statewide fledgling-to-pair ratio, again excluding Pt. Mugu, is likely somewhere in the range between 0.79-0.87. Breeding success was strikingly localized rather than clustered; successful sites (generally accepted as those with fledgling production/pair >1) spanned the entire geographic range. These included ten sites: PGE Pittsburg, NAS Alameda, Venice Beach, Seal Beach, Santa Margarita River/North Beach and Saltflats Island, Batiquitos Lagoon/Mouth, Naval Training Center, Delta Beach North, and Tijuana River North. Seven sites were particularly successful at producing large numbers of fledglings: NAS Alameda, Venice Beach, Seal Beach, Huntington Beach, Santa Margarita River/North Beach, Mission Bay/Mariner's Point, and Delta Beach North combined produced approximately 82% of the total fledglings produced statewide (midpoints of Total Fledgling ranges for the State and individual sites used for calculation).

The greatest relative increases in total number of nesting pairs occurred at the following sites (included are only those where nesting also occurred in 1992, with percent of 1992 number in parentheses): Mussel Rock Dunes (218%), Huntington Beach (170%), Santa Margarita River/North Beach (126%) and Saltflats (186%),



Batiquitos Lagoon/Mouth (867%), Mission Bay/Mariner's Point (171%), Delta Beach North (250%) and South (700%), Chula Vista Wildlife Reserve (260%), Saltworks (475%), Tijuana River North (475%) and South (187%). Significant declines occurred at only three sites: Batiquitos Lagoon/Northeast (25%), San Elijo Lagoon (36%), D Street Fill (17%).

Clutch Size - Clutch size at Type 1 sites ranged from 1 to 4 (Table 5), with a statewide  $\bar{X} = 1.91$  ( $n=2523$  nests). Hatching success at Type 1 sites ranged from 0-100%, with a mean of approximately 69.7% (midpoints of ranges for San Elijo Lagoon, D Street Fill, and Chula Vista Wildlife Reserve used for calculation).

Sources of Breeding Failure - Predation was the major cause of breeding failure in 1993 (Table 6); documented and suspected predators included by-now familiar species. Sites with the greatest diversity of species preying on terns were located in San Diego County, yet sites where monitors reported that predation had a significant negative effect on tern reproductive success were scattered throughout the State (Mussel Rock Dunes, VAFB Beach 2, VAFB Purisima Point, Terminal Island, Seal Beach, Bolsa Chica, Huntington Beach, Santa Margarita River/North Beach and Saltflats, San Elijo Lagoon, Mission Bay/FAA Island, Mariner's Point and North Fiesta Island, NAS North Island, Delta Beach South, D Street Fill, Chula Vista Wildlife Reserve, Saltworks, and Tijuana River). Monitors at two sites reported that vegetation encroachment into nesting areas exacerbated the already intense predation pressure by providing refuge for predators (San Elijo Lagoon: raccoons, NAS North Island: ants). Predation pressure at San Elijo Lagoon was also intensified by high water levels leaving only a narrow strip of dry land available as nesting substrate; terns became easy prey for predators moving through and foraging in the area. Gull predation at Mission Bay/FAA Island was exacerbated by disturbance to nesting terns as the result of fireworks displays at nearby Seaworld and recreational activities associated with the Over-The-Line Tournament at nearby Fiesta Island; gulls were documented to take at least 35 eggs from 24 nests.

Humans continue to directly cause tern mortality. Nests were inadvertently trampled at Mussel Rock Dunes and Tijuana River South. Eggs and chicks at Tijuana River South were also lost to human-driven bicycles and all-terrain and 4-wheel-drive vehicles. Military aircraft accidentally killed two fledglings on the runway at NAS Alameda, and a helicopter of unknown origin landed on FAA Island at Mission Bay, killing several chicks and blowing several eggs from nests. A fledgling was injured as the result of getting caught up in discarded fishing line at Mission Bay/Mariner's Point, and an adult was unintentionally caught in a trap meant for a depredating owl (Mission Bay/FAA Island).

Eggs and chicks were also lost to hypothermia, and fencing and flooding problems. Sixty chicks were found dead at Mission

Bay/Mariner's Point with no clear evidence as to the cause.

Sources of Disturbance - Sources of site disturbance (Table 7) were believed to either underlie the abandonment of nests or whole breeding areas, 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 in 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 intrusion continues to ill-affect terns. Although military exercises in tern nesting areas are infrequent and the effects unclear, monitors reported at least temporary nest abandonment (White Beach), habitat destruction (Santa Margarita River/Saltflats Island), and Marines running through the nesting site (Santa Margarita River/Saltflats) as the result of such procedures. The human-related threats to terns on public lands are more obvious. Pedestrians alone, and/or their pets, cause disturbance/flushing, if not direct mortality. ORV and bicycle riders drive through nesting areas. Monitors reported many other types of human-generated problems, including people walking through the area to feed ducks (Baticuitos Lagoon/Park and Ride), fireworks displays (on-going at Seaworld during summer) and weekend recreational tournaments causing terns to flush (Mission Bay/FAA Island), owners encouraging pet dogs to swim to the island at Baticuitos Lagoon/Northeast, golfers apparently inadvertently smacking balls into tern nesting areas (Baticuitos Lagoon/Park and Ride, Mission Bay/Mariner's Point), fishermen illegally in the area leaving unattended hooked lines (San Elijo Lagoon), and boaters landing on site or people camping overnight next to perimeter fence (Mission Bay/Mariner's Point).

Fourth of July festivities are likely a problem at many sites, although information of this type has not been requested on report forms. However, the disturbance to nesting adults, chicks, and fledglings at Venice Beach each July 4th is so intense that I include it as a new category. A nearby city-run night-time fireworks display brings hundreds of people to the beach, many of whom proceed to ignite their own displays. As it is a public beach, only my informative urging and pleading throughout the night, together with compassionate responses on the part of often inebriated revelers, brings about any lessening of disturbance to terns by increasing the distance between booming fireworks and the perimeter fence, or altering the target direction of bottle rockets. No matter how successful my efforts, however, terns repeatedly fly up in disturbance throughout the night. Although fireworks debris is always found within the fence the next morning, and tern eggs have been abandoned in the days following the Fourth, it is impossible to attribute any particular abandonment to

fireworks disturbance.

Vandalism by humans was also reported at several sites. People tore down part of the fence at Mission Bay/North Fiesta Island, and illegally entered sites and stole log books, data sheets, leg bands, decoys, beach chairs, posted signs, or other equipment at Venice Beach, Mission Bay/North Fiesta Island, Delta Beach North, and D Street Fill. In addition, newly posted signs were defaced at Batiquitos Lagoon/Park and Ride, and the slats preventing chick escape were removed from the fence at Mission Bay/Mariner's Point.

The high water level of lagoons in San Diego County reduced the land available to terns for nesting, as did encroachment of vegetation (at Chula Vista Wildlife Reserve, 70-80% of the site was estimated to be covered and unusable). Vegetation encroachment during the season was felt to influence the lack of a second wave at Seal Beach. Vegetation clearing was still underway at Newport Slough as terns arrived; lack of open space plus predator presence was believed to underlie the lack of nesting at that site. Predator presence likely affected the decision of arriving terns to abandon Oakland Airport as well. Heavy rains in June washed out nesting substrate at NAS North Island and likely limited nesting of second wave pairs.

## **DISCUSSION**

The steep increase in the statewide number of California least tern breeding pairs over the last five years continued in 1993. The 2321 approximation (midpoint of range) for statewide Total Pairs may be viewed as a minimum because of the lack of Pt. Mugu data (Pt. Mugu had 133 pairs in 1992); the actual number of breeding pairs of least terns in California can be conservatively estimated at 2400. Thus from a recent low of 944 pairs in 1987, breeding population size had increased by 94% in 1991, to 1830 pairs (Fancher 1992), and by 123% in 1992; the current estimate of 2400 represents a 154% increase in the number of pairs, or more than two-and-a-half times the size of the population only six years ago. This dramatic increase in breeding population size is directly attributable to the efforts of people working on behalf of terns to enhance and protect breeding areas. Fencing repair, vegetation removal, monitor presence, education of the public, and predator management all increase the reproductive potential of least terns. Accurate estimation of statewide Total Fledglings is a bit more difficult due to both the complete lack of data from Pt. Mugu and the "unknown" component of the Seal Beach estimate. Seal Beach has been consistently successful at fledging terns in recent years (Obst and Johnston 1992, Johnston and Obst 1992, Caffrey 1993b), although those fledgling data may now also be viewed with some reservation. Crediting monitors with the ability to assess relative success, and therefore assuming that terns at Seal Beach have

maintained a fledgling-to-pair ratio equal to at least 1.0 for the recent past, the number of fledglings produced at that site in 1993 was likely between 214 and 314. Thus, despite heavy predation pressure at many sites, and a variety of human-related constraints on tern reproductive success, a minimum of 1848-2009 fledglings were added to the population in 1993.

The number of sites used by nesting terns throughout the State fluctuates from year to year, as sites become either attractive, through site preparation efforts, or unattractive, as a function of human, predator, or other environmental disturbance, to arriving terns. The drop to 35 from 38 sites in 1992 reflects the (hopefully) temporary loss of seven sites used last year (Table 3), and the addition of four sites, all of which had been used by terns in the past. No new sites were known to have been established in 1993. Site abandonment was attributed to prohibitive levels of disturbance of various kinds (Results: Distribution); terns were actually observed to arrive at both Oakland Airport and Pismo Dunes, and then abandon each site after a few days, apparently because of conspicuous predator presence (particularly red foxes) and intense on-shore winds, respectively. Adult and newly-fledged terns en route south for the winter, however, continued to use Oakland Airport as a post-breeding stop after dispersing from NAS Alameda.

Astute observation and lots of hard work by monitors and Animal Damage Control personnel prior to tern arrival resulted in the sites at Santa Clara River, Terminal Island, Batiquitos Lagoon/Park and Ride, and Naval Training Center being selected by breeding pairs of terns in 1993. The removal of predators, combined with other site preparation procedures (see Methods), seemed to tip the balance at Terminal Island and Naval Training Center.

Throughout the State, sites experienced increases in the number of breeding pairs present as a function of both the general increase in statewide population size, and some shuffling around among sites as some were deemed unusable by arriving terns. Some of the most dramatic increases were attributed to such shuffling: Mussel Rock Dunes was thought to have inherited pairs abandoning Pismo Dunes, and pairs that abandoned D Street Fill were likely the source of the large increases at Delta Beach North and South, Chula Vista Wildlife Reserve, Saltworks, and Tijuana River North and South. Batiquitos Lagoon/Mouth was thought to be the recipient of some of the past success at nearby Camp Pendelton. Mariner's Point is the least problem-laden of the sites at Mission Bay, and consequently experienced high recruitment from that area.

The few dramatic declines in breeding pair numbers were thought to be not only a function of intense human and pet presence (Batiquitos Lagoon/Northeast), or predator presence and/or water problems (San Elijo Lagoon, D Street Fill) in 1993, but in the case of D Street Fill, also a response to the heavy predation pressure

experienced in 1992.

Mean clutch size for Type 1 sites (1.91) was comparable to that determined in recent years (1992: 1.87, Caffrey 1993b, 1991: 1.98, Johnston and Obst 1992, 1990: 1.94, Obst and Johnston 1992). Monitors at virtually every site with low hatching success attributed the loss of eggs either directly to predation (Mussel Rock Dunes, VAFB Beach 2, VAFB Purisima Point., Santa Margarita River/Saltflats, San Elijo Lagoon, Chula Vista Wildlife Reserve, Tijuana River North and South) or to the combined effects of predation on eggs and nest abandonment in response to predation pressure (NAS North Island). The intrusion into nesting areas by humans and pet or feral dogs and cats was felt to underlie the complete lack of hatching at Batiquitos Lagoon/Northeast and Park and Ride, and 30 eggs were abandoned late in the season at Mission Bay/Mariner's Point for unknown reasons.

Predation took its toll on the production of fledglings from hatchlings as well. Throughout the State, predation was the major cause of breeding failure in 1993. Again, at virtually every site with low fledgling production per pair (in this case, less than approximately 0.9, Table 4), monitors attributed breeding failure to predation. The only exceptions included (1) the two Batiquitos Lagoon sites, where human-related problems resulted in no hatching, (2) the two sites at Ormond Beach, where human-related disturbance was thought to underlie site abandonment in early to mid-July, dooming the offspring of the second wave, (3) Bolsa Chica, where Caspian terns moved in and basically took over the island, (4) Upper Newport Bay, a Type 2 site where determination of the causes of egg and chick loss is impossible, and (5) White Beach, where discussion of the likely cause of low fledgling production was not included in site reports.

The adverse effects of predation on tern reproductive success ranged from prohibiting nesting entirely (Results: Distribution) to limiting the number of pairs at particular sites (Results: First Wave), delaying the onset of nesting (Terminal Island: crows), direct predation on eggs (Table 5) and/or chicks and fledglings (Table 4), as well as causing abandonment of nests at those sites, and causing early abandonment of whole sites (Terminal Island: peregrine falcon, Huntington Beach: crows), which limited second wave nesting and doomed the eggs and dependent offspring still present.

Predation is obviously an important variable in the California least tern recovery story. That approximately 82% of the total fledglings produced statewide came from only seven of the 35 sites used in 1993 is testament to the substantial negative impact predation can have on tern reproductive success. Four of those seven sites (NAS Alameda, Santa Margarita River/North Beach, Mission Bay/Mariner's Point, and Delta Beach North) had permanent ADC personnel removing all potential predators; this was thought to

underlie high fledgling production in the face of what would have been intense predation pressure. The other three sites were deemed "lucky", although it was the unconventional means by which predators were controlled at Venice Beach that permitted the success of that site.

Crows have historically been the major predators at Venice Beach, and in 1993, prior to tern arrival, crows were present and crow tracks covered the site. In the past, crow carcasses had been used successfully to thwart crow predation at Venice (e.g., Caffrey 1993b). Due to a freezer-space crunch in the fall of 1992 at UCLA, I let students dissect the 15 carcasses in my possession, and I kept the heads. In mid-April 1993, I placed groups of seven and eight crow heads at the north- and south- east corners of the Venice Beach site, and swept the sand clean. Not a single crow track subsequently appeared inside the fence and no predation occurred, although two families of crows continued to forage, roost, and loaf only meters away for the duration of the tern breeding season.

Such successful non-lethal methods of predator management are the exception rather than the rule; the usual approach to controlling predators involves active removal by ADC. Yet several sites with ADC at work throughout the season (see Methods) endured high levels of predation and produced few fledglings. Therein lies the basis for recent calls for re-evaluation of current predator control policies, and the establishment of a predator management plan that incorporates not only the sustainability of terns, but also evaluation of our ability to accurately assess the impact of predation, consideration of other special-status species, and an understanding of the important role of predation as a force of natural selection acting on terns, and in maintaining ecological balance.

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. Military exercises, accidental captures by ADC, and naive duck-feeding excursions notwithstanding, people and their pets, bicycles, ORVs, helicopters, golfballs, fireworks, and abandoned fishing line, and their penchant for vandalism, continue to negatively impact the reproductive success of California least terns.

## RECOMMENDATIONS

Funding - Underlying many of the limits on tern reproductive success is the lack of funds available for site preparation, site maintenance, site enhancement, and monitoring. 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. Sources of funding must be found not only for site enhancement and the establishment of new sites, but also to simply maintain the status quo (e.g., the fence at Venice Beach is in dire need of repair). Sources of funding for predator management would also help to alleviate some of the intense predation pressure at CDFG sites without access to ADC. And again, funding for adequate monitor presence must be secured.

Nesting Sites - Acquiring shore-front property is as difficult as it sounds, yet the creation of new sites must proceed to buffer the potentially devastating effects, on a local level, of predation, human disturbance, and future El Niño events. Individual sites are often either successful or not regarding fledgling production, and a single predator can be enough to tip the balance toward the latter. In 1993, fledglings produced at only seven sites comprised approximately 82% of the State total. This points to the vulnerability of the species' recovery to local threats, and begs the establishment of new sites.

Enhancement of well-established, incipient, and potential sites remains a priority. Human-related threats to terns are ostensibly mollifiable; enclosing nesting areas within fencing and educating the public as to the contents is one solution, yet is not always possible in practice. With an eye toward approaching that ideal, however, fencing repair or better fencing, better enforcement, and/or bilingual signs are badly needed at Mussel Rock Dunes, Pismo Dunes, Ormond Beach, Venice Beach, Batiquitos Lagoon/Northeast and Park and Ride, San Elijo Lagoon, San Diequito Lagoon, Mission Bay North Fiesta Island and Mariner's Point, and Tijuana River Estuary. Similarly, a fox-proof fence would go far to make the otherwise lovely site at Oakland Airport almost perfect.

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. The latter was apparently the case at Newport Slough in 1993, and monitors at several other sites (Oakland Airport, Seal Beach, the islands at Batiquitos Lagoon/Mouth, San Elijo Lagoon, Mission Bay/Mariner's Point and North Fiesta Island, and Chula Vista Wildlife Reserve) felt that more aggressive vegetation clearing would enhance the breeding success of terns. Clearing all vegetation in a buffer zone around nesting areas decreases the attractiveness to predators, and

is strongly recommended in appropriate situations. Additionally, getting a handle on water levels in both Batiquitos and San Elijo Lagoons is absolutely required to maintain these areas as California least tern nesting sites.

In the past, terns have returned to breed in areas unused for variable periods of time (e.g., Mission Bay/North Fiesta Island in 1992), and 1993 saw the return of terns to Santa Clara River, Terminal Island, Batiquitos Lagoon/Park and Ride, and Naval Training Center; 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 (e.g., Mission Bay/Mariner's Point and Delta Beach South in the past). Their use at sites used year after year can direct terns to particularly suitable areas (e.g., Delta Beach North).

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.

A strong attempt was made in 1993 to standardize and improve monitoring and reporting methodology (Caffrey 1993a); this effort will continue in 1994.

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 tern breeding 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 (as well as the paperwork quagmire), 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.

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 1993a) 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. In 1993, monitors at Oakland Airport, Batiquitos Lagoon/Northeast, and San Elijo Lagoon requested predator-control assistance in their Final Reports. In addition, crow carcasses work so well at Venice Beach at keeping crows out of the nesting area that I strongly recommend we pursue this means of non-lethal intervention at sites plagued by crows (e.g., Huntington Beach would have been even **more** successful if crows had been deterred). Can we get some stuffed ones made so that we can re-use them year after year?

### **ACKNOWLEDGEMENTS**

Much of this section is the same as that of the 1992 report; the people working on behalf of least terns in the state of California continue to be some of the nicest and most compassionate people I am privileged to know. I have added a couple of things, and changed some names, but refuse to remove much. I remain honored to acknowledge the contributions of the many people listed here. Each one truly gave a piece of themselves to this work; their generosity and dedication was overwhelming. I am proud to be associated with all of you.

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 predation, human recklessness, and that sometimes nightmarish phenomenon we like to call bureaucracy. Thanks to all of you: Laura Collins, Leora Feeney, Mary Perry,

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cooperation in site protection at Santa Clara River and McGrath Beach, and in particular Vince Ciccerio, for assistance with fencing at McGrath Beach. We still cannot thank Pat Baird enough for her unwavering committment to the incipient site at Dockweiler Beach (which experienced a landing but no breeding in 1993) and seemingly endless supply of energy on its behalf.

Almost lastly: wise, calm, trusting, supportive, and encouraging, none of this would be possible without Ron Jurek. His love of, and concern for, these littlest of terns permeates this work.

And finally, my own very special thanks to Brian Foster for lots of last-minute site-specific details needed to complete this report, and Alice Gibb and Gary Gillis, who continue to buck tradition by getting **all** of their reports in on time. I'd also like to thank Ron Jurek, and especially Charlie Peterson, for their careful reading of, and helpful comments on, a draft of this manuscript.

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## APPENDIX: MILITARY SITES

Naval Air Station, Alameda (NAS Alameda)  
Vandenberg Air Force Base (VAFB Beach 2, and Purisima Point)  
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)

Table 1. Type, primary contact, and number of breeding season visits for each site in the state of California. Type 1 sites are monitored from inside; Type 2 from the outside. An asterisk next to site name indicates it is either a new site this year, or one used for the first time in several years. Unused indicates historically used sites unoccupied by nesting terns in 1993 (1: site unused for several-many years, 2: site used in recent past). Primary contacts can be reached through CDF&G office in Sacramento.

	Type	Primary Contact	# Visits
<b>San Francisco Bay Area</b>			
PGE, Pittsburg	2	Laura Collins	9
Port Chicago (Allied)	unused1	Laura Collins	
NAS Alameda	1&2	Laura Collins	66
Oakland Airport	unused2	Leora Feeney	99
<b>San Luis Obispo/Santa Barbara Counties</b>			
Mussel Rock Dunes	1	Morgan Boucke	36
Pismo Dunes	unused2	Rob Burton	54
San Antonio Creek	unused1	Morgan Boucke	
Vandenberg AFB, Beach 2	2	Allan Naydol	52
VAFB Purisima Point	2	Allan Naydol	54
Santa Ynez River Mouth	unused1	Morgan Boucke	
<b>Ventura County</b>			
Santa Clara River*	1	Morgan Boucke	56
McGrath Beach	unused2	Morgan Boucke	
Ormond Beach: Edison	2	Morgan Boucke	28
Middle Site	unused2	Morgan Boucke	
Perkins Rd	2	Morgan Boucke	17
Point Mugu	2	Ron Dow	na
<b>Los Angeles/Orange Counties</b>			
Venice Beach	1	Carolee Caffrey	58
Terminal Island*	1	Kathy Keane	28
Seal Beach	1	Tom Alexander	24
Bolsa Chica	1	Carolee Caffrey	27
Huntington Beach	1	Doreen Stadtlander	36
Newport Slough	unused2	Doreen Stadtlander	36
Upper Newport Bay	2	Carolee Caffrey	18

<b>San Diego County</b>			
White Beach	1	L Belluomini	63
Santa Margarita River:			
North Beach	1	L Belluomini	66
Saltflats	1	L Belluomini	65
Saltflats Isl	1	L Belluomini	65
Buena Vista Lagoon	unused2	Elizabeth Copper	
Aqua Hedionda	unused1	Elizabeth Copper	
Batiquitos Lagoon: NE	1	Elizabeth Copper	18
Park and Ride*	1	Elizabeth Copper	18
Mouth	1	John Konecny	18
San Elijo Lagoon	1	Robert Patton	18
San Diequito Lagoon	unused2	John Konecny	
Los Penasquitos	unused1	Elizabeth Copper	
Mission Bay: FAA Isl	1	Brian Foster	30
Mariner's Point	1	Ginger Johnson	58
N Fiesta Isl	1	Brian Foster	18
Crown Point	unused1	Elizabeth Copper	
Stony Point	unused1	Elizabeth Copper	
South Shores	unused1	Elizabeth Copper	
Cloverleaf	unused1	Elizabeth Copper	
Lindbergh Field	unused1	Elizabeth Copper	
Naval Training Center*	1	Elizabeth Copper	59
NAS North Island	1	Elizabeth Copper	117
Delta Beach: North	1	Elizabeth Copper	112
South	1	Elizabeth Copper	41
Grand Caribe Island	unused1	Elizabeth Copper	
D Street Fill	1	Brian Foster	61
Chula Vista Wldlf Res	1	Brian Foster	50
Salt Works	1&2	Jennifer Price	26
Tijuana River: North	1	Robert Patton	24
South	1	Robert Patton	24

Table 2. Chronology of California Least Tern reproductive activities, 1993. For date of arrival, "earlier than or equal to" indicates terns were already present on the first day of monitoring. "Later than or equal to" for departure indicates last day terns observed, although actual departure date could be later. Second wave occurrence was determined for each colony: if yes, beginning date is provided; if no, date provided is that through which "lack of" determination was made; nr reflects a "not really" sentiment on mid-season or final Site Report (no clear-cut demarcation between waves existed). First Egg, Chick, and Fledgling dates indicate actual date, if known, or the first date observed ("earlier than or equal to"). Blank spaces indicate no eggs, chicks, or fledglings produced.

Table 2.

	Activity Period		Second Wave?	Date of First		
	Arrive	Depart		Egg	Chick	Fledgling
PGE, Pittsburg	5/3	8/23	yes, 7/4	≤5/10	≤6/3	≤6/23
NAS Alameda	4/26	7/31	nr, 6/10	≤5/4	5/27	≤6/16
Oakland Airport	4/28	8/8	no			
Mussel Rock Dunes	5/3	8/3	yes, 6/21	≤5/14	≤6/11	≤7/5
Pismo Dunes	5/5	8/15	no			
Vandenberg AFB, Beach 2	≤5/27	7/23	no, 7/23	≤5/27	6/11	≤7/3
VAFB Purisima Point	4/30	8/6	no, 8/6	≤5/27	6/16	≤7/2
Santa Clara River	4/30	na	yes, 7/17	≤6/23	7/2	7/17
Ormond Beach: Edison	≤5/21	≥7/10	yes, 7/1	5/31	6/18	7/7
Perkins Rd	4/26	8/28	yes, ≤6/26	na	7/11	na
Point Mugu	na	na	na	na	na	na
Venice Beach	4/20	≥8/17	nr, 6/8	≤4/30	5/17	≤6/10
Terminal Island	4/22	7/18	yes, 6/12	5/17	6/9	6/26
Seal Beach	4/29	7/7	yes, 6/16	4/29	5/9	6/16
Bolsa Chica	4/21	7/27	yes, 6/10	≤5/4	5/11	≤7/5
Huntington Beach	4/23	7/14	yes, 6/7	5/4	5/24	6/14
Upper Newport Bay	4/27	7/15	no, 7/15	≤5/4	≤6/10	6/29



White Beach	4/29	8/7	yes, 6/3	5/4	5/29	6/19
SM River: North Beach	4/17	8/14	yes, 6/1	5/4	5/25	6/15
Saltflats	4/17	8/1	yes, 6/1	5/4	5/25	6/20
Saltflats Isl	4/17	8/1	yes, 6/2	5/6	5/27	6/20
Batiquitos Lagoon: NE	5/8	8/14	yes, 7/11	≤7/11	≤7/24	
Park and Ride	5/15	8/1	no, 8/21	≤5/31		
Mouth	5/1	8/14	yes, 6/20	≤5/15	≤5/31	≤6/26
San Elijo Lagoon	4/12	9/11	yes, 6/23	5/15	≤6/17	
Mission Bay: FAA Isl	4/30	7/30	yes, 6/4	5/7	6/3	6/22
Mariner's Point	4/26	8/16	no, 8/16	5/2	5/24	6/14
N Fiesta Isl	4/25	7/5	no, 8/6	5/12	6/6	6/28
Naval Training Center	4/26	8/4	yes, 6/10	5/15	6/6	6/25
NAS North Island	4/18	8/13	yes, 6/13	5/8	6/2	6/28
Delta Beach: North	4/15	7/27	yes, 6/7	5/6	5/29	6/15-19
South	4/21	7/25	yes, 6/30	5/15	6/6	6/23
D Street Fill	4/17	7/15	yes, 6/10	5/7	5/28	6/23
Chula Vista Wldlf Res	4/29	7/31	yes, 6/9	5/14	6/9	6/28
Saltworks	5/5	8/20	yes, 6/27	5/12	6/2	6/25
Tijuana River: North	≤4/22	9/3	nr, 6/25	≤5/14	6/3	≤7/1
South	≤4/22	9/3	nr, 6/25	≤5/7	≤6/3	6/25

Table 3. First wave totals for 1993 California Least Tern breeding season; included are all sites with nesting terns in either 1993 or 1992. Type 1 colonies are monitored from the inside; Type 2 from the outside. Total Nests includes known renests of first wave pairs. Total Pairs are followed by numbers of first wave pairs at each colony in 1992 (in parentheses). Total Eggs generally not available at Type 2 colonies.

	Colony Type	Total Pairs	Total Nests	Total Eggs
PGE, Pittsburg	2	2 (2)	2	5
NAS Alameda	1&2	113-116 (111)	120	247
Oakland Airport	1&2	0 (2)	0	0
Mussel Rock Dunes	1	45 (22)	45	92
Pismo Dunes	1	0 (4)	0	0
VAFB Beach 2	2	10 (2)	15	31
VAFB Purisima Point	1	9 (15)	13	23
Santa Clara River	1	14 (0)	14	28
McGrath Beach, 3 sites	1	0 (17)	0	0
Ormond Beach: Edison	2	9 (4)	na	na
Middle Site	2	0 (5)	0	0
Perkins Rd	2	0 (9)	0	0
Point Mugu	2	na (107)	na	na
Venice Beach	1	219 (193)	219	459
Terminal Island	1	5 (0)	5	11
Seal Beach	1	198 (189)	198	391
Bolsa Chica	1	142 (122)	142	274
Huntington Beach	1	144 (130)	144	275
Newport Slough	1	0 (1)	0	0
Upper Newport Bay	2	50 (46)	50	na

White Beach	1	27 (31)	27	56
Santa Margarita River:				
North Beach	1	308 (269)	308	604
Saltflats	1	59 (36)	59	108
Saltflats Island	1	27 (29)	27	53
Buena Vista Lagoon	2	0 (3)	0	0
Batiquitos Lagoon:				
Northeast	1	0 (1)	0	0
Park and Ride	1	4 (0)	4	8
Mouth	1	18 (3)	18	34
San Elijo Lagoon	1	7 (22)	7	17
San Diequito Lagoon	1	0 (7)	0	0
Mission Bay: FAA Island	1	112 (158)	112	207
Mariner's Point	1	205 (120)	205	382
N. Fiesta Island	1	6 (5)	6	12
Naval Training Center	1	1 (0)	1	2
NAS North Island	1	43 (49)	43	88
Delta Beach: North	1	69 (23)	69	132
South	1	7 (1)	7	14
D Street Fill	1	20 (135)	29	55
Chula Vista Wldlf. Res.	1	48 (0)	48	93
Saltworks	1	38 (8)	40	77
Tijuana River: North	1	19 (4)	25	49
South	1	73 (39)	82	155
<b>Total</b>		2051-2054 (1930)		>3982 (>3386)

Table 4. Totals for 1993 California Least Tern breeding season; only those sites with nesting pairs included. Total Pairs and Fledglings/Pair numbers are followed by mean 1992 data (in parentheses). Seal Beach Total Fledglings (364\*), and therefore Fledglings/Pair (1.84\*), are overestimates (see Methods). Total Fledglings and Fledglings/Pair for the 2 sites at Ormond Beach are pooled, as are 1992 comparison data for the (then) 3 sites at Ormond Beach. Any discrepancy between 1993 Total Pairs and Total Nests reflects renesting attempts by pairs.

Table 4.

	Total Pairs	Total Nests	Total Fledglings	Fledglings/ Pair
PGE, Pittsburg	2 (2)	3	4	2 (.50)
NAS Alameda	126-128 (125)	135	204-210	1.59-1.66 (1.73)
Mussel Rock Dunes	61 (28)	66	35-40	.57-.66 (.32)
VAFB Beach 2	10	15	5-9	.50-.90 (.50)
VAFB Purisima Point	9 (12)	13	7	.78 (.08)
Santa Clara River	14-16 (0)	16	14	.88-1.0 (1.35)
Ormond Beach: Edison	14 (18)	na	> 9 (17)	> 64 (.94)
Perkins Rd	3	na		
Point Mugu	na (133)	na	na (72)	na (.54)
Venice Beach	246 (229)	246	280	1.14 (1.07)
Terminal Island	10 (0)	10	8-12	.67-.80
Seal Beach	198 (219)	201	364*	1.84* (1.25)
Bolsa Chica	142 (131)	155	26-47	.18-.33 (.24)
Huntington Beach	234 (138)	235	157	.67 (.23)
Upper Newport Bay	50 (46)	50	12-20	.24-.40 (.24)

White Beach	31 (31)	38	15	.48 (.36)
SM River: North Beach	338 (269)	404	396	1.17 (.62)
Saltflats	67 (36)	84	21	.31 (.53)
Saltflats Isl	30 (29)	35	33	1.10 (.55)
Batiquitos Lagoon: NE	2 (8)	2	0	0 (.51)
Park and Ride	4 (0)	4	0	0
Mouth	26 (3)	29	32-38	1.23-1.46 (0)
San Elijo Lagoon	8 (22)	9	0	0 (.09)
Mission Bay: FAA Isl	133 (158)	150	45-50	.34-.38 ( $\geq$ .33)
Mariner's Point	205 (120)	205	140	.68 (.58)
N Fiesta Isl	6 (5)	6	2	.33 (.40)
Naval Training Center	2-3 (0)	3	3-5	1.0-2.5
North Island NAS	43 (49)	52	14	.33 (.10)
Delta Beach: North	95 (38)	127	130	1.37 (.66)
South	7 (1)	8	2-4	.29-.57 (1)
D Street Fill	23 (135)	32	1	.04 (.14)
Chula Vista Wldlf Res	52 (20)	61	4-6	.08-.12 (.92)
Saltworks	38 (8)	62	8	.21 ( $\geq$ .63)
Tijuana River: North	13-25 (4)	39	36	1.44-2.77 (1.75)
South	63-82 (39)	93	2	.02-.03 (.80)
<b>Total</b>	>2305-2337 (2106)		1998-2059 (1362-1448)	.85-.89 (.65-.69)

Table 5. Clutch sizes and hatching success for nests in Type 1 colonies. Santa Margarita River/Saltflats Island and Mission Bay/Mariner's Point each had one nest with a clutch size of 4 (not shown). "Unsure" denotes either the number of nests abandoned or preyed upon prior to completion at Type 1 colonies (thus actual clutch size unknown), or the total number of nests at Type 2 colonies (thus Total Number of Eggs not available). Mean clutch size provided for known clutch sizes only.

Table 5.

## Clutch Size

	1	2	3	Unsure	Mean	Total Eggs	% Hatch
PGE, Pittsburg	1	1	1		2.00	6	100
NAS Alameda	5	112	12	6	2.13	275	86
Mussel Rock Dunes	8	53	5		1.95	129	54
VAFB Beach 2	1	12	2		2.07	31	68
VAFB Purisima Point	2	9	2		2.00	26	58
Santa Clara River	1	15			1.94	31	na
Ormond Beach: Edison				14		na	na
Perkins Rd				3		na	na
Point Mugu	na	na	na	na		na	na
Venice Beach	28	204	14		1.94	478	96
Terminal Island	1	7	2		2.10	21	81
Seal Beach	20	161	20		1.97	396	97
Bolsa Chica	24	123	8		1.90	294	94
Huntington Beach	65	162	8		1.22	286	86
Upper Newport Bay				50		na	na



White Beach	6	29	3		1.92	73	78
SM River: North Beach	61	333	10		1.87	757	88.9
Saltflats	27	57			1.68	141	25.5
Saltflats Isl	7	27			1.86	56	86.2
Batiquitos Lagoon: NE	1	1			1.50	3	0
Park and Ride		4			2.00	8	0
Mouth	6	22	1		1.83	53	83
San Elijo Lagoon		6	3		2.33	21	14-24
Mission Bay: FAA Isl	37	111	2		1.77	265	82
Mariner's Point	38	158	8		1.86	382	68
N Fiesta Isl	2	2	2		2.00	12	92
Naval Training Center		3			2.00	6	83
NAS North Island	8	37	7		1.98	103	48
Delta Beach: North	20	107			1.84	234	80
South		8			2.00	16	100
D Street Fill	5	26	1		1.88	60	77-92
Chula Vista Wldlf Res	12	48	1		1.82	111	58-76
Saltworks	13	38	2		2.21	117	86
Tijuana River: North	6	33			1.85	72	60
South	16	75	2		1.85	172	38

Table 6. Causes of California Least Tern breeding failure. Documented and suspected avian and mammalian predators are indicated, as well as other sources of mortality. An asterisk next to predator species indicates that predator-control measures were taken (the predator was removed), most often by ADC. Birds: BcNH - Black-crowned Night Heron, BnO - Barn Owl, BwO - Burrowing Owl, CT - Caspian Tern, Cr - American Crow, G -gull species, GBH - Great Blue Heron, GbT - Gull-billed Tern, GE - Great Egret, GH0 - Great Horned Owl, H -Harrier, K - American Kestrel, LS -Loggerhead Shrike, M - Meadowlark, Os - Osprey, Ow - owl species, PF - Peregrine Falcon, R - Raven, RtH - Red-tailed Hawk, SE - Snowy Egret. Mammals: BC - Bobcat, C - Domestic Cat, Cy - Coyote, D - Domestic Dog, F - Red Fox, FC - Feral Cat, FD - Feral Dog, GS - Ground Squirrel, Op - Opossum, Rc - Raccoon, Spk - Spotted Skunk, Stk - Striped Skunk. Other: A - Ant, Fl - Flooding (nests innundated as the result of 1: high water level in lagoon, 2: heavy rain, 3: spring tides), FP - Fencing Problems (3: adverse weather exposed bottom of fence and chicks escaped/died, 4: rusted bottom of fence caused moderate to severe injuries in several chicks), Hu - Human-related mortality (1: pedestrians caused egg or chick mortality, 2: aircraft killed two fledglings, 3: trap intended for depredating owl fatally injured adult tern, 4: helicopter (unknown origin) landed on site, HU5 - fishing line found wrapped around leg of injured fledgling, Hy - Hypothermia, Rn - Heavy rains and resultant mud contributed to death of one chick, Unk - Unknown, V - Human-driven vehicles.

Table 6.

## Predation

	Documented		Suspected		Other
	Bird	Mammal	Bird	Mammal	
PGE, Pittsburg			GE, SE, LS, K		
NAS Alameda			G, R, K		Hy, Hu2
Mussel Rock Dunes				Cy	Hu1
VAFB Beach 2		Cy			
VAFB Purisima Point			H, Cr, G		
Santa Clara River					
Ormond Beach: Edison					
Middle Site					
Perkins Rd					
Venice Beach					
Terminal Island			K*		
Seal Beach			GBH, K, LS, Rth		
Bolsa Chica	PF		CT, M		Fl2
Huntington Beach	Cr				
Upper Newport Bay					

White Beach	Ow*				
SM River: North Beach	GBH*,H*,Ow*	BC*			
Saltflats	H*,Ow*	Spk			
Saltflats Isl	H*				
Batiquitos Lagoon: NE				Rc,D	
Park and Ride				D,Rc	
Mouth				D	Fl1
San Elijo Lagoon	R,K	Rc,Cy			
Mission Bay: FAA Isl	G*,Ow		PF		Hu3,Hu4, FP3,FP4,A*
Mariner's Point		C	GBH*,G*,K		HU5,Unk
N Fiesta Isl			H,K,R	C	Rn
Naval Training Center			GHO*,BnO*,K*, R*,RTH*	C*	
North Island NAS	BwO*		K*,G*,GBH,R*,PF	C*,GS*	Fl2,A*
Delta Beach: North	H*,GbT*		K*,PF*	FC*	A*
South	GbT*,H*		K*		
D Street Fill	H*		GbT*,K*,LS*	FD*,Cy	
Chula Vista Wldlf Res			GbT*,PF,H,K*,G*	FD*	
Saltworks			PF,GbT,CT,H,G	FD*	
Tijuana River: N and S	LS,R*,M,K*	D*	H,PF,Os,G,GbT	GS*,C*,Stk*	Hu1,V,Fl3

Table 7. Sources of nesting site disturbance: there was no direct evidence of actual predation or mortality caused by indicated sources, however, sources were believed to underlie lack of nesting, or nest or site abandonment, or exacerbate sources of mortality. Documented or suspected predator species (Table 6) not included here (see text). Predators listed here were either (1) present at site prior to or during season and removed (\*), or (2) obvious to monitors and suspected to be the cause of nest or site abandonment. Human disturbance was military or recreational in nature: Mlt - base personnel (on foot or in vehicles) involved in military exercises approached or entered nesting area, Rec1 - pedestrians (beachgoers, surfers, joggers) with or without pets in and/or around nesting area, Rec2 - bicycles and/or ORVs in and/or around nesting area, Rec3 - fishermen left unattended hooked lines in roosting areas on shore, and in foraging areas in channel, Rec4 - fireworks at Seaworld and campers at weekend event flushed terns, Rec5 - boaters landing on site and campers at perimeter fence. Other: J4 - July 4th activities, Vnd - humans intentionally entered and vandalized site, Vg - vegetation overgrowth prohibited or limited nesting, or exacerbated predation pressure, Wnd - persistent strong onshore winds likely prohibited nesting, WL - water level in lagoon high and reduced amount of nesting habitat, WO - heavy rains washed-out nesting habitat. All other abbreviations as in Table 6.

	Human	Animal	Other
PGE, Pittsburg		RtH,H,R,G,CT	
NAS Alameda		PF,H*,BnO	
Oakland Airport		R,H,F*,Op*,Stk*,C*	Vg
Mussel Rock Dunes	Rec1		
Pismo Dunes	Rec2		Wnd
VAFB Beach 2		RtH,H,K,LS,BC	
VAFB Purisima Point	Mlt	RtH,K,LS,Cy,BC	
Santa Clara River	Rec1		
Ormond Beach: Edison	Rec2		
Perkins Rd	Rec1,Rec2		

Venice Beach			Vnd, J4
Terminal Island		Cr*, PF	
Seal Beach			Vg
Bolsa Chica			F12
Huntington Beach		K	
Newport Slough			Vg
Upper Newport Bay			
White Beach	Mlt		
SM River: North Beach			
Saltflats	Mlt		
Saltflats Isl	Mlt		
Batiquitos Lagoon: NE	Rec1, Rec2	K, LS	WL
Park and Ride	Rec1		
Mouth	Rec1		Vg, WL
San Elijo Lagoon	Rec1, Rec3	GBH, GE, BcNh, Cr, Ow, LS, M, Stk	Vg, WL
Mission Bay: FAA Isl	Rec4		
Mariner's Point	Rec5		
N Fiesta Isl	Rec1		Vnd
Naval Training Center	Mlt, Rec1		
North Island NAS			Vg, WO
Delta Beach: North			Vnd
South			
D Street Fill			Vnd
Chula Vista Wldlf Res			Vg
Saltworks			
Tijuana River: N and S	Rec1		