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CALIFORNIA LEAST TERN BREEDING SURVEY

1997 SEASON

by
Kathy Keane

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ABSTRACT

Approximately 4,017 pairs of California least terns *(Sterna antillarum browni)* nested at 38 sites along the coast of California in 1997, as reported by least tern monitors. This represents a 19% increase from 1996 pair estimates, and a 55% increase from 1995 pair estimates, more than compensating for the 7% decrease between 1994 and 1995. Recruitment cannot entirely account for this increase in least tern pairs, as reported fledgling production for both 1994 and 1995 was low. Immigration from other least tern populations has been suggested, and improved survival on wintering grounds may be a factor, but supporting data for these hypotheses are lacking. Overestimates of pair numbers and/or underestimates of fledglings by monitors may also partially explain this apparent increase. Reported pair and fledgling values are always imprecise estimates that are not scientifically derived; moreover, consistent methods for obtaining them, as recommended in annual monitoring packets, are not being used at all nesting sites.

Reproductive success and adult survival in 1997 was affected by a number of predators, particularly at San Diego County sites. However, fledgling estimates (3,140 to 3,322) for 1997 were 55% to 64% higher than 1996 and 200% higher than 1995 estimates. The statewide fledglings-per-pair value (0.78 to 0.83) was also higher than for the previous three years. San Diego County supported over 57% of 1997 statewide pairs and produced over 58% of statewide fledglings at 20 nesting sites; the Santa Margarita River nesting sites alone supported over 18% of statewide pairs. More than 50% of the statewide breeding population was concentrated in six nesting sites (NAS Alameda, Venice Beach, Huntington Beach, Santa Margarita River North Beach, Mariner's Point, and Delta Beach North); these sites also produced over 64% of the State's fledglings. Santa Margarita River North Beach and NAS Alameda had the highest (over 1.2) fledglings-per-pair values. The Tijuana River nesting sites reported the lowest fledglings-per-pair value (0.01 - 0.02) in the State due to unprecedented burrowing owl predation on adults, a host of other predators in the site vicinity, and human disturbance and intrusion into the nesting site. No evidence of local prey shortages was reported by monitors for any nesting site in 1997.

Keane, K. 1997. California least tern breeding survey, 1997 season. Calif. Dep. Fish and Game, Wildl. Manage. Div., Bird and Mammal Conservation Program Rep. 98-12 , Sacramento, CA 46 pp.

INTRODUCTION

The California least tern *(Sterna antillarum browni)* is one of three subspecies of least tern that breeds in North America. A migratory species, it nests from April through August along the western coast of North America from the San Francisco Bay area, California, to Baja California Sur, Mexico. Least terns presumably winter in Central America or northern South America, although the specific locations of their wintering sites remain unknown. The subspecies was listed as endangered under the federal Endangered Species Act on October 13, 1970 and under the California Endangered Species Act on June 27, 1971. The interior race of the least tern *(Sterna antillarum athalassos),* also federally listed as endangered, primarily occupies the Mississippi River valley and its tributaries. The eastern coast race *(Sterna antillarum antillarum)* nests from Massachusetts to Florida (Massey 1974).

California least terns historically nested in several small, scattered aggregations on sandy beaches and salt flats along the coast (Chambers 1908). The progressive loss during the early part of this century of undisturbed sandy beaches resulted in a severe reduction in both nesting sites and numbers of nesting pairs (Chambers 1908). By the 1940's, terns were gone from most beaches of Grange and Los Angeles counties and were considered sparse elsewhere (Grinnell and Miller 1944).

The current breeding range of the least tern in California extends along the coast from the Tijuana River estuary, just north of the U.S.-Mexico border, to the San Francisco Bay (Small 1994). Following listing under the federal and State endangered species acts, the number of least tern nesting sites gradually increased from 23 in 1976, when statewide censuses were initiated, to 38 in 1997. Estimated numbers of nesting pairs have also escalated from 664 in 1976 to over 4,000 in 1997. Protection of nesting sites with fencing and signage has effectively limited human disturbance at most nesting sites. However, both native and non-native predators have been implicated in major losses of eggs, chicks and occasionally adults (see Appendix A, Tijuana River) at several sites and over several years. Although many native animals are currently, and have likely historically been, least tern predators (e.g., American kestrel, common raven, gray fox, coyote), the proximity of nesting sites to human-modified habitats has resulted in increased threats of predation. For example, feral cats and dogs, free-roaming house cats, introduced red foxes, and animals whose populations benefit from human presence (e.g., American crow) have exerted strong predation pressures at many nesting sites. In addition, many predators appear to benefit from the localized and abundant prey source provided by the few remaining nesting areas.[2] In addition, occasional summer storm systems (as in 1995), recurrent or continual human disturbance (e.g., Tijuana River), and occasional deliberate human-induced mortality affect reproductive success. Finally, El Niño systems, or other winter storms that influence water temperature or salinity, may in turn affect least tern prey availability, which can result in chick mortality due to starvation (Caffrey 1997). Thus, although the least tern population has increased substantially from its pre-listing status, continued monitoring and predator management at nesting sites will be required to ensure its long-term survival.

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[2] According to A. I. McCormick, quoted in Bent (1921), the beaches of Los Angeles County in 1899 "from Santa Monica southward, afford excellent breeding grounds for numberless birds of this species." By 1943, "breeding stations [are] few…., owing to almost complete human use of suitable beaches" (Grinnell and Miller 1944). In 1997, Los Angeles County supported only two least tern nesting sites.

Least tern monitoring studies throughout the State of California have been conducted annually since 1973 to estimate numbers of nesting pairs and reproductive success. Experienced monitors conduct nesting site surveys per protocol established in monitoring packets provided annually. Monitors that conduct surveys within nesting sites, marking and checking nests during each visit, are authorized to do so through 10(a)(l)(A) permits issued by the United States Fish and Wildlife Service (USFWS) as well as a Memorandum of Understanding issued by the California Department of Fish and Game (CDFG). Results of monitoring studies conducted annually from 1973 through 1996 are summarized in annual reports compiled by the CDFG and available through the CDFG Non-game Bird and Mammal Section.

METHODS

Monitor Selection and Instruction

Site monitors were selected based on past least tern monitoring experience and on knowledge of particular nesting sites. Names of primary site monitors and their assistants are provided in Table 1, which also includes a summary of the type of monitoring conducted at that site (Type 1 or Type 2 site; see Monitoring Methods below), and site preparation methods, further discussed below under Site Preparation. Monitoring methods were detailed in monitoring packets provided in previous years (e.g., Caffrey 1995a). In mid-April 1997, a monitoring packet sent to all monitors included a mid-season report form, instructions for preparing the final report (including protocols for estimating pairs and fledglings), and sample field data sheets and mortality log forms, although some monitors opted to use their own methods of data collection.

Monitors also received a diskette with seven spreadsheets for entering final report data, and a mailer (addressed to Kathy Keane) for the diskette. Spreadsheets requested data on site preparation, nest numbers and estimated pairs, productivity, mortality due to factors other than predators, and predator losses. The diskette also included a Master Nest Log spreadsheet for monitors wishing to maintain digital information on each nest, such as initiation date, type and date of outcome (e.g., hatched, lost to predators, abandoned). Finally, all monitors were provided a list of names, phone numbers and e-mail addresses of all monitors by nesting site. They were encouraged to communicate with monitors in their region regarding the potential for movement of renesting birds among sites (to assist in estimating pairs) and to coordinate simultaneous fledgling counts. For example, in 1996, banded Santa Margarita River fledglings were observed at Batiquitos Lagoon, and fledglings fly between the Ormond Beach nesting site and Naval Air and Weapons Station NAWS] Point Mugu nesting site.

In addition to information provided in monitoring packets, a workshop was presented by Loren Hays of the United States Fish and Wildlife Service (USFWS) and Kathy Keane, author of this report, at the USFWS Field Office in Carlsbad on March 23, 1997. All monitors were encouraged to attend, although several were unable to do so. Information on least tern biology, population trends, results of published and unpublished research, monitor permitting, identification of least tern fledglings versus those of other terns, monitoring methods, and techniques to minimize monitor disturbance were discussed at the workshop. Hopefully, this type of workshop can be offered on at least a semi-annual basis. According to Loren Hays of USFWS, future issuance of 1 O(a)(l)(A) permits may depend in part on workshop attendance.

Site Preparation and Protection

Site preparation methods are summarized in Table 1, such as the type of fence (see legend on Table 1); whether or not interpretive signs, chick shelters or decoys were provided at the site; and whether vegetation management was conducted prior to least tern nesting in 1997. Fencing types vary from site to site, depending upon the potential for human and predator access, on the consistency of nesting areas used from year to year, and on the jurisdiction in which the site is located. For example, at Ormond Beach, nesting is concentrated nearly every year in different locations of the beach, so permanent fencing is not practical. At the other end of the spectrum, sites on recreational beaches such as Huntington and Venice, or sites with active military training nearby (e.g., Santa Margarita River) are protected with permanent fencing and chick fence, which must be frequently maintained during the season to ensure that chick losses do not occur.

Fences, depending upon type and maintenance, can minimize access by humans as well as by potential mammalian predators. In addition to fence placement, other methods of active and proactive predator management are used prior to and during least tern nesting at many sites. In 1997, Wildlife Services (formerly Animal Damage Control), a division of the United States Department of Agriculture, provided predator management services at these sites: Naval Air Station (NAS) Alameda, NAWS Point Mugu, Batiquitos Lagoon, San Diego County sites administered by the U.S. Navy (White Beach, Santa Margarita River sites, Naval Training Center, North Island NAS, Delta Beach North and South, and Naval Amphibious Base [NAB]-Ocean), and City of San Diego sites (Mariner's Point, North Fiesta Island). Port of San Diego sites (Lindbergh Field, D Street Fill, Chula Vista Wildlife Refuge) and USFWS Refuges (Tijuana Wildlife Refuge) have used Wildlife Services in previous years but in 1997 contracted with BioResource Consultants for predator management. Other sites (e.g., Huntington Beach, Seal Beach, Venice Beach, Bolsa Chica, and Vandenberg AFB) contract with other experienced predator managers on a scheduled or as-needed basis. Still other sites (Saltworks, McGrath State Beach, Ormond Beach, Pismo [Oceano]Dunes) may not receive any predator management. All predator managers operate under 10(a)(l)(A) permits that authorize access within least tern nesting sites, and possess depredation permits that authorize the trapping or other removal of animals protected under the Migratory Bird Treaty Act or other environmental laws.

Vegetation management also varies among nesting sites. Minsky (1987) and Erickson (1985) reported mean percent cover values of less than 5% for nesting areas they sampled. However, the proximity of many nesting sites to populations of invasive weeds often results in vegetation cover too dense to support least tern nesting. Vegetation management it is not necessary for some nesting sites, while at other sites intensive management in the form of herbicides or mechanical removal is conducted (see Table 1). Chick shelters, often in the form of ceramic roof tiles, are sometimes used at sites with little to no vegetation growth, but chick use of such shelters has also been observed at sites where sufficient vegetation appears to be present (e.g., L.A. Harbor Terminal Island). Interpretive signs are used at several nesting sites (see Table 1), particularly at those with frequent human visitation. Site-specific information, when provided by monitors, on other preparation techniques is summarized in Table 1.

Monitoring Methods

Site Types

Type 1 sites are those in which monitors enter the nesting site and temporarily disturb nesting terns while marking and checking nests; most nesting sites in 1997 were considered Type 1 sites. This type of monitoring allows for the collection of more detailed data than for Type 2 sites, which are monitored from the outside only, with monitors counting birds observed in incubating posture to estimate nest numbers. Monitors at Type 1 nesting sites walk through the site (occasionally using portable blinds), looking for unmarked (new) nests, marking them, and checking and recording the contents of previously marked nests. Nests are typically marked with numbered tongue depressors or other wooden stakes; at some nesting sites where egg predation is a problem, less conspicuous marking may be used. Thus, monitoring at Type 1 sites provides more quantitative data (e.g., clutch size, incubation periods, hatching success) and generally more accurate data for nest numbers than at Type 2 sites. In addition, evidence of predation (e.g., mammal tracks, remains of chicks or eggs) can also be noted during monitoring at Type 1 sites and subsequently addressed if warranted. On the other hand, monitor disturbance is minimized at Type 2 sites, and behavioral observations and some predation events may be more easily observed. Monitors at Type 1 sites typically cannot evaluate nest attendance, census chicks (see discussion of fledgling counts) or observe chick feeding (sometimes important in terms of prey availability). In addition, monitors at Type 1 sites may occasionally miss predation events while monitoring (it may be difficult to hear the specific least tern alarm calls used in the presence of a predator in the din of those used in response to monitor presence). Thus, distinct advantages and disadvantages exist for the two types of monitoring.

Nest and Pair Counts

In addition to numbers of nests, monitors also calculate the number of pairs, which is used to derive a statewide population estimate. Although less accurate than the number of nests, this value is generally a better indicator of population status. For example, during years when egg predation is high, nest numbers will also be high because many pairs may initiate new nests (renest) when their first and possibly subsequent nests are lost (Massey and Atwood 1981). Thus, the numbers of nests cannot be compared from year to year to reliably evaluate population trends. Monitors calculate the number of pairs using the total number of nests, minus the estimated number of nests initiated by renesting pairs (renests) from the same or another nesting site. However, the number of pairs is actually impossible to determine accurately without observations of uniquely banded birds at each nest.

Nesting Waves

Findings by Massey and Atwood (1981) and assessments of recaptures of numerous banded birds of known age at the Santa Margarita River nesting sites indicate that pairs nesting early in the season are generally experienced breeders (3-years old and older). Later nests are generally those of renesting pairs and of first breeders (2-year old birds) that may arrive after older birds. Generally, nests early in the season during what has been called the “first wave” are assumed to be those of pairs nesting for the first time that year, so the number of “first wave” pairs is simlar to the number of “first wave” nests. The number of late-season (“second wave”) nests, minus the estimated number of renesters, provides an estimation of “second wave” pairs. During years

when recruitment is expected to be high (e.g., high productivity two years prior) and losses to predators are low early in the season, renesters typically contribute minimally to "second wave" nest numbers. Alternatively, "second wave" nests have a higher probability of being renests when low recruitment is anticipated and/or major egg and chick losses are apparent early in the season. Estimating pairs for the "second wave," however, can be problematic, as it may be difficult to determine when the "second wave" begins. At some sites, two peaks in nesting are apparent, with the number of newly initiated nests declining through early June and a smaller, second peak (and sometimes two peaks) or "second wave" of nesting from mid-June into early July (e.g., Caffrey 1997, Figure 1 - State and South; Caffrey 1998 Figure 3 - Venice Beach, White Beach). At such sites, the date that numbers of new nests start to climb once again is used as the beginning of the "second wave." However, at many sites, and at some sites during some years, only one peak of nesting is apparent, with the number of new nests gradually declining from early June through the end of the season (e.g., Caffrey 1997, Figure 3 - Bolsa Chica). For this reason, "first wave" and "second wave" have been referred to in quotes (Caffrey 1997 and 1998). June 15 has historically been used for sites with no second peak of nesting to denote the beginning of the "second wave," so that similar methods to estimate pairs can used at all sites.

Fledgling Counts

Monitors must also estimate the fledgling numbers for their site. An accurate estimate may be obtained by conducting frequent "chick round-ups" at fenced sites and recording band numbers of chicks recaptured just prior to fledging. Banding is not conducted at most sites, however, as many monitors are not permitted banders. Also, the expansiveness of many sites and availability of sufficient vegetation for chick refuge may diminish the probability of chick recapture. Thus, at most nesting sites, censuses are conducted to estimate fledglings. Because fledglings may be away from the site learning foraging skills during the day, the recommended timing for censusing is just prior to dusk, when they may return with their parents to the nesting site. At some sites, terns leave to roost for the night at other locations, particularly when nocturnal predation or other disturbances are occurring at the nesting site. Monitors at some sites have not succeeded in locating the roosting area for their site; instead, they conduct daytime censuses, which may result in underestimates[3].

Studies of color-banded chicks indicate that fledglings may remain at the site for up to three weeks post-fledging (Massey 1989); of course, this will vary with predation pressures, human disturbance, prey availability and other factors. Based on this information, however, and lacking a better method, monitors are asked to census fledglings during an evening visit to the nesting (or roosting) site every three weeks until a month after the last chick has hatched. The results of such counts are added for an overall estimate of fledglings for the season. However, monitors are cautioned that fledglings may roost, particularly after departing from nesting areas, at sites other than their natal nesting site (e.g., terns banded at Santa Margarita River seen at Batiquitos Lagoon W-2; NAWS Point Mugu and Ormond Beach terns fly between sites). Thus, in the 1997 monitoring packet, dates for conducting simultaneous fledgling counts (June 16, July 7, July 28, and August 18) were recommended to monitors to minimize double-counting.

[3] For example, during one count in Los Angeles Harbor, fledglings increased from 35 prior to dusk to 79 at dusk.

Monitoring Hatching Success and Losses

In addition to calculating pair and fledgling numbers, monitors record losses to predators of eggs, chicks, fledglings and adults, Monitors were asked to distinguish between "suspected" or "documented" predation events. Documented predators are those actually observed preying on least tern eggs, chicks or adults or for which absolutely unequivocal sign is observed (e.g., mammal tracks at a nest, a raptor pellet with tern remains, a chick or adult carcass or remains that suggest a specific type of predator, or tracks or feathers of an avian predator within the nesting site). Suspected predators are those seen near the nesting site or flying over the site but not observed taking prey or leaving depredation evidence as described above. Monitors at Type 1 sites also record factors affecting hatching success not directly related to predators (egg infertility or abandonment, eggs lost to flooding or human intrusion, eggs incubated beyond expected hatching date [generally infertile]), and observed mortality of chicks, fledglings or adults not directly related to predators.

Data Analysis and Report Compilation

Information from mid-season report forms submitted to Kathy Keane by monitors was summarized in table format, listing numbers of nests initiated as of June 8 and potential threats to reproductive success observed by that date. The mid-season report table was submitted in early July to Ron Jurek of CDFG and to all monitors by mail or e-mail. Monitors from all sites, except those administered by the U.S. Navy, also submitted final spreadsheet reports on the provided diskettes to Kathy Keane. Spreadsheet information from each site was copied into a master spreadsheet, which was used to prepare the tables in this report. Reproductive success for each site was calculated by dividing the estimated number of fledglings for the season by the number of pairs at that site. Mean clutch size was calculated by dividing the total number of eggs by the total number of nests. No statistical analyses or additional calculations were conducted.

Changes in Nesting Site Names or Use

The terms "nesting sites" and "colonies" have been confused and misused in past years by least tern researchers. Caffrey (1997), using terminology provided in previous annual reports, defined a nesting site as the location for a discrete and contiguous group of nesting birds, and a colony as the general location of a breeding area, where birds from separate nesting sites may share roosting and foraging areas. According to this definition, colonies may include more than one nesting site, and if all pairs within a colony nest within a single, contiguous nesting site, the colony name and site name are the same (Caffrey 1997 and 1998). Erickson (1985) referred similarly to nesting sites as "colonies" and "sub-colonies." However, in ornithological literature, the term "colony" typically refers to a colonially nesting group of birds on a breeding site, rather than to a geographical location. Thus, in this report, the term "nesting site" is used unless the discussion refers to a group of nesting terns. The names of "nesting sites" used in this report remain the same as those used for "colonies" in previous reports; for "colonies" that supported more than one "nesting site," both names are provided as they were in previous reports.

Monitors generally report data separately for non-contiguous nesting sites in the same general location (e.g., Delta Beach North and South; Santa Margarita River North Beach, Salt Flats and Salt Flats Island; Vandenberg AFB Purisima Point and Beach 2). At the following sites, however, monitors combined data and reported it as for one nesting site in 1997:

- Tijuana River includes data for sites north and south of the river, reported separately in previous years;
- Santa Clara River includes data for the mouth and McGrath Lake (combined in 1996 but separate in previous years);
- Ormond Beach includes data for Perkins and Edison sites, now difficult to delineate.

Nesting site names changed in 1997 from those used in 1996 to more accurately reflect location and/or jurisdiction, per their site monitors, are as follows:

- Pismo Dunes is now called Pismo (Oceano) Dunes,
- Mussel Rock Dunes is now Mussel Rock/Guadalupe Dunes.
- Terminal Island is now called L.A. Harbor Terminal Island (see below).

Nesting sites used in 1997 but not in 1996 include:

- Vandenberg Beach 2, not used since 1994;
- Hollywood Beach north of the Channel Islands Harbor entrance, Oxnard, previously unused;
- L.A. Harbor Pier 400 and L.A. Harbor TC2, created in the winter of 1997 in the Los Angeles Harbor southwest of Terminal Island (eventually to replace Terminal Island); and
- Batiquitos Lagoon E-2, created in the winter of 1996 but used only by nesting western snowy plovers during the 1996 least tern nesting season.

Site preparation and proactive predator management was conducted at Chula Vista Wildlife Refuge; thus, it is included in the tables in this report, although no nesting was noted here in 1997. Oakland Airport is also included in 1997 data tables, although it has not supported nesting since 1995; the site is still monitored regularly and is important as a pre- and post-breeding site.

RESULTS AND DISCUSSION

Distribution and Productivity by Region

Approximately 4,017 pairs of California least terns nested at 38 nesting sites (Figure 1) along the coast of California in 1997 and produced an estimated 3,140 to 3,322 fledglings (Table 2A). Statewide pair estimates increased 19% and fledgling estimates increased by 55% to 64% over 1996 numbers (Table 2A). Some fledgling increase was expected, however, as productivity in 1996 was low because of substantial predation at many sites (Caffrey 1998). Six sites (NAS Alameda, Venice Beach, Huntington Beach, Santa Margarita River [shortened in report tables to SM River] North Beach, Mariner's Point, and Delta Beach North) were the only sites with over 5% each of statewide total pairs. Combined, these sites supported 57% of statewide pairs and produced 69% to 73% of the State's fledglings for 1997. Summaries provided by monitors for some nesting sites are included in Appendix A.

Twenty nesting sites in San Diego County (more than half of the State's 38 sites) harbored the majority (2,288, or 57%) of statewide least tern pairs and generated 56% to 60% of statewide fledglings (Table 2B). San Diego County fledgling estimates in 1997 reflected an 80% increase from 1996 fledgling estimates. The seven Los Angeles/Orange County nesting sites, including the new sites in the Los Angeles Harbor, supported 3 1% of the State's pairs; this was a 33% increase from 1996 pair estimates in the region. The Los Angeles/Orange County region also produced 25% to 30% of the State's fledglings in 1997, a nearly 70% increase over the 1996 regional total.

The San Luis Obispo/Santa Barbara and Ventura County regions supported over 6% of the State's population but less than 5% of statewide fledglings for 1997. Pair estimates for the San Luis Obispo/Santa Barbara region declined by 41% from 1996 estimates. Fledgling production for both regions decreased substantially, by 44% for Santa Barbara/San Luis Obispo region and by 50% for Ventura County (Table 2A), largely due to predators and abandonment (see below). The San Francisco Bay region, primarily NAS Alameda, supported only 6% of statewide pairs but produced approximately 10% of statewide fledglings. Pair estimates in San Francisco Bay increased 17% from 1996 numbers, and fledgling estimates in 1997 were 34% higher than in 1996 (Table 2B).

Chronology

The first nests of 1997 were initiated at Seal Beach, Bolsa Chica, Huntington Beach and Venice Beach (Table 3A). White Beach, SM River North Beach, Lindbergh Field, Upper Newport Bay, Mission Bay Mariner's Point, Delta Beach North were close behind. First nests at Santa Clara River were not initiated until the beginning of June. Sites where nesting was not initiated until approximately the middle of June or later (L.A. Harbor TC2, Pismo [Oceano] Dunes, Batiquitos Lagoon E-2 - Table 3A) likely supported primarily renesting birds.

Sites where nesting was completed early in the season included L.A. Harbor Terminal Island (abandoned after all four nests were depredated; night-time lighting could also have been a factor) and PGE, Pittsburgh. No new nesting occurred at Lindbergh Field and Batiquitos Lagoon E-l after the middle of June. New nests continued to be initiated at most other sites until late June (e.g., Bolsa Chica, Mission Bay North Fiesta Island, Ormond Beach) or the middle of July (e.g., L.A. Harbor Pier 400, Mission Bay Mariner's Point, SM River North Beach, Delta Beach North). The last nests of the season were initiated at Tijuana River and L.A. Harbor TC2 (Table 3A).

In an effort to promote prompt report completion by monitors, data on the number of new nests initiated each week were not requested from monitors as in 1995 and 1996 (Caffrey 1997 and 1998). Thus, the number of sites exhibiting a "second wave," and the existence of a "second wave" statewide, were not possible to determine in 1997. However, several sites (e.g., NAS Alameda, Seal Beach, Huntington Beach, Batiquitos Lagoon W-2, Mission Bay nesting sites, Saltworks) reported dates other than June 15 for the beginning of the "second wave" (Table 3A). As monitors were asked to use June 15 only if no "second wave" was apparent at their sites (see Methods), this suggests that at least a small "second wave" of nest initiations was apparent at the 13 sites reporting dates other than June 15 for "Date of Second Wave Start" (Table 3A).

Data on "first wave" and "second wave" nests and pairs were not provided for some sites (Table 3A). However, provided data were used to estimate "first wave" and "second wave" nests and pairs statewide (Table 3B). Accordingly, statewide pair estimates for the "second wave" (204) represented only 5% of total 1997 pairs (4,017), compared with 12% of total 1996 pairs, 15% of 1995 pairs, and 24% of 1994 pairs (Table 3C). Lower numbers of "second wave" pairs in 1997 may be due partially to poor fledgling production in 1995, resulting in fewer first-time breeders nesting during the "second wave" (Massey and Atwood 1981). However, the number of nests per pair in 1997 (1.11) was also lower than for 1994 (1.23), 1995 (1.15) and 1996 (1.19) (Table 3C). Monitors may have underestimated renesting in 1997, or mortality (see Causes of Reproductive Failire below) may have been low in 1997 compared with the previous three years (although quantitative mortality data for those years are unavailable), resulting in few renesting attempts. The 1997 nests-per-pair value is most similar to that for 1995 (Table 3C) when reported prey shortages at several sites (Caffrey 1997) likely deterred renesting.

Clutch Size and Hatching Success

Table 4 summarizes productivity statewide and for each nesting site. A total of 4,449 nests were reported statewide, and 7,902 eggs were found in 4,257 nests (Type 2 sites did not report egg numbers). Mean clutch size for the season was 1.86 eggs per nest, higher than in 1995 (1.71) but slightly lower than 1996 (1.89) (Caffrey 1997 and 1998). Highest mean clutch sizes were at SM River Salt Flats Island, Batiquitos Lagoon E-l and E-3, San Elijo Lagoon, NAB Ocean and D Street Fill (Table 4). In contrast to 1995 and 1996 (Table 5 of Caffiey 1997 and 1998), a mean clutch size of 2.0 or greater was not reported for any site (Table 4); reasons for this are unclear. Batiquitos Lagoon E-2 reported the lowest clutch size in 1997 (Table 4); however, this site probably supported only renesting birds (Table 3).

Mean hatching success (number of eggs hatched divided by the total number of eggs) was 79.8%, similar to that in 1996 (81.1%) but higher than 1995 (76.5%)(Caffrey 1997 and 1998). Batiquitos Lagoon E-l and Delta Beach South had the highest hatching success in 1997, while Seal Beach, Batiquitos Lagoon E-2 and Mission Bay FAA Island had the lowest hatching success due to predation and high numbers of infertile eggs (see subsequent tables). Vandenberg Beach 2 and L.A. Harbor Terminal Island had no hatching success (Table 4). Table 4 also summarizes data from recommended fledgling counts every three weeks, which some monitors used. Table 4 totals for "Total Fledglings" and "Total Fledglings Other Methods" cannot be added for total statewide fledglings, as some monitors used more than one method and reported data for both columns. See Table 2A for fledgling numbers by site.

Causes of Reproductive Failure

Table 5 summarizes reported causes, other than predators, of reproductive failure. A total of 20 eggs statewide were lost to vandalism or trespassing by humans on foot, vehicle, or horse. Indirect effects of human disturbance (i.e., egg or chick abandonment) are not included in this total. Tijuana River, which is susceptible to trespass by equestrians, illegal irmnigrants and U.S. Border Patrol agents (it is located directly north of the U.S.-Mexico border), reported the highest losses of eggs to human damage. The Tijuana River sites and Santa Margarita River North Beach also reported losses of several eggs to flooding (Table 5).

Total abandoned eggs for the State were 725; Tijuana River also had the highest number of abandoned eggs, likely due to the high levels of human disturbance described above. Venice Beach, Seal Beach, SM River North Beach, Mission Bay Mariner's Point and Delta Beach North also had high numbers of abandoned eggs. However, sites with the highest percentages of abandoned eggs in 1997 were Vandenberg Beach 2, White Beach, Batiquitos Lagoon E-2, North Island NAS, and Tijuana River (Table 5).

A total of 361 non-predator-related chick deaths were recorded statewide in 1997. Quantitative statewide data on chick mortalities are unavailable for 1995 and 1996 (Caffrey 1997 and 1998). However, in 1995, nearly as many (355) dead chicks (including some fledglings) were counted at only two nesting sites (Venice Beach and NAS Alameda), when least tern food shortages[4] were suspected at some sites (Caffrey 1997). Dead chick numbers represented approximately 6% (Table 3) of the 6,308 eggs hatched for the season (Table 4); fledgling losses represent another 1% of total eggs hatched. Fifteen adult deaths were also reported statewide in 1997 (Table 5). Presumed causes of mortality were not requested in 1997; however, when site summaries (Appendix A) were provided, monitors reported no apparent signs of trauma or evidence of prey shortages, so at least some deaths can likely be attributed to natural mortality.

Table 6 summarizes reported losses to predation by documented and suspected predators (see Methods). Total reported statewide losses to predators in 1997 included 334 eggs, 245 chicks, 41 fledglings and 100 adults. Many more losses not possible to estimate were reported by monitors as "unknown." Data on losses to predators provided for U.S. Navy sites in San Diego did not include predator types; these are summarized on the last page of Table 6 under "Losses Not Reported by Predator Type." The highest egg losses in 1997 were attributed to western gull, American crow, burrowing owl and unreported predators (Table 6). Chick losses to American kestrel and red-tailed hawk were higher than for other reported predators; peregrine falcon and unreported predators took more fledglings than other reported predators. The Tijuana River site lost an extraordinary number of adults to primarily one pair of burrowing owls; unfortunately, the offending pair of owls was not located until a minimum of 42 to 44 least tern adults had been depredated, as evidenced by their carcasses at the burrow. Another 13 adults were lost in 1997 to peregrine falcons at four nesting sites; 29 more adults were taken by unreported predators (Table 6). Reported predation losses are likely minimum numbers, as predation that results in no evidence (e.g., raptors catching prey at the site and consuming it elsewhere) undoubtedly occurs during hours when monitors or predator management specialists are not present to document its occurrence.

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[4] Assumptions about least tern food shortages are based upon indirect evidence, as least tern prey, often ephemeral and localized, is difficult to sample. Factors suggesting a potential prey shortage include low mean clutch sizes, poor nest attendance, kleptoparasitism among least tern adults, high numbers of abandoned nests, dropped fish too large for chick consumption on the nesting site, and high chick mortality (Caffrey 1997). Some least tern monitors claim these factors are equivocal as they can also be attributed to high levels of predation, However, others questioned about this assertion stated that some of these observations would not be apparent unless terns were nearly continually defending the nesting site from potential predators. For example, (1) Dr. Charles Collins found normal chick weights and low chick mortality (other than to predation) even when the Huntington Beach nesting site experienced very high levels of kestrel predation; (2) Seal Beach reported egg abandonment of 12% but low chick mortality (Table 5) despite repeated visits by a peregrine in 1997. Anecdotal information from local bait barges on populations of small anchovies may also be used when prey shortages are suspected.

Comparisons with Previous Years

Significant changes in site use between 1996 and 1997 include L.A. Harbor Terminal Island, which supported 56 pairs in 1996 but only four in 1997; however, new nesting sites in L.A. Harbor in 1997 supported 76 pairs. Several other sites reported substantial increases or decreases in numbers of pairs as compared with 1996 estimates, with the highest increases in San Diego County at Batiquitos Lagoon W-l, Mission Bay North Fiesta Island and San Elijo Lagoon. Mission Bay North Fiesta Island probably absorbed several pairs from the nearby Mission Bay FAA Island, where pair numbers decreased from those reported in 1996 by 89% (Table 2A).

Estimated pairs (4,017) for 1997 represent a 19% increase from 1996 pair estimates, and a 54% increase from 1995 pair estimates. The apparent, substantial increase cannot be explained entirely by recruitment, as reported fledgling production for both 1994 and 1995 was low (Figure 2). In the absence of evidence of immigration from other least tern populations (e.g., recapture of birds banded from other regions), it is possible that this increase is due to better survival on wintering grounds, but because least tern wintering locations are unknown, this hypothesis cannot be substantiated.

Overestimates by monitors of least tern pairs could contribute to an apparent increase. Although monitors readily concede that substantial predator losses may occur beyond those suspected or documented, we may be less likely to consider, when estimating pairs, that renesting may follow these and other losses (assuming, of course, that losses occur sufficiently early in the season, and are entire clutches or broods, so that renesting may occur). For example, predator losses of 334 eggs and 245 chicks (Table 6), losses of 1,181 additional eggs and chicks to other sources of mortality (Table 5), and many additional "unknown" losses (Table 6) suggest that more renesting may have occurred in 1997 than was estimated by monitors (see Recommendations). However, as discussed in Methods, accurate pair estimates can only be obtained by closely monitoring a uniquely banded population for renesting, a time-consuming and expensive research effort.

Possible underestimates of fledglings in previous years may also partially explain this discrepancy. Fledgling estimates are imprecise approximations (see Methods); however, consistent methods for obtaining these estimates, as recommended in annual monitoring packets, are not being used at all nesting sites. Monitors at some sites allege an inability to locate night roosting sites and are counting fledglings during daytime monitoring hours, when many may be foraging elsewhere. In other cases, fledglings may disperse before they are censused; at some sites, counts every two weeks, rather than every three weeks, may yield a better estimate. Monitors may also be overestimating predation and thereby underestimating fledgling production for their sites (see Recommendations).

Least tern pair estimates have generally increased from 1985 through 1996 (Figure 2), except for decreases of 7% or less. It will be interesting to observe whether least tern pair estimates or productivity in 1998 indicate any effects of the 1997-1998 El Niño.

RECOMMENDATIONS

Funding

Funding for least tern monitoring and predator management has always been an issue of concern. Although the least tern population appears to be continuing to increase, this success story would certainly reverse itself if funding for monitoring and management is discontinued or significantly reduced. The proximity of most nesting sites to potentially high levels of human disturbance and predation compels a need for sometimes very intensive monitoring and predator management. As human populations near least tern nesting areas continue to increase, these threats will only be exacerbated. These facts must be successfully communicated to those individuals, far removed from day-to-day least tern management, who make funding decisions.

Currently, most monitors with only CDFG funding are provided sufficient reimbursement to visit their sites only several hours per week and thus may not be observing many instances of predation or human disturbance that may otherwise have been prevented. Increased funding would allow monitors to spend more time at nesting sites and thereby enhance tern reproductive success. Although all sites would benefit from increased monitoring, the Tijuana River sites need at least one full-time monitor and predator manager to observe and attempt to prevent instances of human disturbance and predation. Egg or chick losses to equestrians and other trespassers should be well documented and immediately reported to USFWS Law Enforcement, who should be ready to issue citations.

Funding for predator management would also enhance the reproductive success of sites with only CDFG funding. As stated in the acknowledgements below, predator management provided by the U.S. Navy, City of San Diego and other entities has been essential in enhancing the least tern reproductive success. However, at sites with only CDFG funding, predator management funds are sparse. For example, Wally Ross and Ron Brown volunteered numerous hours in 1997 for as-needed predator management at Venice Beach and Bolsa Chica, and several sites, particularly those in Ventura and San Luis Obispo counties, have no predator management at all.

Nesting Sites

Site managers are appreciated, as stated below, for their ambitious efforts in site preparation and maintenance. However, several CDFG sites would benefit from better site preparation, and the Venice Beach site is at the top of the list. Monitors volunteered innumerable hours during 1997 to install and maintain the Venice chick fence. Thousands of beach-goers observe this site each year, and the neglected condition of the fence does little to enhance their impression of endangered species and wildlife management. USFWS and CDFG must meet with Venice Beach site management (Los Angeles County Harbors and Beaches) and the site owner (California State Parks) to discuss and designate responsibilities for future site maintenance. Many other sites (e.g., Ormond Beach) could benefit from temporary or permanent fencing and/or better enforcement to effectively exclude human intrusion. Others are in need of additional fencing to effectively deter mammalian predators. Still others could benefit from interpretive signs, both in English and Spanish. If funding in future years can be increased, a portion should be dedicated toward such much-needed enhancement efforts at existing nesting sites.

In addition, creation of new nesting sites is always a priority. For example, Los Angeles County still supports only two nesting areas - Venice Beach and Los Angeles Harbor. The attempt several years ago at creating an additional site south of Venice Beach failed; however, Malibu Lagoon may be an option for a new nesting location. Creation of additional sites in Ventura County and areas to the north should also be considered in future years.

Monitoring

The development of methods to improve the accuracy of estimating pairs and fledglings is a high priority. Monitors now estimate total pairs for a site by subtracting the assumed number of renesters, which is generally pure speculation, from the total number of nests. A potentially better method of estimating pairs would consider the number of renesting pairs that a given site may generate, rather the number of pairs renesting at that site. For example, monitors would subtract all losses of entire clutches and broods[5] that occur prior to a certain date (beyond which renests would not be expected) from the total number of nests for the season. Thus, pairs will only be counted when they renest. Pair estimates may not be more accurate for a given site (since unsuccessful pairs may renest elsewhere), but this method may yield a more accurate estimate of pairs statewide. In addition, pair estimates may be easier to derive than the current nebulous values, and this suggested method also avoids estimating "first wave" and "second wave" pairs.

Monitors not conducting dusk counts should be using chick recapture data or reliable chick census data to estimate fledglings; otherwise, they must expend more effort in attempting to locate the roosting site and conduct dusk fledgling counts. Daytime fledgling counts day must be considered underestimates (see footnote 3) and should be adjusted accordingly. Finally, monitors must make an effort to coordinate simultaneous fledgling counts with monitors of nearby sites (e.g., Batiquitos and Santa Margarita River sites) to minimize double-counting.

Another fledgling estimation method that may account for birds departing earlier than three weeks would make use of the ratio of fledglings to adults during each count. Adults as well as fledglings would be counted during dusk censuses[6], and the ratio of fledglings to adults for each count can be averaged for the season and used with the estimate of total pairs, multiplied by 2, to derive an estimate of total fledglings for the season. For example, if fledgling numbers were approximately half that of adults (ratio 0.5) during counts, and the estimated number of pairs for the season was 100 (200 adults), then the fledgling estimate would by 200 times 0.5, or 100.

Although it may not be practical for some large sites, the use of a portable blind is highly recommended when at all possible. Nests can be more easily located, information on nest attendance and other behaviors can be observed, and a census of chicks close to fledging can be maintained to corroborate (or to supplement or replace) data obtained from fledgling counts.

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[5] The latter, of course, is more difficult to estimate without chick banding records or observations from a blind.

[6] Dusk counts are also recommended for this method, as ratios derived during daylight hours, when some parents may be foraging away from the site, may be inaccurate. However, this assumes that birds whose mates are incubating eggs or attending unfledged chicks are roosting with their mates rather than among the flocks of censused fledglings; however, dusk observations at nests (Keane 1987) did not locate both pair members.

Predator Management

In her 1996 report (Caffrey 1998), Carolee Caffrey stated that "Wiping out all potential predators prior to the onset of nesting would clearly benefit terns, but it 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." She adds, "Thus, some sort of ecologically- and ethically- sound predator management program must be worked out, and soon." These opinions are shared by many, if not a majority of, least tern monitors and resources agency personnel. Predator management can be credited with the significant recent increases in least tern pairs. However, the removal in 1997 of burrowing owls not implicated as least tern predators from Tijuana Estuary was unfortunate. The USFWS previously initiated preparation of a least tern predator management plan and should consider its completion a top priority.

ACKNOWLEDGEMENTS

I would like to recognize those who assisted in the successful fulfillment of this contract. I would first like to thank Ron Jurek for his ultimate patience and ability to tolerate my independence. Dr. Charles Collins is appreciated for his unfailing guidance, and for executing the logistical parts of this contract with the California State University, Long Beach (CSULB) Foundation. I also thank Ravi Khatra of the CSULB Foundation for the smooth administration of this contract. Jack Fancher of USFWS and Barbara Massey are appreciated for their willingness to address my many questions or concerns; Jack Fancher is also belatedly acknowledged for the comprehensive and useful least tern bibliography he compiled and maintains. Loren Hays organized a successful least tern monitoring workshop; I look forward to working with Loren on future workshops.

I will also try to recognize here the many individuals that have contributed to least tern nesting success during this and previous years. It is unlikely that terns would be doing even half as well as they are without the financial contributions and many hours of effort expended by site managers in site preparation and maintenance. These dedicated site managers include NAS Alameda, Vandenberg AFB, Ventura Audubon Society, NAWS Point Mugu, Port of Los Angeles, USFWS Refuges (Seal Beach and Tijuana River), California State Parks (Pismo [Oceano] Dunes and Huntington Beach), U.S. Navy SOUTHWEST DIV (for all San Diego County Navy sites), City of San Diego (for Mission Bay sites), County of San Diego (San Elijo Lagoon) and Port of San Diego (Lindbergh Field, D Street Fill and Chula Vista Wildlife Refuge). Chick fencing was installed at Venice Beach by volunteers Sherry Ross, Wally Ross, Justin Brown, Elisa Graham, Chanelle Davis, Nick Liberato and Mike Taylor. Elisa Graham and Mike Taylor also maintained the fence throughout the season, and Wally Ross installed five interpretive signs on his own time. The numerous volunteers of the Batiquitos Lagoon Foundation and local Audubon chapters that participated in site preparation efforts are also much appreciated. Thank you all very much, and keep up the wonderful work.

Many of the site managers mentioned above also provide generous funding for monitoring, and they are much appreciated for this, as State funding for monitoring is never abundant. I sincerely thank the following for funding least tern monitoring and/or predator management on sites within

thank the following for funding least tern monitoring and/or predator management on sites within their jurisdictions: NAS Alameda, PGE Power Plant in Pittsburgh, California State Parks (monitoring at Pismo [Oceano] Dunes State Park and predator management at Huntington Beach State Park), Vandenberg Air Force Base, NAWS Point Mugu, Port of Los Angeles, USFWS Refuges (Seal Beach and Tijuana River), U.S. Navy SOUTHWESTDIV (for White Beach, Santa Margarita River sites, Naval Training Center, North Island NAS, Delta Beach North and South, and NAB Ocean), Port of San Diego (Lindbergh Field, D Street Fill, and Chula Vista Wildlife Refuge, and City of San Diego (predator management at North Fiesta and Mariner's Point).

I will not take the time to list all field monitors by name, as names of assistant monitors were not provided for some sites (see Table 1), so I would undoubtedly miss some. But I extend my heartfelt thanks to each and every site monitor, whether you spent only a few or several hundred hours monitoring nesting sites in 1997.

Similarly, I do not know by name many of the personnel of U.S.D.A. Wildlife Services, but these dedicated individuals are also acknowledged for their commitment toward enhancing least tern productivity. Although we may differ in our some of our opinions about predator management, the least tern population could not have reached 4,000 pairs so quickly without your many years of effort. Pete Bloom, Carl Thelander, Brian Walton, and all assistants to these individuals, are also much appreciated for their tireless predator management efforts in 1997. Wally Ross is acknowledged for his contributions toward tern productivity at Seal Beach, Huntington Beach and Los Angeles Harbor. In addition, Wally and his assistant Ron Brown were always ready and willing to handle as-needed predator management with limited monetary return at Bolsa Chica and Venice Beach; reproductive success at these sites was clearly enhanced by their efforts. Don Reierson and Elaine Paine of the University of California, Riverside are also greatly appreciated for promptly and successfully addressing the problems of ant predation at several nesting sites.

Primary site monitors are sincerely appreciated for your efforts in complying with the changes I made in 1997, particularly with new system of final reports I attempted this year. Although some of us had problems with compatible Excel formats, all (except monitors for U.S. Navy sites) were able to submit completed diskettes to me, which greatly facilitated data entry and calculations. Carolee Caffrey has my sincere sympathy for the numerous hours of data entry she must have spent for previous year's reports. I was surprised and happy to see it work out so well and so nearly painlessly the first year. I also thank primary site monitors for your cooperation with, and tolerance of, a new principle coordinator in 1997 after working so well with Carolee Caffrey in previous years. Finally, although some of us may differ about the "how" of least tern management, there's no question that we all understand, and are dedicated to addressing, the "why." I respect and thank you all for your unfailing dedication and look forward to working with you in future years.

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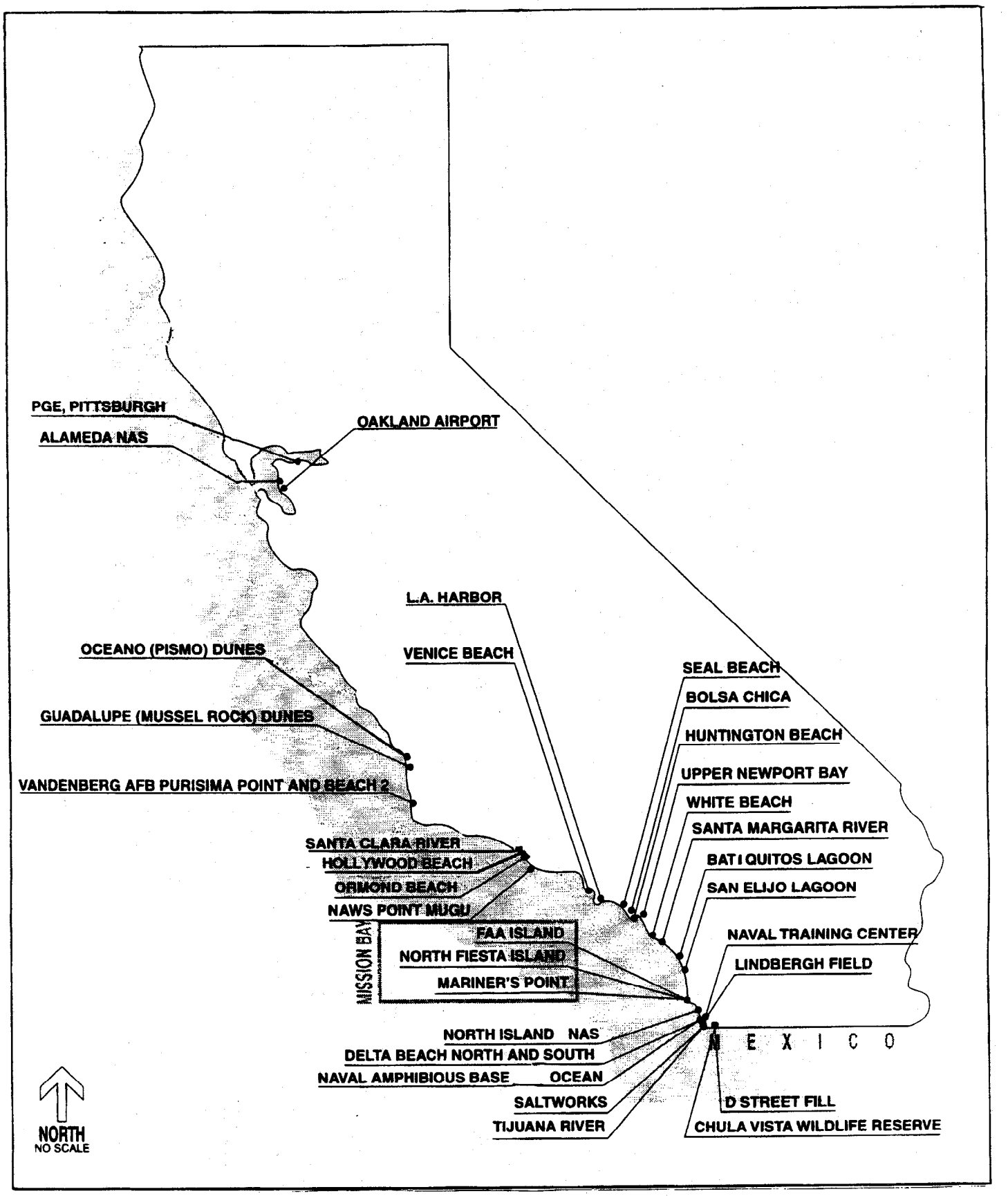

Figure 1. Approximate Locations of California Least Tern Nesting Sites, 1997

Table 1. California Least Tern Site Preparation and Monitor Information, 1997

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Site Name	Site Type[a]	Fence Type[b]	Name of Primary Monitor	Names of Other Monitors	Inter-pretive signs at site?	Chick shelters?	Decoys?	Grid System?	Vege-tation Manage-ment[c]?	Other Site Preparation?	By Whom?
PGE, Pittsburgh	1	2	Laura Collins	N/A	YES	NO	NO	NO	4	fill holes	Pg&E
NAS Alameda	1	1	Laura Collins	Leory Feeney	YES	YES	NO	YES	4	cover holes; clean shelters; add 25 tons gravel	Navy
Oakland Airport	2		Leora Feeney	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
Oceano (Pismo) Dunes	2	3	Anne Marie Tipton	Dan Cordova, Wendy Thomlinson	YES	3	NO	NO	6	NA	NA
Mussel Rock/Guad. Dn	1	4	Paloma Nieto		NO	NO	NO	NO	6		
Vandenberg Beach	2	2 4	Sandra J. Schultz	Thomas E. Applegate	NO	NO	NO	NO	NO	NO	NA
Vandenberg Purisima	2	1	Sandra J. Schultz	Thomas E. Applegate	NO	NO	NO	NO	NO	NO	NA
Santa Clara River	1	Temp	Don Davis	Art Marshall, Jan Lewison, Linda O'Neil, Terry O'Neil, Jane Davis	YES	NO	NO	NO	Yes (Arundo Removal Only)		Ventura Audubon
Hollywood Beach	?	?	Reed Smith		?	?	NO	NO	NO	NO	
Ormond Beach	2	3	Jamie L. Jackson	Morgan and Walter Wehjte	YES	NO	NO	YES	6	Baricades put in at entrance to McWayne property	City of Oxnard
NAWS Point Mugu	no dat	no data	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
Venice Beach	1	2	Mike Taylor	Elisa Graham	YES	YES	NO	YES	4	Sand shoveling	Taylor, Graham
LA Harbor Terminal Isl.	1	2	K. Keane	N. Mudry; W. Ross, N. Liberato	NO	YES	YES	YES	1	YES	POLA
LA Harbor Pier 400	1	1	K. Keane	N. Mudry: W. Ross, N. Liberato	NO	YES	YES	YES	6	YES	POLA

Table 1. California Least Tern Site Preparation and Monitor Information, 1997

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Site Name	Site Type[a]	Fence Type[b]	Name of Primary Monitor	Names of Other Monitors	Inter-pretive signs at site?	Chick shelters?	Decoys?	Grid System?	Vege-tation Manage-ment[c]?	Other Site Preparation?	By Whom?
LA Harbor TC2	1	4	K. Keane	N. Mudry; W. Ross, N. Liberato	NO	NO	NO	NO	6	NO	
Seal Beach	1	1	Michael Mitchell	Pat Collins, Mike Taylor, Sue Hoffman, Jeff Johnson, and	NO	168	NO	YES	4	maintenance and preseason predator management	and contracted predator control specialist - Wally Ross
Bolsa Chica	1	4	Gary Gillis	Jill Frayne, Kathy Keane	NO	15	NO	YES	?		
Huntington Beach	1	2	Doreen Stadtlander	Wally Ross	YES	24	NO	YES	1	new chick barrier fencing installed	State Parks, David Pryor, Wally Ross
Upper Newport Bay	1	4	Mike Taylor, Gary Gillis	none	NO	15	NO	NO	NO	NO	
White Beach	1	no data	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
SM River North Beach	1	no data	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
SM River Salt Flats	1	no data	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
SM River Salt Flats Is.			NO DATA	NO DATA	NO DATA	O DAT	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
Batiquitos Lagoon W-1	1	1	Adam Whelchel	Kathy Keane,John Konecny, Nathan Mudry	YES	16	YES	YES	2	decoys, chick shelters	
Batiquitos Lagoon W-2	1	1	Adam Whelchel		YES	40	YES	YES	6		
Batiquitos Lagoon E-1	1	1	Adam Whelchel		YES	10	NO	YES	6		
Batiquitos Lagoon E-2	1	1	Adam Whelchel		YES	14	YES	YES	6		
Batiquitos Lagoon E-3	1	1	Adam Whelchel		YES	30	YES	YES	2		

Table 1. California Least Tern Site Preparation and Monitor Information, 1997

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Site Name	Site Type[a]	Fence Type[b]	Name of Primary Monitor	Names of Other Monitors	Inter-pretive signs at site?	Chick shelters?	Decoys?	Grid System?	Vege-tation Manage-ment[c]?	Other Site Preparation?	By Whom?
San Elijo Lagoon	1	3	Robert Patton	Teesha Hahn, Karla Solloa	YES	NO	NO	NO	6	a double-strand. smooth wire on T-post fence is maintained, signs posted, and water levels managed	San Diego County Parks and San Elijo Lagoon Consenancy staff and volunteers
Mission Bay FAA Island	1	4	Jennifer Price	none	NO	NO	NO	NO	1	YES, by rototiller. Needs to be more extensive and more selective of vegetation	California Dept of Fish and Game
Mis. Bay Mariner's Pt	1	1	Ginger Johnson	none	Yes	40	No	Yes	2	Keep-out signs visible from water	John Konecny
Mis. Bay N. Fiesta Isl.	1	2	Jennifer Price	none	NO	NO	NO	NO	1	YES, imported sand and irrigation of vegetation.	Citv of San Diego
Naval Training Center	1	no data	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA

Table 1. California Least Tern Site Preparation and Monitor Information, 1997

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Site Name	Site Type[a]	Fence Type[b]	Name of Primary Monitor	Names of Other Monitors	Inter-pretive signs at site?	Chick shelters?	Decoys?	Grid System?	Vege-tation Manage-ment[c]?	Other Site Preparation?	By Whom?
Lindbergh Field	1	3	Robert Patton	Susan Euing, Brian Foster, Elizabeth Copper, Chris Hutcherson, Julie Ayala, Nathan Turnbaugh, Nathan Herzog	NO	NO	NO	YES	4 (2 and 3)	8" plastic mesh fabric chick barrier was erected, storm drains were covered with plastic mesh;a grid system was surveyed & coordinates were painted on the asphalt & on the chick barrier	San Diego Unified Port District and Zoological Society of San Diego personnel
North Island NAS	1	no data	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
Delta Beach North	1	no data	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
Delta Beach South	1	no data	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
NAB Ocean	1	no data	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
Chula Vista WR	1	3	Robert Patton	Susan Euing, Brian Foster, Julie Ayala, Elizabeth Copper	YES	YES	YES	YES	4 (1,2 & 3)	the grid system was surveyed and tiles placed	San Diego Unified Port District and Zoological Society of San Diego personnel

Table 1. California Least Tern Site Preparation and Monitor Information, 1997

page 5 of 5

Site Name	Site Type[a]	Fence Type[b]	Name of Primary Monitor	Names of Other Monitors	Inter-pretive signs at site?	Chick shelters?	Decoys?	Grid System?	Vege-tation Manage-ment[c]?	Other Site Preparation?	By Whom?
D Street Fill	1	3	Robert Patton	Susan Euing, Julie Ayala,Nathan Turnbaugh, Nathan Herzog, Brian Collins, Teesha Hahn, Karla Solloa	YES	YES	YES	YES	1 and 2	the grid system was surveyed and tiles placed, debris and trash removed	USFWS refuge staff, Zoological Society of San Diego staff and volunteers, San Diego Unified Port District staff and Urban Corps
Saltworks	1		Elizabeth Copper	John Konecny, Brian Foster	NO	few tiles	NO	NO	NO	barricade of one dike	Saltworks
Tijuana River	1	3	Robert Patton	Brian Collins, Nathan Turnbaugh, Nathan Herzog, Chris Hutcherson	YES	NO	YES, at south site	NO	6	signs erected and fence repairs prior to season; additional signs and twine barracades placed around nesting areas as needed through the season	USFWS refuge staff

a Type 1 sites: monitors walk through the site, marking and checking nest contents. Type 2 sites: monitors conduct observations from outside the nesting site.

b 1) fence excludes most mammalian predators (e.g., chain link or other fence that fully encloses the site)
2) site fence as for 1 but also cantilevered &/or with barbed wire at the top to exclude cats and other climbing mammals
3) fencing does not exclude most mammalian predators (e.g., not fully fenced on all sites, or fenced only with posted signs and twine).
4) No enclosure whatsoever

c 1) site is mechanically graded or dragged; 2) vegetation is manually removed; 3) herbicide (Roundup or Rodeo) is used;
4) a combination of 1,2, or 3 is used; 5) vegetation is removed by other means; 6) vegetation management is not necessary.

Table 2A. California Least Tern Pairs and Fledglings by Nesting Site, 1997

SITE NAME	1997 Pairs	1996 Pairs	% + or - from 1996	1997 Nests	1997 Fledglings low	1997 Fledglings high	1996 Fledglings	% + or - from 1996	1997 Fledglings per Pair low	1997 Fledglings per Pair high
SAN FRANCISCO BAY										
PGE, Pittsburgh	**4**	4	0	6	**2**	**2**	4	-50	**0.5**	**0.5**
NAS Alameda	**244**	208	17	258	**316**	**316**	233	36	**1.3**	**1.3**
Oakland Airport	**0**	0	0	0	**0**	**0**	0	0	**0**	**0**
SAN LUIS OBISPO/SANTA BARBARA COUNTIES:										
Oceano (Pismo) Dunes	**6**	0	N/A	21	**4**	**4**	0	N/A	**0.67**	**0.67**
Guadalupe/Mussel Rock Dunes	**30**	47	-36	30	**23**	**23**	27.5	-16	**0.77**	**0.77**
Vandenberg AFB - Beach 2	**3**	0	N/A	4	**0**	**0**	0	0	**0**	**0**
Vandenberg AFB - Purisima Pt	**25**	62	-60	39	**0**	**0**	11	-100	**0**	**0**
VENTURA COUNTY:										
Santa Clara River	**43**	28	54	43	**37**	**37**	20	85	**0.86**	**0.86**
Hollywood Beach	**8**	0	N/A	8	**13**	**13**	0	N/A	**1.63**	**1.63**
Ormond Beach	**63**	85	-26	63	**47**	**54**	155	-70	**0.75**	**0.86**
NAWS Point Mugu	**74**	69	7	82	**12**	**20**	?	?	**0.16**	**0.27**
L.A./ORANGE COUNTIES:										
Venice Beach	**375**	271	38	400	**263**	**263**	92	186	**0.70**	**0.70**
L.A. Harbor Terminal Island	**4**	56	-93	4	**0**	**0**	47.5	-100	**0**	**0**
L.A. Harbor Pier 400 (new site)	**73**	N/A	N/A	93	**105**	**105**	N/A	N/A	**1.44**	**1.44**
L.A. Harbor TC2 (new site)	**3**	N/A	N/A	8			N/A	N/A		
Seal Beach	**178**	150	19	188	**53**	**174**	100	-89 to +74	**0.30**	**0.98**
Bolsa Chica	**141**	147	-4	145	**61**	**61**	20	205	**0.43**	**0.43**
Huntington Beach	**373**	300	24	373	**325**	**325**	255	27	**0.87**	**0.87**
Upper Newport Bay	**82**	55	49	82	**25**	**25**	14	79	**0.30**	**0.30**
SAN DIEGO COUNTY:										
White Beach	**17**	38	-55	19	**18**	**18**	7.5	140	**1.06**	**1.06**
SM River North Beach	**728**	557	31	758	**930**	**930**	230	304	**1.28**	**1.28**
SM River - Salt Flats	**41**	83	-4	43	**30**	**30**	6	650	**0.73**	**0.73**
SM River - Salt Flats Is.	**39**			41	**15**	**15**			**0.38**	**0.38**
Batiquitos Lagoon W-1	**83**	39	113	83	**254**	**254**	228	11	**0.94**	**0.94**
Batiquitos Lagoon W-2	**59**	46	28	73						
Batiquitos Lagoon E-1	**25**	37	-32	25						
Batiquitos Lagoon E-2	**0**	0	N/A	7						
Batiquitos Lagoon E-3	**104**	83	25	110						
San Elijo Lagoon	**9**	2	350	9	**5**	**9**	3	67	**0.56**	**1.00**
Mission Bay FAA Island	**20**	188	-89	28	**10**	**10**	2.5	300	**0.50**	**0.50**
Mission Bay Mariner's Point	**268**	250	7	342	**150**	**180**	125	20	**0.56**	**0.67**
Mission Bay North Fiesta Isl.	**76**	11	591	82	**20**	**20**	4.5	344	**0.26**	**0.26**
Naval Training Center	**0**	0	0	0	**0**	**0**	0	0	**0.00**	**0.00**
Lindbergh Field	**102**	63	62	102	**46**	**53**	100	-51	**0.45**	**0.52**
North Island NAS	**22**	49	-55	27	**13**	**13**	22	-41	**0.59**	**0.59**
Delta Beach North	**310**	190	63	349	**300**	**300**	200	50	**0.97**	**0.97**
Delta Beach South	**15**	15	0	25	**10**	**10**	10	0	**0.67**	**0.67**
NAB Ocean	**85**	72	18	91	**45**	**45**	60	-25	**0.53**	**0.53**
Chula Vista Wildlife Refuge	**0**	0	0	0	**0**	**0**	0	0	**0**	**0**
D Street Fill	**38**	25	52	41	**0**	**0**	15	-100	**0**	**0**
Saltworks	**36**	22	64	49	**6**	**8**	2	250	**0.17**	**0.22**
Tijuana River	**211**	137	54	298	**2**	**5**	26	-92	**0.01**	**0.02**
TOTALS	**4017**	3389	19	4449	**3140**	**3322**	2021	55 - 64	**0.78**	**0.83**

Table 2B. California Least Tern Pairs and Fledglings by Region, 1997

REGION	1997 Pairs	% of Statewide Population	1996 Pairs	% + or - from 1996	1997 Fledglings low	1997 Fledglings high	% of Statewide Fledglings	1996 Fledglings	% + or - from 1996
San Francisco Bay	248	6	212	17	318	381	10	237	34
San Luis Obispo/Santa Barbara Counties	64	2	109	-41	27	27	1	39	-44
Ventura County	188	5	182	3	109	124	3 - 4	175	-50
Los Angeles/Orange Counties	1229	31	979	26	832	953	25 - 30	529	69
San Diego County	2288	57	1907	20	1854	1900	56 - 60	1042	80

Table 3A. California Least Tern Pair and Nest Data, 1997

page 1 of 2

Site Name	Date of First Nest	Date of "Second Wave" Start[a]	Total NESTS "First Wave"[a]	Minus Estimated Renesters "First Wave"	TOTAL PAIRS "First Wave"	Total NESTS "Second Wave"	Minus Estimated Renesters "Second Wave"	TOTAL PAIRS "Second Wave"	TOTAL NESTS 1997	TOTAL PAIRS 1997	Date of Last New Nest
PGE, Pittsburgh	20-May	2-Jun	4	0	4	2	2	0	6	4	2-Jun
NAS Alameda	14-May	9-Jun	234	11	223	24	3	21	258	244	4-Jul
Oakland Airport	none	NONE	none	none	none	none	none	none	0	0	none
Oceano (Pismo) Dunes	20-Jun	20-Jun	0	0	0	21	15	6	21	6	10-Jul
Mussel Rock/Guad. Dn	21-May	NONE	30	0	30	0	0	0	30	30	2-Jul
Vandenberg Beach 2	22-May	NONE	2	0	2	2	1	1	4	3	2-Jul
Vandenberg Purisima	22-May	NONE	28	10	18	11	4	7	39	25	6-Jul
Santa Clara River	3-Jun	NONE	43	0	43	0	0	0	43	43	9-Jul
Hollywood Beach	5-Jun	NONE	8	0	8	0	0	0	8	8	12-Jun
Ormond Beach	~ May 17	NONE	63	0	63	0	0	0	63	63	29-Jun
NAWS Point Mugu	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	82	74	NO DATA
Venice Beach	5-May	NONE	391	25	366	9	0	9	400	375	8-Jul
LA Harbor Terminal Isl.	23-May	NONE	4	0	4	0	0	0	4	4	31-May
LA Harbor Pier 400	12-May	14-Jun	70	5	65	23	15	8	93	73	16-Jul
LA Harbor TC2	14-Jun	14-Jun	0	0	0	8	5	3	8	3	4-Aug
Seal Beach	1-May	11-Jun	178	0	178	10	10	0	188	178	18-Jun
Bolsa Chica	3-May	NONE	145	4	141	0	0	0	145	141	25-Jun
Huntington Beach	5-May	17-Jun	341	0	341	32	0	32	373	373	8-Jul
Upper Newport Bay	8-May	NONE	82	0	82	0	0	0	82	82	16-Jun
White Beach	6-May	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	19	17	26-Jun
SM River North Beach	6-May	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	758	728	12-Jul
SM River Salt Flats	15-May	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	43	41	12-Jul
SM River Salt Flats Is.	10-May	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	41	39	6-Jul
Batiquitos Lagoon W-1	10-May	NONE	80	0	80	3	0	3	83	83	21-Jun
Batiquitos Lagoon W-2	10-May	15-Jun	55	0	55	18	14	4	73	59	5-Jul
Batiquitos Lagoon E-1	12-May	NONE	25	0	25	0	0	0	25	25	11-Jun
Batiquitos Lagoon E-2	5-Jul	5-Jul	0	0	0	7	7	0	7	0	2-Jul
Batiquitos Lagoon E-3	12-May	NONE	104	0	104	6	6	0	110	104	25-Jun
San Elijo Lagoon	21-May	NONE	7	0	7	2	0	2	9	9	2-Jul
Mission Bay FAA Island	18-May	1-Jun	26	6	20	2	2	0	28	20	26-Jun
Mis. Bay Mariner's Pt	7-May	9-Jun	282	44	238	60	30	30	342	268	14-Jul
Mis. Bay N. Fiesta Isl.	19-May	14-Jun	76	0	76	6	0	0	82	76	27-Jun

Table 3A. California Least Tern Pair and Nest Data, 1997

Site Name	Date of First Nest	Date of "Second Wave" Start[a]	Total NESTS "First Wave"[a]	Minus Estimated Renesters " First Wave"	TOTAL PAIRS "First Wave"	Total NESTS "Second Wave"	Minus Estimated Renesters "Second Wave"	TOTAL PAIRS "Second Wave"	TOTAL NESTS 1997	TOTAL PAIRS 1997	Date of Last New Nest
Naval Training Center	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	0	none
Lindbergh Field	6-May	NONE	102	0	102	0	NA	0	102	102	10-Jun
North Island NAS	14-May	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	27	22	5-Jul
Delta Beach North	9-May	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	349	310	18-Jul
Delta Beach South	11-May	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	25	15	10-Jul
NAB Ocean	14-May	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	91	85	11-Jul
Chula Vista WR	NONE	NONE	NONE	NONE	NONE	NONE	NONE	0	0	0	NA
D Street Fill	10-May	NONE	38	0	38	3	3	0	41	38	5-Jul
Saltworks	15-May	17-Jun	24	0	24	25	13	12	49	36	10-Jul
Tijuana River	15-May	NONE	216	4	211	82	82	0	298	211	31-Jul
TOTALS			**2658**[b]	109	2548[c]	356[b]	212	138'	4449	4017	

a See text for discussion of "first wave" and "second wave"

b Data do not add up to Total Nests 1997 because data on "first wave" and "second wave " nests were not provided for several sites

c Data do not add up to Total Pairs 1997 because data on "first wave" and "second wave" pairs were not provided for several sites

NOTE: when monitors provided a range, the mean for that range was used and rounded up when necessary

Table 3B. Estimated "First Wave" and "Second Wave" Numbers, 1997

	Total NESTS "First Wave"	Minus Estimated Renesters "First Wave"	TOTAL PAIRS "First Wave"	Total NESTS "Second Wave"	Minus Estimated Renesters "Second Wave"	TOTAL PAIRS "Second Wave"	TOTAL NESTS 1997	TOTAL PAIRS 1997
Totals for All Sites, as Above	2658	109	2548	356	212	138	4419	4017
Totals for Sites with NO DATA for "First Wave" and "Second Wave"	0	0	0	0	0	0	1535	1331
Totals for Sites with Reported Data	2658	109	2548	356	212	138	3014	2686
Proportion of total Nests (3014) for Sites with Reported Data	0.881	0.036	0.818	0.118	0.071	0.046	1.003	0.894
Statewide Estimates using Above Values	3934	161	3771	527	31-i	224	4461	3977[a]

a A 1% discrepancy in the above pair estimates (4017 pairs from data provided by monitors. minus 3977 pairs estimated from reported data on first and second wave pairs = 40 pairs or 1%) suggests that statewide estimates for "first wave" and "second wave" are fairly accurate.

Table 3B. California Least Tern Nest and Pair Estimates for 1994 through 1997

	Total Nests "First Wave"	Total Pairs "First Wave"	"First Wave" Percent of Total Pairs	Total Nests "Second Wave"	Total Pairs "Second Wave"	"Second Wave" Percent of Total Pairs	Total Nests	Total Pairs	Total Nests Per Pair
1997	3934	3771	94	527	204	5	4449	4017	1.11
1996[a]	3096	2973	88	925	388	12	4021	3361	1.20
1995[b]	2362	2198	85	646	400	15	3008	2598	1.16
1994[c]	unknown	2120	76	unknown	672	24	3446	2792	1.23

a From Caffrey 1998. Table 3

b From Caffrey 1997. Table 3

c From Caffrey 1995b. Table 3

Table 4. California Least Tern Productivity Data, 1997

page 1 of 2

Site Name	Total Nests	Total Eggs	Mean Clutch Size[a]	# Eggs Hatched	% Hatching[b]	Fledglings June 16[c]	Fledglings July 7	Fledglings July 28	Fledglings August 18	Total Fledg-lings	Fledgling estimate method[d]	Total Fledg-lings, Other Methods
PGE, Pittsburgh	6	11	1.8	7	63.6	0	1-2	0	0	0	1 count	2
NAS Alameda	258	493	1.9	427	86.6	0	270-280	15	5	0	average min & max estimates	316
Oakland Airport	0	0	0.0	0	0.0	0	0	0	0	0	none	0
Oceano (Pismo) Dunes	21	35	1.7	6	17.1	NA	0	4	0	4	3W	
Mussel Rock/Guad. Dn	30	45	1.5	27	60.0	8	12	3	0	23	3W	
Vandenberg Beach 2	4	7	1.8	0	0.0	0	0	0	not done	0	3W	0
Vandenberg Purisima	39	unknown	unknown	unknown	unknown	0	0	0	not done	0	3W	2
Santa Clara River	43	81	1.9	66	81.5	0	0	11	26	37	Maximum evening roost count	
Hollywood Beach	8	unknown	unknown	unknown	unknown					0	1 count	13
Ormond Beach	63	unknown	unknown	N/A	N/A	0	47	0	0	47	3W	50.5
NAWS Point Mugu	82	unknown	unknown	unknown	unknown						one count	16
Venice Beach	400	667	1.7	610	91.5	45-50	110	60-80	30-40	263	3W	
LA Harbor Terminal Isl.	4	8	2.0	0	0.0	0	0	0	0	0	3W	
LA Harbor Pier 400	93	170	1.8	134	78.8	0	45	45	8	98	3W	
LA Harbor TC2	8	14	1.8	12	85.7	0	0	5	2	7	3W	
Seal Beach	188	361	1.9	213	59.0	22	31	0	0	53	3w	174
Bolsa Chica	145	258	1.8	212	82.2	15	45	1	0	61	3w	
Huntington Beach	373	689	1.8	644	93.5						modified 3W	325
Upper Newport Bay	82	159	1.9	129	81.1	4	16	5	0	25	3W	
White Beach	19	36	1.9	24	66.7						unknown	18
SM River North Beach	758	1423	1.9	1237	86.9						unknown	930
SM River Salt Flats	43	76	1.8	64	84.2						unknown	30
SM River Salt Flats Is.	41	80	2.0	69	86.3						unknown	15
Batiquitos Lagoon W-1	83	161	1.9	145	90.1				NA		3W	
Batiquitos Lagoon W-2	73	135	1.8	122	90.4				NA		3W	
Batiquitos Lagoon E-1	25	49	2.0	48	98.0				NA		3W	254
Batiquitos Lagoon E-2	7	8	1.1	3	37.5				NA		3W	
Batiquitos Lagoon E-3	110	221	2.0	188	85.1				NA		3W	

Table 4. California Least Tern Productivity Data, 1997

page 2 of 2

Site Name	Total Nests	Total Eggs	Mean Clutch Size[a]	# Eggs Hatched	% Hatching[b]	Fledglings June 16[c]	# Fledglings July 7	# Fledglings July 28	# Fledglings August 18	Total Fledg-lings	Fledgling estimate method[d]	Total Fledg-lings, Other Methods
San Elijo Lagoon	9	18	2.0	15	83.3	0	5 to 9	0 to 4	0	9	C	7
Mission Bay FAA Island	28	40	1.4	15	37.5	0	1	8	1	10	3W	10
Mis. Bay Mariner's Pt	342	658	1.9	586	89.1	0	100-150	30	1	0	C	165
Mis. Bay N. Fiesta Isl.	82	155	1.9	141	91.0	0	5	15	0	20	3W	20
Naval Training Center	0	0	0.0	0	0	0	0	0	0	0	none	0
Lindbergh Field	102	197	1.9	141	71.6	0-3	49	1	0	51.5	C	50
North Island NAS	27	45	1.7	30	66.7						unknown	13
Delta Beach North	349	651	1.9	586	90.0						unknown	300
Delta Beach South	25	48	1.9	46	95.8						unknown	10
NAB Ocean	91	179	2.0	160	89.4						unknown	45
Chula Vista WR	0	0	0.0	0	0	0	0	0	0	0	C	0
D Street Fill	41	81	2.0	53	65.4	0	2 to 3	3 to 5	0	6.5	C	7
Saltworks	49	91	1.9	69	75.8	0	4	1	0	0	counts during site visits	7
Tijuana River	298	552	1.9	79	14.3	0	1 to 2	1 to 3	0		C	3.5
TOTAL	**4449**	**7902**	**1.86[e]**	**6308**	**79.8**	**94 - 102**	**740 - 808**	208 - 236	**73 - 83**	**715[f]**		**2770[e]**

(4257 = total nests for sites with reported egg numbers)

a Mean clutch size (number of eggs per nest) is calculated **by** dividing the number of eggs by the number of nests

b Hatching success is calculated by dividing the number of eggs hatched by the total number of eggs

c See test for discussion of fledgling count dates

d 3W = fledgling numbers estimated by adding total counts from censuses every three necks: C = combination of 3 W and recapture data (see test)

e Mean statewide clutch size is the total number of eggs divided by the total number of nests for sites with reported egg numbers (not provided for Type 2 sites)

f Adding these two columns results in higher fledgling numbers than reported in Table 2 because some monitors used two census methods and reported results in both columns

Table 5. California Least Tern Non-Predator Mortality, 1997

page 1 of 2

Site Name	Number of Human-damaged Eggs	Number of Eggs Lost to Flooding	Number of Infertile or Abandoned Eggs	Percent Infertile & Abandoned Eggs[a]	Number of Eggs of Unknown Outcome	Number of Dead Chicks	Number of Dead Fledglings	Number of Dead Adults
PGE, Pittsburgh	0	0	0	0	2	0	0	0
NAS Alameda	0	0	11	0.04	0	16	5	1
Oakland Airport	0	0	0	0	0	0	0	0
Oceano (Pismo) Dunes	0	0	5	0.23	18	0	0	0
Mussel Rock/Guad. Dn	4	0	3	0.07	6	0	0	0
Vandenberg Beach 2	0	0	2	0.29	0	0	0	0
Vandenberg Purisima	0	0	13	unknown	26	1	0	0
Santa Clara River	0	0	6	0.07	12	3	0	0
Hollywood Beach	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown
Ormond Beach	6	0	0	unknown	most eggs	1	0	0
NAWS Point Mugu	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown
Venice Beach	0	0	57	0.09	0	110	8	1
LA Harbor Terminal Isl.	0	0	0	0	0	0	0	0
LA Harbor Pier 400	2	0	9	0.05	0	4	0	0
LA Harbor TC2	0	0	2	0.14	0	0	0	0
Seal Beach	0	0	43	0.12	105	5	3	2
Bolsa Chica	0	2	25	0.10	6	6	0	1
Huntington Beach	0	0	12	0.02	1	13	0	1
Upper Newport Bay	0	0	2	0.01	28	2	0	0
White Beach	0	4	8	0.22	0	1	1	2
SM River North Beach	0	44	86	0.06	0	83	24	3
SM River Salt Flats	0	4	5	0.07	0	0	0	0
SM River Salt Flats Is.	0	0	8	0.10	0	0	0	0
Batiquitos Lagoon W-1	0	0	12	0.07	0	6	0	0
Batiquitos Lagoon W-2	0	0	9	0.07	0	4	2	0
Batiquitos Lagoon E-1	0	0	1	0.02	0	0	0	0
Batiquitos Lagoon E-2	0	0	4	0.50	1	0	0	0
Batiquitos Lagoon E-3	0	0	15	0.07	10	6	2	0
San Elijo Lagoon	0	0	0	0	0	1	0	0
Mission Bay FAA Island	0	0	2	0.05	0	0	0	0
Mis. Bay Mariner's Pt	0	0	69	0.10	235	25	8	0
Mis. Bay N. Fiesta Isl.	0	0	10	0.06	2	2	4	0

Table 5. California Least Tern Non-Predator Mortality, 1997

page 2 of 2

Site Name	Number of Human-damaged Eggs	Number of Eggs Lost to Flooding	Number of Infertile or Abandoned Eggs	Percent Infertile & Abandoned Eggs[a]	Number of Eggs of Unknown Outcome	Number of Dead Chicks	Number of Dead Fledglings	Number of Dead Adults
Naval Training Center	0	0	0	0	0	0	0	0
Lindbergh Field	0	0	21	0.11	15	15	7	1
North Island NAS	0	0	14	0.31	0	1	1	0
Delta Beach North	0	0	60	0.09	0	36	3	2
Delta Beach South	0	0	1	0.02	0	1	0	0
NAB Ocean	0	0	13	0.07	0	3	1	0
Chula Vista WR	0	0	0	0	0	0	0	0
D Street Fill	0	0	7	0.09	11	3	0	0
Saltworks	0	0	1	0.01	11	0	0	0
Tijuana River	8	21	189	0.34	160	13	0	1
TOTALS	**20**	**75**	**725**	**0.09**	**649**	**361**	**69**	**15**

a Total eggs abandoned or infertile divided by the total number of eggs laid (see Table 4)

NOTE: when monitors provided a range, the mean for that range was used and rounded up when necessary

Table 6. California Least Tern Losses to Predators, 1997

page 1 of 7

Predator	Site Name[a]	Suspected or Documented?[a]	Number of Eggs Lost	Number of Chicks Lost	Number of Fledglings Lost	Number of Adults Lost	Predator Management?	Scheduled (SPM) or as needed (ANM) predator management?	Was it Effective?	If not, why?
AMERICAN CROW	Bolsa Chica	D	13				YES	ANM	yes	
	Mussel Rock/Guad. Dn	D	1				NO	NONE	N/A	
	PGE, Pittsburgh	S	4				NO	NONE	N/A	
	Seal Beach	S	10				YES	SPM	yes	
	Terminal Island	D	4				YES	SPM	yes	
	LA Harbor Terminal Island	S	2				YES	SPM	NO	terns abandoned site
	Vandenberg Beach 2	D	2				NO	NONE	NA	
	Vandenberg Purisima	D	8	unknown			YES	ANM	yes	
	Vandenberg Purisima	S	6				YES	ANM	yes	
	Venice Beach	S	Some				YES	ANM	yes	
	TOTAL recorded/reported losses:		**> 50**	**unknown**						
AMERICAN KESTREL	NAS Alameda	D		2	2		YES	SPM	yes	
	D Street Fill	D		3	unknown		YES	both	YES	
	D Street Fill	S	unknown	unknown	unknown		NO	both	NO	
	Huntington Beach	S&D		5	2		YES	SPM	YES	
	Lindbergh Field	D		3	unknown		YES	both	YES	
	Lindbergh Field	S		unknown	2		YES	both	YES	
	Mis. Bay Mariner's Pt	D		4			YES	YES	YES	
	Mis. Bay Mariner's Pt	S&D		50-60			YES	YES	NO	
	Mis. Bay N. Fiesta Isl.	D			1		YES	SPM	NO	Too late!
	Seal Beach	D					YES	SPM	YES	
	Tijuana River	S		unknown	unknown		YES	both	NO	trap-shy
	Venice Beach	D		1			YES	ANM	YES	
	TOTAL recorded/reported losses:		**unknown**	**> 68-78**	**> 7**					

Table 6. California Least Tern Losses to Predators, 1997

page 2 of 7

Predator	Site Name[a]	Suspected or Documented?[a]	Number of Eggs Lost	Number of Chicks Lost	Number of Fledglings Lost	Number of Adults Lost	Predator Management?	Scheduled (SPM) or as needed (ANM) predator management?	Was it Effective?	If not, why?
ANTS	D Street Fill	D		6			YES	ANM	possibly	
	Lindbergh Field	D	2	1			YES	ANM	possibly	difficult to assess; many species
	Mis. Bay Mariner's Pt	D	1				No	ANM	?	
	Tijuana River	S	1	4			YES	ANB	possibly	difficult to assess
	TOTAL recorded/reported losses:		**4**	**11**						
BARN OWL	NAS Alameda	S		4	?		YES	SPM	YES	
	Tijuana River	D	unknown	unknown	unknown	1	YES	both	YES	NA
	Tijuana River	S	unknown	unknown	unknown	unknown	YES	both	YES	
	TOTAL recorded/reported losses:		**unknown**	**> 4**	**unknown**	**> 1**				
BURROWING OWL	Tijuana River	D	26	1	unknown	1	YES	both	YES	NA
	Tijuana River	S	13	unknown	unknown	41-43	YES	both	YES	not all
	TOTAL recorded/reported losses:		**39**	**> 1**	**unknown**	**42-44**				
COMMON RAVEN	D Street Fill	S	unknown	unknown			YES	both	YES	
	Lindbergh Field	D	1	unknown			NO	both	NO	trap-shy
	Lindbergh Field	S	unknown	unknown			NO	both	NO	trap-shy
	San Elijo Lagoon	S	unknown	unknown			NO	NONE	NA	
	Seal Beach	S	5				YES	SPM	YES	
	Tijuana River	S	unknown	unknown			YES	both	NO	trap-shy
	Mis. Bay FAA Island Island	S	unknown				YES	ANM	YES	(or Western Meadowlark)
	TOTAL recorded/reported losses:		**> 6**	**unknown**						

Table 6. California Least Tern Losses to Predators, 1997

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Predator	Site Name[a]	Suspected or Documented?[a]	Number of Eggs Lost	Number of Chicks Lost	Number of Fledglings Lost	Number of Adults Lost	Predator Management?	Scheduled (SPM) or as needed (ANM) predator management?	Was it Effective?	If not, why?
COYOTE	D Street Fill	S	unknown	unknown			YES	both	YES	
	Mussel Rock/Guad.	D	3				NO	NONE	N/A	
	Oceano (Pismo) Dunes	D		1			NO	NONE	N/A	
	Oceano (Pismo) Dunes	D	2				NO	NONE	N/A	
	San Elijo Lagoon	D	1	unknown			NO	NONE	NA	
	San Elijo Lagoon	S	unknown	unknown			NO	NONE	NA	
	Tijuana River	D	6	unknown			YES	both	NO	trap shy
	Tijuana River	S	unknown	unknown			YES	both	NO	trap shy
	Vandenberg Beach 2	D	3				NO	NONE	NA	
	TOTAL recorded/reported losses:		**> 15**	**> 1**						
FERAL DOG OR FERAL CAT	NAS Alameda	S		2	?		YES	SPM	YES	
	Lindbergh Field	S	1 to 3	unknown			YES	both	NO	trap shy
	Saltworks	S	1				WFVZ	ANM	unkNOwn	
	Tijuana River	S	unknown	unknown			YES	both	YES	
	Tijuana River	S	1	unknown			YES	both	NO	trap shy
	TOTAL recorded/reported losses:		**> 5**	**> 2**						
GRAY FOX	Lindbergh Field	S	1 to 3	unknown			YES	both	NO	trap shy
	Saltworks	S					WFVZ	ANM	unknown	
	TOTAL recorded/reported losses:		**1 to 3**	**unknown**						
GREAT BLUE HERON	Batiquitos Lagoon W-2	S		?			YES	YES	NO	No evidence to warrant action
	PGE, Pittsburgh	S		4			NO	NONE	N/A	
	LA Harbor TC2	S		4 to 8			NO	SPM	N/A	too many
	Tijuana River	S	unknown	unknown			NO	both	NO	individuals
	TOTAL recorded/reported losses:		**unknown**	**> 12**						

Table 6. California Least Tern Losses to Predators, 1997

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Predator	Site Name[a]	Suspected or Documented?[a]	Number of Eggs Lost	Number of Chicks Lost	Number of Fledglings Lost	Number of Adults Lost	Predator Management?	Scheduled (SPM) or as needed (ANM) predator management?	Was it Effective?	If not, why?
GREAT HORNED OWL	Vandenberg Purisima	D	4			9	YES	ANM	NO	many owls, one was trapped last year and was trap shy
	Vandenberg Purisima	S		1		4	YES	ANM	NO	see above
	TOTAL recorded/reported losses:		4	1		13				
WESTERN GULL	Mission Bay FAA Island	D	2				YES	ANM	YES	
	Lindbergh Field	S	1	unknown			NO	both	NO	urban setting hinders effective PM
	Mis. Bay Mariner's Pt	D		4			YES	YES	YES	
	Mis. Bay Mariner's Pt	S	50 to 60	10			YES	YES	YES	
	Ormond Beach	S	unknown	unknown	unknown	unknown	NO	NONE	N/A	N/A
	LA Harbor Pier 400	D	18				YES	SPM	NO	> 100 gulls
	LA Harbor Pier 400	S	3				YES	SPM	NO	> 100 gulls
	Saltworks	D	2				unknown	ANM	N/A	
	Tijuana River	S	unknown	unknown			YES	both	YES	
	TOTAL recorded/reported losses:		**> 86**	**> 14**	**unknown**	**unknown**				
LOGGERHEAD SHRIKE	D Street Fill	S		unknown			YES	both	YES	
	Mis. Bay N. Fiesta Isl.	D			1		YES	SPM	NO	
	Seal Beach	D		2			YES	SPM	YES	
	Tijuana River	S		unknown			YES	both	NO	trap shy
	TOTAL recorded/reported losses:			**> 2**	**1**					

Table 6. California Least Tern Losses to Predators, 1997

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Predator	Site Name[a]	Suspected or Documented?[a]	Number of Eggs Lost	Number of Chicks Lost	Number of Fledglings Lost	Number of Adults Lost	Predator Management?	Scheduled (SPM) or as needed (ANM) predator management?	Was it Effective?	If not, why?
NORTHERN HARRIER	NAS Alameda	S	12				YES	SPM	YES	
	NAS Alameda	D			2		YES	SPM	YES	
	D Street Fill	S	unknown	unknown	unknown		NO	both	NO	sensitive sp.
	Mis. Bay N. Fiesta Isl.	S					YES	SPM	YES	
	Ormond Beach	S	unknown	unknown	unknown	unknown	NO	NONE	N/A	N/A
	Seal Beach	D		8			YES	SPM	YES	
	TOTAL recorded/reported losses:		**> 12**	**> 8**	**> 2**	**unknown**				
PEREGRINE FALCON	NAS Alameda	D		1	4		NO	SPM	N/A	
	NAS Alameda	S			1	1	NO	SPM	N/A	
	D Street Fill	S		unknown	unknown	1	NO	both	NO	sensitive sp.
	Lindbergh Field	D		unknown	unknown	2	NO	both	NO	sensitive sp.
	Lindbergh Field	S		unknown	unknown	5	NO	both	NO	sensitive sp.
	Seal Beach	D			4	4	YES	SPM	NO	
	TOTAL recorded/reported losses:			**> 1**	**> 5**	**13**				
RED-TAILED HAWK	Seal Beach	S		2			YES	SPM	YES	
	Batiquitos Lagoon E-1	D		45-48			YES	YES	YES	
	Batiquitos Lagoon E-2	S		?	?		YES	YES	NO	No direct evidence to warrant action
	Batiquitos Lagoon E-3	D		10 to 20?	?		YES	YES	YES	many more than reported
	Batiquitos Lagoon W-2	S		?			YES	YES	NO	No direct evidence but
	Mis. Bay N. Fiesta Isl.	S					YES	SPM	YES	
	TOTAL recorded/reported losses:			**> 70**	**unknown**					

Table 6. California Least Tern Losses to Predators, 1997

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Predator	Site Name[a]	Suspected or Documented?[a]	Number of Eggs Lost	Number of Chicks Lost	Number of Fledglings Lost	Number of Adults Lost	Predator Management?	Scheduled (SPM) or as needed (ANM) predator management	Was it Effective?	If not, why?
OTHER SPECIES:										
Black widow spider	NAS Alameda	D		2			YES	SPM	YES	
Black-bellied plover	D Street Fill	S	2				NO	both	NO	only took aband. eggs
Black-bellied Plover	Tijuana River	S	3				NO	both	NO	only took aband. eggs
Black-crowned night heron	Tijuana River	S	unknown	unknown			NO	both	NO	individuals not ID'd
Brewer's blackbird	Oceano (Pismo) Dunes	D	2				NO	NONE	N/A	
Brewer's blackbird	Oceano (Pismo) Dunes	D	2				NO	NONE	N/A	
Calif. ground squirrel	LA Harbor Terminal Island	S	2				YES	SPM	NO	terns abandoned site
Cooper's hawk	Batiquitos Lagoon W-1	D		1			YES	YES	NO	trapping ineffective
domestic dog	D Street Fill	S	unknown	unknown			YES	both	NO	trap shy
European starling	Seal Beach	D					YES	SPM	NO	
Gull-billed tern	Tijuana River	S	unknown	unknown			NO	both	NO	sensitive status of sp
Raccoon	San Elijo Lagoon	S	unknown	unknown			NO	NONE	NA	
rats	Mis. Bay Mariner's Pt	S	5-10				YES	YES	YES	
	TOTAL recorded/reported losses:		**> 21**	**> 3**						
UNKNOWN PREDATORS	NAS Alameda	S		2		1	NO	SPM	N/A	
	Lindbergh Field	S	unknown	5	1		NO	both	NO	trap shy
	Tijuana River	S	10	unknown		unknown	YES	both	NO	trap shy
	Santa Clara River	S	1				NO	NONE	N/A	
	Tijuana River	S	2	unknown			YES	both	NO	trap shy
	Tijuana River	S	1	unknown			NO	NA	NA	
	TOTAL recorded/reported losses:		**> 14**	**> 7**	**1**	**> 1**				

Table 6. California Least Tern Losses to Predators, 1997

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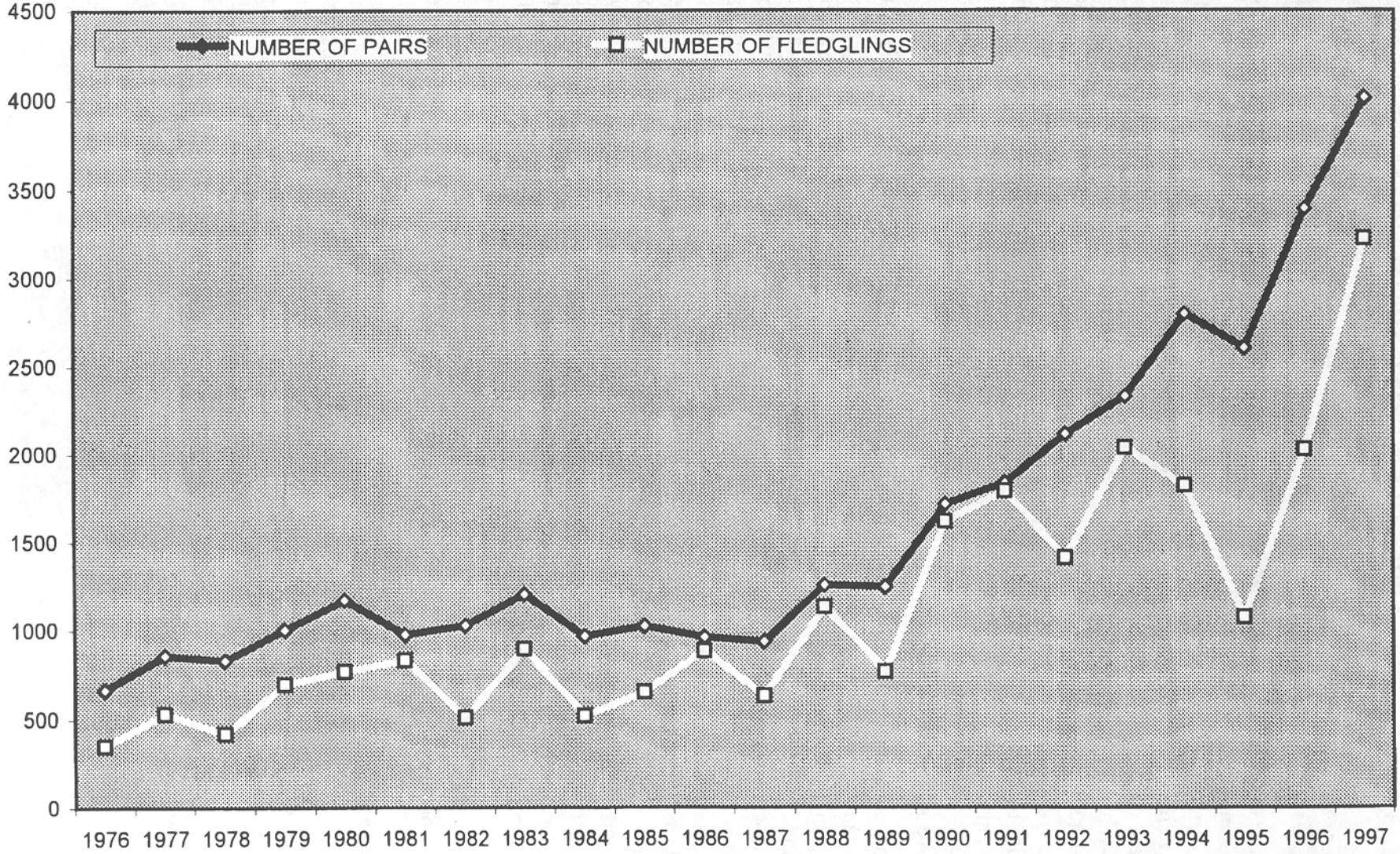
Predator	Site Name	Suspected or Documented?[a]	# of Eggs Lost	# of Chicks Lost	# of Fledglings Lost	# of Adults Lost	Predator Management?	Scheduled (SPM) or as needed (ANM) predator management?	Was it Effective?	If not, why?
OTHER LOSSES NOT REPORTED BY PREDATOR TYPE	NAWS Point Mugu	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	YES	SPM	NO DATA	
	Hollywood Beach	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO	NONE	NO DATA	
	White Beach	NO DATA					YES	SPM	NO DATA	
	SM River North Beach	NO DATA	54	6	13	20	YES	SPM	NO DATA	
	SM River Salt Flats	NO DATA	2				YES	SPM	NO DATA	
	SM River Salt Flats Is.	NO DATA	3			1	YES	SPM	NO DATA	
	Naval Training Center	NO DATA					YES	SPM	NO DATA	
	North Island NAS	NO DATA	1	5	5	2	YES	SPM	NO DATA	
	Delta Beach North	NO DATA	6	23	7	6	YES	SPM	NO DATA	
	Delta Beach South	NO DATA					YES	SPM	NO DATA	
	NAB Ocean	NO DATA	10	1			YES	SPM	NO DATA	
	TOTAL recorded/reported losses:		**76**	**35**	**25**	**29**				
Total recorded/reported losses to all predators:			**EGGS**	**CHICKS**	**FLEDG-LINGS**	**ADULTS**				
			> 334	**> 245**	**> 41**	**> 100**				

a See text for a description of "suspected" and "documented" predators

Figure 2. California Least Tern Pairs and Fledgling Estimates at California Nesting Sites, 1978-1997



APPENDIX A - SITE SUMMARIES

(those provided by monitors)

PGE Pittsburgh

More terns visited the site than was indicated by 4 nesting pairs. There was also an unpaired male present on at least 27 May. There were at least 9 adult terns present on 1 July. The site monitor (Laura Collins) suspected a tenth adult was present was present on 1 July. It appeared that it may have been paired with the ninth adult and/or it was an unpaired male. Laura was confident that there was not a fifth pair involved in the known nesting attempts. There was also a subadult tern (2-year old) present on 1 July and/or it was an unpaired male.

Least terns were first seen at this site on 6 May. However, the appearance of possible least tern guano, between my visits on 22 and 29 April, suggested that tern(s) may have visited the site prior to 29 April. A least tern was last seen at the site on 25 July, after none had been found on 14 July. My last visit was on 1 August.

NAS Alameda

Losses of terns provided in predator information were either observed or evidenced by tern remains except where the notation of "missg" (missing) was used. It should be noted, as usual, especially with the results of a year like 1997, some non-predator losses may have actually been an indirect result of the pressure from the presence of predators such as peregrine falcon and barn owl. Also, some observations from this and past years have shown that there may be occasions when a predator foraging attempt could result in the death of a tern without leaving clear signs of the depredation attempt on the body.

There were 4 peregrine falcons seen in 1997. The site monitor, Laura Collins, suspected least tern nesting was initially delayed due to peregrine falcon "A" (see predator table) and/or the others. The barn owl that was removed had clearly become focused on the tern colony. Observations left no doubt that it had been successful in foraging for terns, even though those observations did not include actual observed depredations or tern remains that were particularly suspect as attributable to it. The last few tern chicks and vulnerable fledglings were allowed to escape their nesting enclosure at the end of July. Due to various factors, there was no other reasonable way to give them a better chance of avoiding the various predators that were encroaching upon the site. The terns all emigrated from the enclosure to an outlying area.

Oceano (Pismo) Dunes

Last year Oceano Dunes SW did not have any Least Tern nests. This year, 21 nest attempts were documented. Earlier in the year Vandenberg Air Force base had a rocket launch that scared away 18 pairs. Possibly nests at Oceano are a result of this occurrence. As in years past, a large exclosure to keep out vehicles was constructed at the southern end of the riding area. Eight nests were set up inside this exclosure. A coyote was seen traipsing through this exclosure, therefore twelve of the eighteen eggs, with unknown fates may have been predated. None of these had visible tracks near them, but the strong winds may have destroyed the evidence.

Vandenberg Purisima Point and Beach 2

Site preparation at Purisima Point involved activating electric fences. As in 1996, no decoys or chick shelters were used at either site, due to concerns that they would attract the attention of predators. Purisima was, as usual, the site with the highest number of birds, with Beach 2 also supporting a few pairs this year. Monitoring at Purisima was conducted three days per week, as usual. The "modified Type 2" approach initiated in 1996 was continued, with a minimal number of entries made into the colony to identify and monitor nests and document predation. Bi-weekly coordination meetings between the least tern monitor, USDA-ADC, USFWS, and VAFB ensured that monitoring and predator control activities entailed minimum intrusion into the colony. The highest adult tern population observed at Purisima was 50 on May 4, followed by a significant decline subsequent to a Delta II launch on May 5. It is believed that birds remaining after the launch disturbance were supplemented by birds returning later. However, the highest number of least terns observed subsequent to the launch was 44; this is significantly less than the 1996 high count of 100 birds. Overall, an estimated nesting population of 25-30 pairs produced 2 fledglings at Purisima Point, compared to 11 chicks fledged in 1996.

At Beach 2, 3 pairs produced 4 nests and no fledglings. Predator monitoring and control was conducted as in prior years, emphasizing non-lethal control measures. Successful measures implemented included use of gull and crow carcasses to deter predation by these species; and live-capture and holding of four great homed owls and one barn owl. The four great homed owls were radio-tagged before release and will be monitored through the next nesting season. Great homed owls were documented as predators on 13 adult terns; great homed owls, American crows and coyote (at Beach 2) were documented nest predators.

Other significant events included a 9 July Delta II launch, which appeared to cause failure of 5 nests due to short-term or permanent abandonment. Up to 3 launches during the nesting season presently are allowed under a USFWS Biological Opinion; options for reducing and/or offsetting future launch impacts are currently under discussion at VAFB. Vandenberg received year-end funding to support a predator study, to be conducted through the Santa Cruz Predatory Bird Research Group. Species to be emphasized in the study include great homed owls, barn owls, coyotes, crows, and great-blue herons. The feasibility of an aversion study, conducted in least tern nesting habitat before the onset of tern/plover season, is also being considered. A secondary purpose of the SCPBRG project is to increase trapping capabilities. ADC, despite their best efforts, are only minimally equipped for live-trapping raptors; in 1997, this exacerbated the great homed owl predation problem, as it took considerable time to trap all the owls.

At Purisima Point, there were no obvious first and second waves. A nest incubated beyond 24 days on Beach 2 was abandoned at the time the chicks were hatching. They did not hatch, but were partially out. There was quite a bit of predation this year, but (as in the 2 previous years), monitors did not attempt to quantify renesting.

Santa Clara River Mouth

(Excellent full-color graphs showing chronology for each nest and nesting sites provided by Don Davis. Also, excellent photos of adult and chick, depredated egg and nesting sites, as well as site maps showing nest locations for each site - Santa Clara River and McGrath Lake.) Don states of the depredated egg photo: "The suspected predation of nest 2 is based upon the discovery of one egg with a bill-shaped crush on the sand approximately 20 meters west of the nest. The discovery was coincident with the disappearance of one egg from nest 2 with no

evidence of hatching (no shell fragments, etc.)." He adds that accurate counts of downy young (<7-day chicks) and runners (>7 days but not fledged) are more difficult (and the data less certain) at McGrath Lake than at the Santa Clara site. McGrath Lake is unfenced and has an abundance of beach debris and plant cover serving as hiding places.

Ormond Beach

April:At the beginning of the season the site monitor, Jamie Jackson, noted that the estuary water level was much lower than it had been the previous year. Jamie was not sure what effect this would have on breeding success.
May: The estuary has been fluctuating between empty and half-full. Jamie had seen adult terns doing their typical fishing dives but did not documented any successful catches. There are quite a few other species of birds at the location, which leads her to believe that there is some form of food in the estuary. She is considering seining the small pond in June.
June: Nesting has been occurring in full force. Terns have been observed with plenty of the appropriate sized fish in their beaks. The site is experiencing an unusually high amount of human disturbance, definitely more than last season at this same time.
July: Something occurred in the second week of July to cause the complete abandonment of the site. Jamie spoke to Kathy Keane as well as Morgan and Walter Wehtje to gain some insight into the events that may have caused the birds to abandon the site. Predator disturbance seems to be the most likely cause for this abandonment.

Los Angeles Harbor - Terminal Island

Site used for tern nesting in previous years supported only four nests; all eggs were removed by predators, and terns abandoned the site by early June. Very bright night-time lighting from the newly operational container terminal adjacent to the site may have contributed to site abandonment, although low hatching success and nest attendance in 1996 suggests that other factors may have also affected 1997 nesting here. Fortunately, the Port of Los Angeles had created an alternate nesting site at Pier 400, discussed below.

Los Angeles Harbor - Pier 400

Newly created lo-acre site in Los Angeles Harbor on site currently being created with dredged material from the harbor. Terns nested throughout the fill area; only a few nests were initiated in the designated 10-acre nesting site.

Los Angeles Harbor - TC2

A new, unprepared site on the Pier 400 transportation corridor under construction; good substrate but little cover. Terns initiated nesting here in mid-June; most were assumed to be renesting pairs that lost first nests to gull predation at Pier 400. For all 3 L.A. Harbor sites, estimated pair numbers exceeded those at the Los Angeles Harbor since 1986, and numbers of fledglings (105) exceeded fledgling estimates here since 1984. Reproductive success values of 1.0 fledglings per nest and 1.31 fledglings per pair exceeded those for all years since Least Tern nesting success has been regularly monitored in the Los Angeles Harbor.

Bolsa Chica

Two American kestrels were also removed from the area as a preventative measure before chicks began hatching. In addition, skimmers arrived on the island in early June and began initiating nests on June 10, and continued nesting through the summer. For next year, it should be decided what needs to be done about this before it occurs [as the skimmers sometimes cause disturbance to nesting terns and occupy nest sites terns may otherwise use].

Huntington Beach

This was a very successful nesting season despite the occurrence of kestrel, which primarily showed up towards the end of the season when most birds had fledged. Kestrels are most likely responsible for colony dispersal. Wally Ross trapped/removed 6 kestrels from the site between 18 and 22 July.

Upper Newport Bay

Gary Gillis observed the island from outside the colony, and Mike Taylor actually went onto the island to count eggs etc. Data are from combined observations by both.

Batiquitos - all sites

The documented presence and observed predation on Least Terns by red-tailed hawks at both the E-l and E-3 and the few sightings or recaptures of chicks at W-2 suggests that predation took a heavy toll at these sites. However, fledgling counts were high, likely due to the presence of fledglings from the Santa Margarita River sites; color-banded fledglings from these sites have been seen roosting on W-2. However, observing bands during dusk counts is difficult. Simultaneous fledgling counts with Santa Margarita River sites are recommended in the future; they were not possible to coordinate in 1997.

San Elijo Lagoon

Prior to the terns' arrival, County of San Diego Parks Department staff posted signs, maintained the fence, and managed water levels in the east basin of the lagoon. Monitoring was conducted April through August one to two days per week. Least terns were observed throughout the lagoon from 23 April through 13 September, with courting and nesting activity at the saltpanne adjacent to the east basin flood control dike at least 21 May through 16 July. At least nine pairs established nine nests with 18 eggs (average clutch size 2.0 eggs per nest). An estimated 83 percent of the eggs hatched (15 eggs from 7 nests), only one active nest was depredated, one egg failed to hatch after 35 days incubation, and one chick died while hatching. At least one adult was depredated but the species responsible could not be determined. Lack of recapture, chick and fledgling count results, and tracks and observations of potential predators on-site indicated that up to six chicks were depredated, but five to nine young are estimated to have fledged from the colony this season. Eggshell fragments and coyote tracks found at the last nest indicated depredation. Regular sightings of ravens and fresh tracks of coyote and raccoon make them the most likely responsible predator for the loss of up to six chicks. Domestic dogs, great blue herons, black-crowned night-herons, red-tailed hawks, and common crows were also observed in the vicinity of the colony.

Mariner's Point

X-Games held nearby were a concern, but the games sponsor, ESPN, was required to provide an on-site monitor throughout the games. No adverse effects on breeding success were noted.

North Fiesta Island

A kestrel was observed actively foraging in the colony just prior to the hatching period; however, it was not pursued until it was actually observed taking a fledgling. By this time the colony was severely diminished.

Lindbergh Field

Prior to the terns' arrival, San Diego Unified Port District personnel applied herbicide, manually removed vegetation, constructed plastic mesh covers over storm drains, and erected 8" tall plastic mesh chick barriers to enclose ovals between operational roadways and taxiways of the southeast airfield. Port District and Zoological Society of San Diego personnel established a 30 m grid system in the oval most frequently used in the past for nesting. Monitoring was conducted April through August one to two days per week.

California least terns were observed from 22 April through 24 July. Terns established 102 nests with 197 eggs (average clutch size 1.93 eggs per nest). An estimated 72 percent of the eggs hatched (141 eggs from 78 to 85 nests). Three active nests were documented with egg predation, one egg was found cracked with no evidence as to the cause, and 36 eggs from 28 nests were abandoned and/or nonviable. The fate of 15 eggs was uncertain, but age of nests and lack of hatching or chick presence makes predation most likely. Fifteen chicks, one fledgling, and one adult were found dead with no apparent signs of trauma. Five fledglings were apparently killed and one injured by aircraft after moving from the colony site to roost on operational taxiways. Predation was documented for 9 chicks, 4 fledglings, and 7 adults, but 52 additional chicks and up to 9 fledglings are estimated to have been depredated. From 46 to 53 young are estimated to have fledged from the colony this season.
American kestrels were observed taking at least 3 chicks, and kestrels are suspected of predation of at least two fledglings and the majority of other chick losses. Peregrine falcons were observed taking an adult least tern, injuries on another carcass indicated predation by a peregrine as well, and peregrines are suspected of preying on at least 5 other adults. A western gull is suspected of preying on at least one egg and a common raven took at least one previously abandoned egg. At least one chick and two eggs were depredated by ants; tracks of a cat and gray fox coincided with depredation of one egg, disappearance of two others, and loss of 5 previously abandoned eggs.

Chula Vista Wildlife Refuge

Prior to the terns' arrival, San Diego Unified Port District staff mechanically dragged and graded the site. Zoological Society of San Diego staff applied herbicide and pruned back vegetation, surveyed the grid system, and placed ceramic tiles for chick shelters. Monitoring was conducted April through July one to two days per week. California least terns were observed from 29 April through 29 July, but on only ten occasions (45% of the monitoring visits). A maximum of seven was observed loafing and foraging on the mudflats east of the prepared site on 1 May. Though observed flying over and in aerial courtship, no least terns were seen landing on the site.

The lack of nesting may have been influenced by vegetation or substrate color, compaction, and coarseness; but predator presence was the most evident detriment. At least one domestic dog was found to be residing in upland scrub adjacent to the prepared site. It was suspected of depredating at least one killdeer nest and was removed. A common raven was observed removing another killdeer egg and was observed over or adjacent to the site on several dates. A peregrine falcon was recorded regularly roosting on structures at the east end of the site and preying on larger terns and shorebirds at the Saltworks just south of the site. Northern harriers, osprey, and gull-billed terns were recorded regularly over or adjacent to the site, and large owl pellets were found on two occasions. Two pairs of western gulls nested along the shoreline of the southwest end of the site and were observed in the site regularly.

D Street Fill

Prior to the terns' arrival, USFWS refuge staff mechanically graded the site and were joined by Zoological Society of San Diego staff and volunteers in pruning back vegetation, surveying the grid system, and placing ceramic tiles for chick shelters. San Diego Unified Port District and Urban Corps personnel cleared trash and debris from the perimeter of the site. Monitoring was conducted April through August one to two days per week. California least terns were observed from 17 April through 12 August. At least 38 pairs established 41 nests with 81 eggs (average clutch size 1.98 eggs per nest). At least 65 percent of the eggs hatched (53 to 61 eggs from 25 to 32 nests), only one active nest was depredated, and 8 eggs from 5 nests were abandoned and/or nonviable. The fate of 11 eggs from 7 nests was uncertain, but age of nests and lack of hatching or chick presence makes predation most likely. Three chicks were found dead with no apparent signs of trauma. Predation was documented for 9 chicks and one adult, but an additional 33 to 35 young are estimated to have been preyed on. Only 6 to 8 young are estimated to have fledged from the colony this season.

At least 3 chicks were observed being preyed on by American kestrels, which are suspected of the depredation of two snowy plover fledglings and the majority of other least tern chick losses. At least 6 chicks were preyed on by ants and remains of one adult indicate perdation by peregrine falcon. Domestic dogs, a coyote, northern harriers, common ravens, and loggerhead shrikes were observed within the nesting area and are suspected of taking chicks and/or eggs as well. Black-bellied plovers apparently opportunistically scavenged at least one abandoned nest, and the egg in another appeared to have been punctured by a western meadowlark.

Tijuana River Estuary

USFWS refuge staff repaired fencing and posted signs prior to the terns' arrival. Additional signs were posted as needed once nesting was underway. Monitoring was conducted April through August one to two days per week. California least terns were observed from 19 April through 8 September. At least 211 to 213 pairs established 298 nests: 259 in the "south site" on beach southeast of the mouth of Tijuana River, 12 on beach north of the river mouth, and 27 at the "north site" south of Seacoast Drive. Average clutch size was only 1.85 eggs per nest, with a total of 552 eggs.

Only 14 to 23 percent of the eggs hatched (79 to 127 eggs from 47 to 83 nests), at least 62 eggs from 41 nests were depredated, 10 eggs from 7 nests were found with damage attributable to either predators or human activity, 8 eggs from 5 nests were destroyed by human activity, 21 eggs from 11 nests were lost to high tides, and 189 eggs from 118 nests were abandoned. The

fate of 130 eggs from 80 nests was uncertain, but age of nests and lack of hatching or chick presence makes predation most likely. Eggs of at least 15 nests were depredated when the adult was depredated at the nest, and at least 26 nests were abandoned following depredation of an adult at the nest. Additional eggs from at least 18 nests were depredated following their abandonment. Ten chicks and one adult were found dead with no apparent signs of trauma, and 5 chicks died while hatching. Predation was documented for 5 chicks and 79 to 82 adults, but an additional 59 to 110 young are estimated to have been preyed on. Only 2 to 5 young are estimated to have fledged from the colony this season.

At least 26 eggs, one chick, and 37 to 38 adult least terns were documented as having been preyed on by burrowing owls. An additional 13 eggs and 41 to 43 adults were suspected of having been depredated by burrowing owls. Burrowing owl predation elsewhere and in previous seasons has been controlled sooner after its initial detection, but the predation inflicted at this colony this season is unprecedented, with up to 18 percent (78 to 81 of 422 to 426) of the colony's breeding adults being removed from the population. Tracks were still being found in the south site after its abandonment by the terns.

At least one egg was apparently preyed on by a rodent, one by a cat or gray fox, and six by a coyote. Barn owls preyed on at least one adult and two eggs were found depredated, but cause could only be identified as avian. Four chicks and one previously abandoned egg were found being consumed by ants. Ten depredated eggs were found but the responsible species could not be ascertained. Each of the above-mentioned species documented as responsible for predation this season is also suspected of additional predation. Feral dogs, a great blue heron, black-crowned night-heron, western gulls, gull-billed terns, American kestrels, and loggerhead shrikes were observed within the nesting area and are suspected of taking chicks and/or eggs as well. Black-bellied plovers apparently opportunistically preyed on the last remaining eggs.