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CALIFORNIA LEAST TERN BREEDING SURVEY

1998 SEASON

by
Kathy Keane

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CALIFORNIA LEAST TERN BREEDING SURVEY, 1998 SEASON [1]

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ABSTRACT

An estimated 4,141 to 4,182 pairs of California least terns nested at 39 nesting sites in 1998 and produced an estimated 2,686 to 2,810 fledglings. Statewide pair estimates increased 3.9%, but fledgling estimates decreased by 14.6% from 1997 estimates, likely due to high chick mortality at many sites. Seven sites (NAS Alameda, NAWS Point Mugu, Venice Beach, Huntington Beach, Santa Margarita River North Beach, Mariner's Point, and Delta Beach North) supported a combined total of 65% of statewide pairs and produced 66% of the state's fledglings in 1998. Fledglings per pair were 0.64 to 0.68, lower than 1997 (0.80).

One of the more interesting findings of 1998 was a report of a nesting pair on evaporation pond dikes near Kettleman City in the San Joaquin Valley. Both eggs hatched and one chick apparently fledged.

It is likely that monitors continue to underestimate renesting, as reported pair estimates are only 378 lower than statewide nest numbers of 4,541, despite 64 eggs lost to flooding, 900 observed dead chicks and minimum losses to predators of 147 eggs and 165 chicks. Another method of estimating pairs was requested and attempted by some monitors in 1998, based upon the number of renesters that a given site may generate, rather than the number of renesting pairs at that site. This estimate was 3,483 pairs, or 84% of estimates derived by the traditional method. Statewide mean clutch size was 1.66 eggs per nest, lower than for the previous three years, suggesting limitations in prey availability, as reported by several monitors. However, statewide mean hatching success was 0.80, similar to the previous two years.

After a 54% increase in pairs and a 200% increase in fledglings between 1995 and 1997, pair numbers increased only 3.8% and fledgling numbers decreased by 14% from 1997. This is likely related to limitations in prey availability during 1998, as evidenced by high chick mortality, poor nest attendance, abnormal chick feeding and kleptoparasitism.

[1] Keane, K. 2000. California least tern breeding survey, 1998 season. Calif. Dep. Fish and Game, Habitat Conservation and Planning Branch Report, 2000-01. Sacramento, CA 43 pp.

INTRODUCTION

The California least tern *(Sterna antillarum browni)* is one of three subspecies of least tern that breed 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 by 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 Orange 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 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 signing 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 the Site Summary Appendix, 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 the 1890s "from Santa Monica southward, afford excellent breeding grounds for numberless birds of this species." By 1943, "breeding stations [are] few and sparsely populated, 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 1997 are summarized in annual reports compiled by the CDFG.

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 to all monitors in spring 1998.

Along with the monitoring packet, 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.

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 1998. 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; Naval Air Weapons Station (NAWS) Point Mugu; Batiquitos Lagoon; San Diego County sites administered by the US. Navy (White Beach, Santa Margarita River sites, Naval Training Center, North Island NAS, Delta Beach North and South, and Naval Amphibious Base [NAB]- Ocean), by the City of San Diego (Mariner's Point, North Fiesta Island), the Port of San Diego (Lindbergh Field, D Street Fill) and USFWS Refuges (Tijuana Wildlife Refuge and Chula Vista Wildlife Refuge). 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 1998 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.

In the 1998 monitoring packet, monitors were also asked to estimate total pairs using a new method discussed in the recommendations section of the 1997 report (Keane 1998). This method uses the number of renesting pairs that a given site may generate, rather the number of pairs renesting at that site. For example, monitors subtract all losses of entire clutches and broods (the latter, of course, being more difficult to estimate) 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 are only counted when they renest. This method for pair estimation may not be more accurate for a given site (since unsuccessful pairs may renest elsewhere) but may yield a more accurate estimate of pairs statewide. This method also avoids estimating “first wave” and “second wave” pairs (see below).

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 at sites other than their natal nesting site, particularly after departing from nesting areas, (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, monitors were encouraged to communicate with monitors of nearby sites to coordinate simultaneous fledgling counts on or near June 16, July 7, July 28, and August 18 to minimize double-counting.

In 1998, monitors were also requested to use a new method for estimating fledglings, based upon the ratio of fledglings to adults during each count. Adults as well as fledglings would be counted during dusk censuses[4], and the ratio of fledglings to adults for each is averaged for the season and used with the estimate of total pairs, multiplied by 2 (to get total adult individuals), to derive an estimate of total fledglings for the season. For example, if fledgling

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

[4] 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 that have not yet produced fledglings are roosting with their mates rather than among the flocks of censused fledglings.

numbers averaged 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 be 200 times 0.5, or 100. However, because most monitors did not attempt to use this method, fledgling estimates derived from this method are not provided in this report.

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 13 and potential threats to reproductive success observed by that date. The mid-season report table was submitted in early July to CDFG and to all monitors by mail or e-mail. Monitors from most 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 unclear in monitoring reports of past years. Caffrey (1997) 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, which birds from separate nesting sites may use for roosting and foraging. 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, although site names remain the same as those used for "colonies" in monitoring reports prior to the 1998 season.

Monitors generally report data separately for non-contiguous nesting sites. At the following sites, however, monitors combined data and reported it as for one nesting site in 1998:

- Tijuana River includes data for sites north and south of the river, reported separately in previous years but combined in 1997 & 1998;
- Ormond Beach includes data for Perkins and Edison sites, combined in 1997 and 1998.

Nesting sites used in 1998 but not in 1997 include:

- The dike of an evaporation pond near Kettleman City in California's Central Valley;
- A new nesting island created at Point Mugu;
- South Shores in Mission Bay, not used previously;
- Chula Vista Wildlife Refuge, which has not been used since 1993.

Nesting sites used in previous years but not used in 1998 include:

- Vandenberg Beach 2;
- Port of Los Angeles Pier 300, no longer available for nesting per an interagency agreement;
- Hollywood Beach in Ventura, where the first known least tern use was reported in 1997;
- Naval Training Center, not used since the 1995 nesting season.

RESULTS AND DISCUSSION

Distribution and Productivity by Region

An estimated 4,141 to 4,182 pairs of California least terns nested at 39 nesting sites (Figure 1 on page 23) along the coast of California in 1998 and produced an estimated 2,686 to 2,810 fledglings fledglings (Table 2A). Statewide pair estimates increased 3.9% from 1997 estimates, but fledgling estimates decreased by 14.6% over 1997 fledgling estimates (Table 2A), likely due to high predator pressure and high chick mortality at many sites. Seven sites (NAS Alameda, NAWS Point Mugu, 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 the total statewide nesting population. Combined, these sites supported 65% of statewide pairs and produced 66% of the state's fledglings in 1998. Fledglings per pair (0.64 to 0.68) were lower than 1997 (0.80) (Keane 1998). Summaries that discuss nest site preparation, reproductive success and/or predator information during 1998 were provided by some monitors for their nesting sites and are included in the Appendix (page 15).

A most interesting finding of the 1998 least tern nesting season was the report of a nesting pair near Kettleman City in California's Central Valley, over 50 miles from the coast. This is in the Tulare Lake Bed, former location of the largest freshwater wetland in California. According to Jeff Seay of H.T. Harvey Associates in Fresno, the nest was located on the dike of an evaporation pond and successfully fledged one young. He also reported sightings of foraging least terns at Lemoore Naval Air Station in both 1997 and 1998 but no nesting.

The two nesting sites in the San Francisco Bay region, primarily NAS Alameda, supported 6% of statewide pairs and produced approximately 4% of statewide fledglings. Pair estimates in the San Francisco Bay region changed little (a 2.4% decrease) from 1997 numbers, although fledgling estimates in 1998 were 69% lower than in 1997 (Table 2B), largely due to an apparent shortage of least tern prey (see the Site Summary Appendix).

The San Luis Obispo/Santa Barbara region (four nesting sites in 1997 but only three in 1998) supported only 1% of the state's nesting pairs and fledglings in 1998, although estimates increased for both pairs (9.4%) and fledglings (44%) from 1997 numbers (Table 2B). The three Ventura County sites supported only 5% in 1997 but 10% in 1998 of the statewide nesting population. A substantial increase in pair estimates at NAWS Point Mugu and a small increase at Ormond Beach resulted in a 112.8% increase for the region over 1997 pair estimates. Fledgling estimates at NAWS Point Mugu increased over 1997 estimates by over 900%, resulting in a 133% increase for the region over 1997 fledgling estimates (Table 2B).

The seven Los Angeles/Orange County nesting sites supported 29% of both pairs and fledglings for the state, slight decreases (2.1% in pairs and 11% in fledglings) from 1997 estimates. Fledgling estimates decreased from 1997 estimates for all Los Angeles/Orange County nesting sites except Los Angeles Harbor and Bolsa Chica (Table 2A and 2B).

The 23 nesting sites in San Diego County (59% of the state's 39 sites) harbored 54% of statewide least tern pairs and generated approximately 59% of statewide fledglings in 1998. Pair estimates in San Diego decreased only slightly (by 1.8%) from 1997, although fledgling estimates in 1998 reflected a 16% decrease from 1997 values (Table 2B).

Chronology; Pair and Nest Numbers

The earliest nests for the 1998 season were reported at NAWS Point Mugu, Delta Beach North, NAB Ocean and SM River North Beach, and the latest nests were located at Mission Bay Mariner's Point and Venice Beach (Table 3A).

Data on "first wave" and "second wave" nests and pairs were not provided for many sites (Table 3A). However, whether or not monitors derived nesting pair numbers by estimating first wave and second wave nests and subtracting renesters (Table3A) or by other methods, it is apparent, as in previous years, that monitors are substantially underestimating renesting pairs and thus overestimating pairs for their site. Statewide nesting pair estimates of 4,163 (Table 3A) are only 378 lower than statewide nest numbers of 4,541, despite reports of 64 eggs lost to flooding, 900 observed dead chicks, among other mortality or losses (Table 5) and minimum losses of 147 eggs and 165 to predators (Table 6).

In an attempt to minimize the problem of overestimating pairs, a new method was requested of monitors in 1998, using the number of renesting pairs that a given site may generate, rather the number of pairs renesting at that site. For sites with no data reported for this new method, pair estimates were derived using the average ratio of pair numbers estimated via the new method (Table 3B) to pair numbers via the old method (Table 3A), calculated from provided data; this ratio was 0.84:1. Statewide pair estimates using the new method are 3,483 (Table 3B), or 84% of those using the old method (4,163; Table 3A), although it is likely this is still an overestimate, given the reported mortality in Tables 5 and 6.

Clutch Size and Hatching Success

Table 4 summarizes productivity statewide and for each nesting site. A total of 4,541 nests were reported statewide, and 6,980 eggs were found in nests with sites reporting clutch sizes. Mean clutch size for the season was 1.66 eggs per nest, lower than 1997 (1.86), 1996 (1.89) and 1995 (1.71) (Keane 1998; Caffrey 1997 and 1998). White Beach and NAWS Point Mugu reported the lowest clutch sizes in 1998; and aside from sites with very small nest numbers, the highest clutch sizes were reported for NAS Alameda, Vandenberg AFB, LA Harbor TC2, and Batiquitos Lagoon W-l and E-2 (Table 4).

Statewide mean hatching success (number of eggs hatched divided by the total number of eggs) was 0.80, similar to 1997 (0.798) and 1996 (0.81), but higher than 1995 (0.76) (Keane 1998; Caffrey 1997 and 1998). Venice Beach, L.A. Harbor Pier 400 and Delta Beach North had the highest hatching success in 1998, while the lowest hatching success, due to predation (see Table 6), was reported for Batiquitos Lagoon W-l and Saltworks. Mussel Rock (Guadalupe) Dunes had no hatching success (Table 4). Table 4 also summarizes data from fledgling counts, although because some monitors used a range, statewide fledgling values (2,686 to 2,810) are presented in Table 2A.

Causes of Reproductive Failure

Table 5 summarizes reported causes of reproductive failure other than predators. A total of six to eight eggs statewide were reported lost to vandalism or trespassing by humans. Indirect effects of human disturbance (i.e., egg or chick abandonment) are not included in this total. A total of 64 eggs from seven sites were reported lost to flooding (Table 5).

Total abandoned or infertile eggs (including those that never hatched and were incubated beyond expected hatching dates) reported for the state were 731, or approximately 10 percent of all eggs statewide. Mission Bay sites (FAA, North Fiesta and South Shores) had, by far, the highest percentages of abandoned/infertile eggs, likely due to high levels of predation (Table 5).

A total of 900 non-predator-related chick deaths were recorded statewide in 1998 (Table 5). Quantitative statewide data on chick mortalities are unavailable for 1995 and 1996 (Caffrey 1997 and 1998), but only 361 chick mortalities were reported for 1997. Several monitors reported evidence of food shortages[5] in 1998, as further described in the Appendix. Dead chick numbers

[5] 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.

represented approximately 16% of the 5,617 eggs hatched for the season; fledgling losses (23 individuals) represent less than 1% of total eggs hatched. Twenty-three adult deaths were also reported statewide in 1998 (Table 5). Presumed causes of mortality were not requested in 1998; however, when site summaries (Appendix) were provided, some monitors reported signs of prey shortages.

Table 6 summarizes reported losses to predation by documented and suspected predators (see Methods). Total reported statewide losses to predators in 1998 included 179 eggs, 141 chicks, 20 fledglings and 43 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." In addition, no data on predator losses were received from several monitors. The highest egg losses in 1998 were attributed to gull species, and unreported predators. Chick losses to American kestrels were higher than for other reported predators. More adults were lost at Santa Margarita River North Beach in 1998 by unreported predators than any other site (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. Reported losses in 1998 are lower than in 1997, when an minimum of 334 eggs, 245 chicks, 41 fledglings and 100 adults were reported lost to predators (Keane 1998).

Comparisons with Previous Years

Figure 2 (page 24) summarizes increases and decreases in least tern pairs and fledglings since 1976. After a 54% increase in least tern pairs and a 200% increase in fledglings between 1995 and 1997, pair numbers only increased 3.8% and fledgling numbers decreased by 14% from 1997. The minimal increase in pairs and the decrease in fledglings is likely related to limitations in prey availability, as evidenced by high chick mortality and abnormal chick feeding (see the Appendix).

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 monitoring recommendations included in the 1997 report (Keane 1998) are reiterated here. 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. Monitors were requested this year to use a new method based upon the number of renesting pairs a given site may generate, rather than the number of renesters that may nest at a given site. However, it was apparent that monitors may still be underestimating renesters, as discussed previously.

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 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.

Monitors were requested in 1998 to try another fledgling estimation method that may account for birds departing earlier than three weeks, using the ratio of adults to fledglings during each count. This is further described in the Methods section of this report, although most monitors did not make use of this method. Preliminary results of population viability analyses conducted by Dr. Jonathan Atwood suggest that monitors are substantially underestimating fledglings, as the estimated current least tern population size is not possible to obtain with the reported fledgling numbers by his calculations. However, many monitors are still not conducting dusk fledgling counts, and, as discussed above, day counts can result in substantial underestimates.

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.

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." She adds, "Some sort of ecologically- and ethically-sound predator management program must be worked out, and soon." These opinions are shared by a majority of least tern monitors and resources agency personnel, and the development of a least tern predator management plan should be considered a top priority.

ACKNOWLEDGEMENTS

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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 and San Diego Audubon Society (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). Thank you all very much, and keep up the wonderful work.

Many of the site managers mentioned above are also appreciated for providing generous funding for monitoring, 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 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 1998.

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. Brian Walton and all his assistants are also much appreciated for their tireless predator management efforts in 1998. Wally Ross is acknowledged for his contributions toward tern productivity at Huntington Beach, Bolsa Chica, Seal Beach, Los Angeles Harbor and Venice Beach. 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.

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APPENDIX - SITE SUMMARIES

The monitors reported the following:

PGE, Pittsburgh: The breeding population at this colony grew from four pairs in 1997 to eleven pairs in 1998. This colony had not appeared to host more than four breeding pairs in any year in any year since it was first monitored in 1984. The 1998 breeding population also exceeded the estimated seven to nine breeding pairs observed in 1984. Food availability for terns at Alameda NAS may have been particularly reduced in 1998. This may have facilitated an increase in the PGE population.

Alameda NAS: Several lines of evidence suggesting a shortage of prey were noted, including: a lag in the initiation of first nests compared with first nest dates for previous years (although this may have been related to predator presence early in the season); poor nest attendance beginning in late June; a high percentage (21 to 26 percent) of nests with incubation periods over 24 days; abnormal chick feeding; a high percentage (47 to 58%) of dead chicks; and kleptoparasitism among adults.

Oceano Dunes SVRA: This year we had the most nests ever, 40! Last year was the second highest number at 21. We also had a very productive year.

Guadalupe/Mussel Rock Dunes: At the time when the two nests were found, a flock of approximately 10 adults and about 18 fledglings had moved to the area (suspected from the Pismo Dunes Vehicular Area). The nests were found within 20 feet of each other and approximately 30-40 feet from the day roosting area of adults and fledglings. The two nests were lost within 5 days of having found them.

Vandenberg AFB - Purisima Point: Notes regarding provided information in tables:

- Table 1, Site Type: Purisima Point is a "Modified Type 2" colony that allows for entrances when predation or other disturbances that may have affected breeding success may have occurred;
- Total eggs: 37, calculated by multiplying the number of known nests by 1.86; the mean clutch size for 14 nests with known contents.
- total fledglings: fledglings do not appear to stay at Purisima Point more than a few days after fledging. This was noted in all 4 years we have been monitoring the site. The fledgling counts are based primarily on day/evening regular monitoring rather than specifiec fledgling counts.

Site preparation at the Purisima Point site involved activating electric fences. As in '96 and '97, no decoys or chick shelters were used at VAFB. There was no least tern breeding activity at the Beach 2 site, or at any historic or potential site other than Purisima Point. Monitoring at Purisima was conducted 3 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 identity and monitor nests and document predation. Bi-weekly coordination meetings between the least tern monitor, USDA-APHIS Animal Damage Control (now Wildlife Services, or WS), U.S. Fish and

Wildlife Service (USFWS), Santa Cruz Predatory Bird Research Group (SCPBRG), and VAFB ensured that monitoring and predator control were conducted with minimum intrusion into the colony. The highest breeding adult tern population observed at the Purisima colony was 44 on June 16. A higher count of 55 adults and 2 fledglings observed on July 12 was presumed to include some migrating birds. Overall, an estimated nesting population of 19 pairs produced 14 fledglings at Purisima Point. This contrasts sharply with 1997, when an estimated 25 least tern pairs produced only 2 fledglings. This significant increase in fledging success was due to a new predator monitoring and control project initiated this year. This pilot study and control project, conducted by the SCPBRG, focused on avian predators, particularly great horned owls that caused significant losses in 1997. The project included radio-tracking of 4 great horned owls that were live-trapped and later released near Purisima Point in '97; live-trapping of additional owls before and during nesting season; live-trapping and later (post-tern nesting) release of 2 barn owls and 3 kestrels; and ongoing avian predator observations in the least tern colony vicinity. In August '98, with the permission of the California Department of Fish and Game and USFWS, a total of 5 banded and radio-tagged great horned owls were relocated to the Livermore area and released. As of 18 Nov 98, 3 owls remain alive at least 150 miles from Vandenberg, one has no signal, and the fate of the last is unknown (possible mortality). There is no indication that any of the great horned owls have returned to VAFB. WS also conducted predator monitoring and control as in prior years. Measures used in prior years that continue to be successful included placement of gull and crow carcasses to deter predation by these species. The electric fence proved an effective deterrent for most coyotes. WS removed and destroyed 13 coyotes and 2 bobcats. One great horned owl that eluded live capture was also lethally taken by WS, and WS also incidentally pole-trapped one kestrel that had to be euthanized due to injury. The electric fence does not appear to deter bobcats. Great horned owls may have taken 2 chicks, and a peregrine falcon was suspected of taking 1 adult and 2 fledglings. No mammalian predation was documented in 1998, and avian predation was dramatically reduced (in '97, great horned owls took as many as 13 adult terns). Other significant events included a 17 May Delta II launch near the tern colony. The launch occurred early in the season, when many birds were still migrating, and no overall change in least tern numbers was noted. There were also a few unauthorized human entries into the colony; no impact on reproductive success was observed. Breeding was late (first nests 13 June), and there were several observations of oversized fish being brought to chicks. 4 chicks and 1 adult were found dead of unknown causes. However, fledging success suggests that El Niño effects were, if present, not pronounced. Future planned activities include continuation of the SCPBRG avian predator project and initiation of a mammalian predator study aimed at developing methods of non-lethal deterrents and control. Indications of a possible food shortage included a 44-day lag in first nests after the arrival of terns.

Ormond Beach: The monitor reported the following: I surveyed at this site from 4/20/98 through 8/21/98. During this time I made 44 monitoring visits to the site. The time spent at the site per visit ranged between 1 and 8.5 hours, with an average time per visit of about 4.5 to 5 hours. I was rather consistent about monitoring 3 days per week (typically Wednesday, Friday, Sunday), except during the inactive periods earlier and later in the season.

The first adult terns were seen on 5/3. The first nest was seen on 5/24. The last nest began on 7/10. New nest initiation was steady from 5/24 until 6/19. Starting 6/19 and until 7/10 (last found nest) there were only 9 new nests, separated by lag-time periods within that time of 5 days (6/19-6/24), 8 days (6/24-7/2) and.....5 days (7/5-7/10). Birds started to depart the site.....by late July and it was *very quiet* by mid-August. On 8/21 (my last visit), there were about 10 terns in the evening at the estuary. These 10 were a mix of adults and fledglings, with some limited feeding of fledglings by adults still occurring. By this time there were no longer any birds in the nesting area and all were loafing by the estuary.

Unlike previous years, the estuary mouth remained open to the ocean for nearly the entire season. The mouth finally closed completely on 8/5, and after that was intermittently either completely closed or open narrowly. During the season, the foredunes and hard pack shifted greatly, and there was much flooding into the foredune and middle dune area.

People and dogs off-leash walking through the dunes were a problem. Of particular disruption to the colony was a group of surfers and similar individuals who spent time (day and throughout the night) at a hut they had built from woody debris at the rack line just into the foredune nesting area. They often foraged for wood through the colony area, walked through the dunes to access the hut, and tossed bottles and trash into the surrounding foredunes. There was also undoubtedly noise disturbance resulting from beach parties at night with fires. There were occasionally off-road vehicles but this was not serious problem.

Throughout the season, the food source was of great curiosity. The terns flew in and out from all directions (with and without fish). There appeared to be some feeding at Mugu Lagoon, in the canal ways between Mugu and Ormond, in the wetland area behind the Ormond dunes (until it dried up), in the J Street Canal, in the Ormond Beach Estuary, in the area of the Port Hueneme Pier and beyond to the northwest, as well as out over the ocean. Unlike previous years, there was apparently much less foraging in the estuary and J Street canal area, perhaps because the estuary mouth was open most of the summer. Although I did observe much flying in and out from the opposite directions of Mugu and Port Hueneme, most of the actual foraging I personally observed took place out over the ocean.

Regarding a possible food shortage: I observed much feeding of mates and young early in the season, but as the season progressed, I more often observed:

- Less feeding of mates and young.
- Adult birds sitting on the nest for hours on end with no relief (no food flown in to them and no partner replacing them on the nest). At least one bird appeared to be on the nest for about 10 days with no relief, or so it appeared to me.
- Nests with eggs left unattended for much longer periods of time.
- Less feeding of fledglings than I'd expected.
- Adults flying in with fish, being chased by other adults and fledglings, and ultimately eating the fish themselves.

Potential predators were western meadowlark, western gull, domestic dog (these three most likely); also gull spp., white-tailed kite, coyote, great blue heron, Caspian tern, kestrel, raven, opossum, black-crowned night heron, feral cat, and northern harrier.

Los Angeles Harbor: Least terns in the L.A. Harbor nested exclusively on Pier 400 in 1998, after the formerly-used Pier 300 site was decommissioned in accordance with guidelines in the 1997 Interagency Nesting Site Agreement. The nesting site constructed in the southern portion of Pier 400 in 1997 (Central Nesting Site) was available for nesting once again in 1998. An additional site, the Southeastern Nesting Site, was also provided in 1998 but was not protected with fencing, as no construction activities were anticipated in the area during the nesting season. The first nests were noted on May 8 at Pier 400 and May 18 at the Pier 400 Access Corridor (TC2), an unprepared site also used for nesting in 1997. Most nesting (89%) on Pier 400 occurred in areas outside the provided nesting sites described above. Nest totals were 178 at Pier 400 and 40 at TC2. The estimated total for least tern pairs (172) exceeded pair numbers since least tern breeding in Los Angeles Harbor has been monitored. This may be related to the fact that least tern prey availability has increased in the Los Angeles Harbor, as suggested by a comparison of foraging data collected since 1994. The Pier 400 and Corridor sites produced an estimated 148 fledglings, more than any year at Los Angeles Harbor nesting sites. However, reproductive success values of 0.68 fledglings per nest and 0.86 fledglings per pair were reduced from 1997 values (1.00 fledglings per nest and 1.31 fledglings per pair).

Reasons for the moderately low reproductive success are unclear. Common ravens removed eggs from eight nests at the Corridor; however, hatching success in 1998 (0.89 eggs hatched per eggs laid) was higher than 1997 (0.76) because more eggs were lost to predators, primarily gulls, in 1997. Although recorded chick and fledgling mortality was higher in 1998 (13 individuals) than 1997 (four individuals), losses do not explain the fact that only 148 fledglings were observed of the 350 eggs that hatched. It is possible that an American kestrel or peregrine falcon was taking chicks when monitors were not present, although no evidence to this effect was observed. Another possibility is that parents departed from nesting sites with their young soon after fledging, so they were not observed during fledgling censuses conducted every three weeks per California Department of Fish and Game (CDFG) protocol.

Bolsa Chica: The monitor reported the following: I believe that the impact of the pair of kestrels was devastating to this colony. There is a large discrepancy between the number of chicks hatched and the number of fledglings. Only 15% of the chicks were found dead total (from predation, starvation, or other causes).

Huntington Beach: An American kestrel was documented at the site on June 19 and was trapped June 20. Two more kestrels were observed at the site July 14, and Wally Ross trapped a total of four kestrels from the site the same day. While some predation most certainly occurred, it is believed that these events had minor effects to reproductive success, based upon the continued high activity level at the colony subsequent to these events and the number of fledglings. Wally Ross' immediate response and trapping success is believed to have minimized the predation level. One nest was lost early in the nesting season as a result of being buried as a ground squirrel mounded material on the nest.

San Elijo Lagoon: California least terns were observed throughout the lagoon from 22 April through 26 August. Late spring storms, closure of the lagoon mouth to the ocean, an unstream sewage spill and a flood gate valve broken in the closedposition on the east basin flood control dike resulted in the primary nesting area of the east basin saltpanne being submerged by up to two feet of water throughout May. One pair of terns established a two-egg nest on the east island. No clear tracks were visible around the eggshell fragments found in the scrape on the next monitoring visit, but raccoons were suspected of being responsible due to tracks elsewhere on the island. Water had receded enough in early June that one nest was established at the northeastern edge of the inundated saltpanne, on a ridge of old dredge spoil on the edge of the saltmarsh. The single egg hatched and the chick appeared to have fledged. The east basin area did not dry out as usual during the nesting season, with water retained in low areas forming channels through the saltpanne. The breeding pair and fledgling were joined in mid-July by migrants roosting and foraging in the east basin. Up to 22 adult and 12 fledgling least terns were observed on 22 July. One depredated adult and one fledgling were found. Again, no clear tracks were associated with the carcasses, but coyotes were suspected due to tracks in the area. By late July most least tern activity had shifted to the central basin. Over 100 CLTs were observed on 29 July, including at least 46 adults and 37 fledglings.

Mission Bay Mariner's Point: Poor nest attendance and abnormal chick feeding was noted here in 1998. Mariner's Point was well prepared but was not large enough to accommodate all terns in Mission Bay. This site needs periodic pest control, at least 3 times during the season: May l, June 1 and July 1.

Mission Bay FAA Island: Gulls are a problem each year. Gulls are impossible to manage as there are hundreds roosting each night and any predator control risks disturbance to the terns. An effective method of deterring gull roosting during the winter is recommended. Also, this site needs improvements in vegetation removal prior to the nesting season.

Mission Bay South Shores: Poor nest attendance and abnormal chick feeding was noted at this site, and low productivity was also a result of a peregrine falcon taking adults. The selection of South Shores as a new nesting site was due to poorly prepared sites designated for Least Terns in East Mission Bay. Both Fiesta and FAA islands were overgrown due to heavy rain that was not compensated for in site preparation. To avoid future use at South Shores, which is not fenced and has heavy human disturbance, both FAA and Fiesta islands need improved vegetation removal.

Chula Vista WR: Following the 1997 nesting season, San Diego Unified Port District capped the southwestern 150 m of the site with sand-shell dredge spoil. Prior to the terns' arrival this season, Zoological Society of San Diego (ZSSD) staff applied herbicide and coordinated mechanical disking and harrowing of the site. ZSSD staff and volunteers pruned back vegetation, surveyed the grid system, and placed decoys and ceramic tiles for chick shelters. Monitoring was conducted April through August one to three days per week. Predator management was conducted by personnel from USDA Wildlife Services. Funding was provided by the San Diego Unified Port District through the Zoological Society of San Diego. California least terns were observed from 21 April to 11 September. Two to three pairs established three nests with six eggs

(average clutch size 2.00 eggs per nest). Three chicks from two of the nests hatched successfully and are estimated to have fledged from the site (50 percent of total eggs, 100 percent of eggs hatched). The two eggs from the first nest and one of the two eggs from the second nest were depredated. Gray fox, striped skunk, and/or rats were suspected due to tracks, scats, and subsequent trapping on-site. They were also documented preying on eggs and chicks at Forster's tern nests on adjacent dikes. Eggshell fragments indicated hatching of a snowy plover nest on the site, but chicks were never observed. The presence of kestrel, harrier, barn owl, raven, gull and/or the above species may account for their losses. Predator management and site preparation (and its lack at adjacent sites early in the season) resulted in the recolonization of this site in 1998. Least terns last nested at this site in 1993 and snowy plover nesting was last recorded in 1984. Forster's terns nested at this site for the first time and established 46 nests. Success was severely limited by losses to high tides and predators, but 15 to 20 young are estimated to have fledged. Additional disturbances may have come from illegal boat landings. Tracks of at least one trespasser with a large dog were found along the shoreline. Snowy plovers, Forster's terns, and Belding's Savannah sparrows may also have been impacted by the notable invasion this season of the aggressive Mexican swimming arched crabs.

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 8-10" 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 two ovals used last year by terns for nesting. ZSSD and SDUPD personnel completed extensive repairs to chick barriers following storm events in late April and early May. Monitoring was conducted April through August one to three days per week. Predator management was conducted by personnel from USDA Wildlife Services. Funding was provided by the San Diego Unified Port District through the Zoological Society of San Diego. California least terns were observed at the airfield from 21 April through 30 July, and at the adjacent bayfront through 18 August. Seventeen to eighteen pairs of terns established 18 nests with 33 eggs (average clutch size 1.83 eggs per nest). A single-egg nest was abandoned, and the fate of one egg from a two-egg clutch was uncertain; but lack of chick sightings and predator presence make depredation likely. At least 31 chicks successfully hatched (93.9 percent). From 18 to 23 young are estimated to have fledged from the colony this season (54-70 percent of total eggs, 58-74 percent of eggs hatched). One adult least tern was found dead on the site with no apparent signs of trauma. The disappearance of one egg from a two-egg clutch and two chicks within five days from hatching coincided with visits to the site by feral cats and western gulls. Gulls and cats were removed from the area, but management efforts were hampered by repeated tampering with traps, the inability to use lethal means, and nesting of gulls on nearby rooftops with difficult access. The disappearance of a third chick and from four to nine large chicks and/or fledglings coincided with hunting on the site by kestrels and peregrine falcons. An additional fledgling was observed being taken by a peregrine. Concern was raised in early May due to spilling of jet fuel from a transport vehicle on a nearby roadway and discharge of some fuel from a storm drain into the adjacent bay and foraging areas. The majority of the spill was contained on land and that in the bay was contained along a relatively limited strip of shoreline. Though terns were observed foraging in the area, no direct impacts were documented; hatching success and chick growth measurements did not indicate any problems and survival

appeared to be limited only by predation. There was an 82 percent reduction in nest numbers from 1997 to 1998 which may have been influenced by predator presence this season, but is most likely attributable to the significant depredation experienced by the colony last year. Fledgling success increased 55 to 61 percent from last season, due to increased predator management efforts.

D Street Fill: Prior to the terns' arrival, Zoological Society of San Diego staff coordinated mechanical discing and harrowing of the site. ZSSD and USFWS staff and volunteers moved rocks from the site, pruned back vegetation, surveyed the grid system, and placed decoys and ceramic tiles for chick shelters. San Diego Unified Port District personnel removed derelict boats and debris from the perimeter of the site. Ant control bait experiments were conducted by personnel of the U.C. Riverside Entomology Department and predator management by USDA Wildlife Services staff. Monitoring was conducted April to early September one to three days per week. Funding was provided by the San Diego Unified Port District through the Zoological Society of San Diego. California least terns were observed at the site from 20 April through 21 August. Six to seven pairs established seven nests with 13 eggs (average clutch size 1.86 eggs per nest). Eleven eggs hatched (85 percent). The two eggs of the first nest were depredated by ravens, and one chick from a three-egg clutch was found dead with no visible trauma. Eight to ten young are estimated to have fledged from the colony this season (61-77 percent of total eggs; 73-91 percent of those that hatched). While up to ten of this season's young were observed to fly, actual reproductive success of the colony is not completely clear due to the presence of predators capable of preying on fledglings, including American kestrels, peregrine falcons, and northern harriers. A helicopter landed adjacent to the nests in late June, but apparently did no direct damage. There was an 83 percent reduction in nest numbers from 1997 to 1998 which is most likely attributable to the significant depredation and low reproductive success experienced by the colony last year (41 nests produced only six to eight fledglings). Nest initiation and colony size may also have been hindered early this season by the presence of predators, late spring rains and resulting vegetation, and by the presence of derelict boats on the shoreline of the site, and disturbance by the boats' occupants and their dogs. Numbers of pairs and nests of western snowy plovers were also significantly decreased at the D Street Fill this season. However, least tern reproductive success rates (number of fledglings per nest) increased this season by 87 to 88 percent over that of 1997.

Tijuana River: U.S. Fish and Wildlife Service refuge staffrepaired fencing and posted signs with assistance from California Department of Parks and Recreation and Department of Forestry staff and correctional camp crews prior to the terns' arrival at the Tijuana Estuary. Additional signs were posted as needed once nesting was underway. Monitoring was conducted April through mid-September, one to three days per week.

California least terns were observed from 23 April through 10 September. At least 85 pairs established 124 nests. Forty-four nests were established south of the Tijuana River, including three approximately 100 m north of the U.S.-Mexico border, 12 adjacent to a berm on the beach midway between the border and 4river, and 29 in the "south site" on the beach southeast of the

mouth of the river. Eight nests were established north of the river, including 25 on the beach north of the river mouth, 49 amid dunes approximately 200 m north of the river and 6 at the "north site" south of Seacoast Drive. Average clutch size was 1.69 eggs per nest, with a total of 210 eggs.

An estimated 43 to 60 percent of the eggs hatched (91 to 126 eggs from 55 to 75 nests) at least 32 eggs from 24 nests were abandoned or failed to hatch, 11 eggs from eight nests were depredated, two eggs from one nest were found with damage attributable to either predators or human activity, a two-egg clutch was destroyed by human activity, and a two-egg clutch was lost to high tides. The fates of 34 eggs from 23 nests were uncertain, but age of nests and lack of hatching or chick presence make predation most likely. Additional eggs from at least five nests were destroyed following their abandonment, another was stepped on, and another depredated.

One chick and three adults were found dead with no apparent signs of trauma, and one chick died while hatching. Predation was documented for two chicks and three adults, but an additional 28 to 79 young are estimated to have been preyed upon. From 45 to 61 young are estimated to have fledged from the colony this season.

At least one egg was apparently preyed on by a rodent, one by a ground squirrel, four by cats, two by a coyote, and two by a gull, An American kestrel was observed preying on a tern chick. A peregrine falcon preyed on at least one adult least tern, and feathers indicated at least two more had been depredated. One depredated egg and one chick 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. Opossums, gull-billed terns, northern harriers, barn owls, a short-eared owl, a burrowing owl, and loggerhead shrikes were observed within the nesting areas and are suspected of taking chicks and/or eggs. Snakes, feral dogs, striped skunk, great blue heron, black-crowned night heron; Cooper's hawk, white-tailed kite, common raven, American crow, and western meadowlark were also recorded in the area. Black-bellied plovers apparently opportunistically preyed on eggs of a previously-abandoned nest.

There was a 58 percent reduction in nest numbers from 1997 to 1997 which may have been influenced by predator presence this season, but is most likely attributable to the significant depredation and low reproductive success experienced by this colony last year. Nest initiation and colony size may have been hindered this season by late spring storms. However, reproductive success improved this season, with a 46 to 77 percent increase in hatching success and an 82 to 97 percent increase in numbers of fledglings.

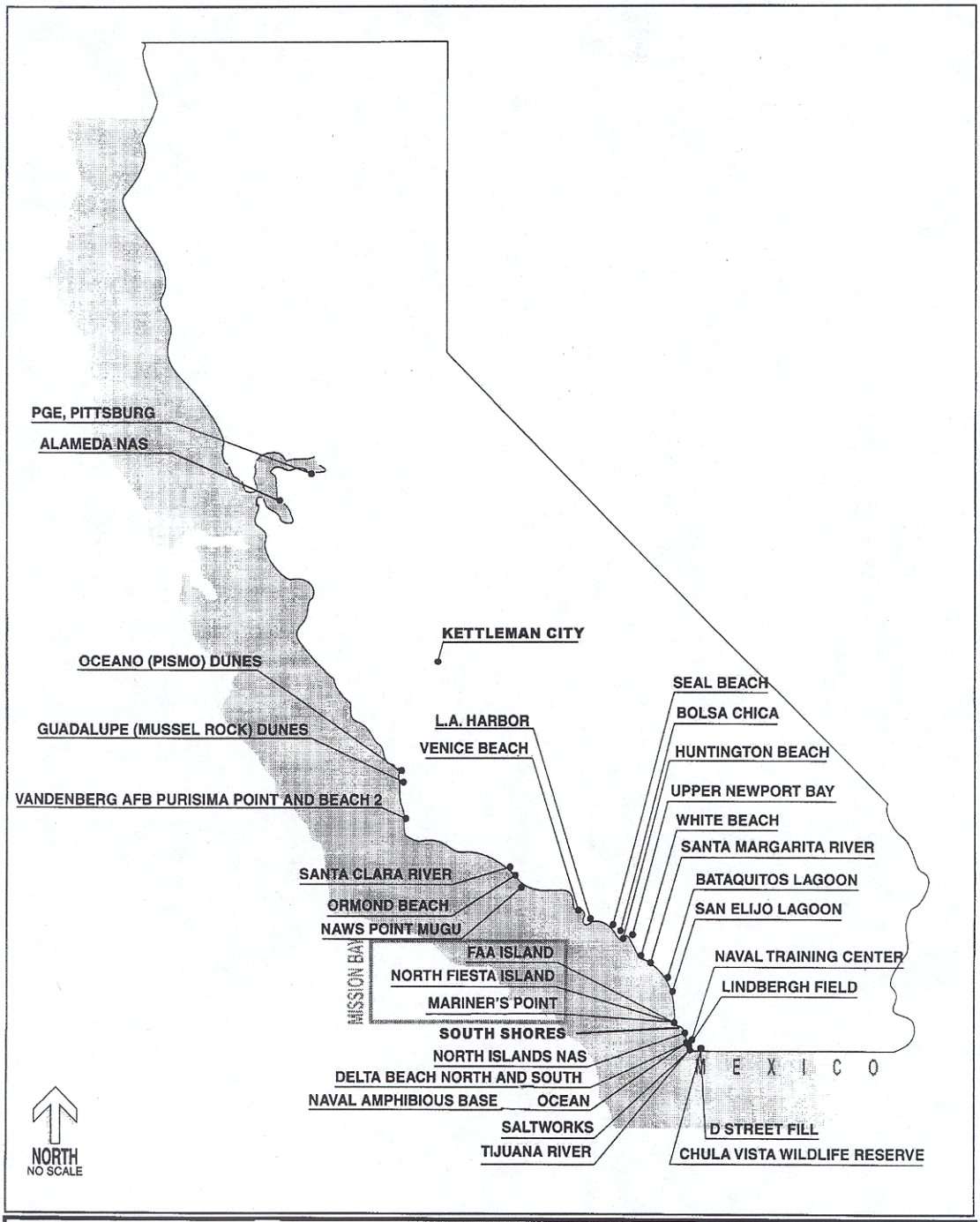

Figure 1. Location of California Least Tern Nesting Sites, 1998

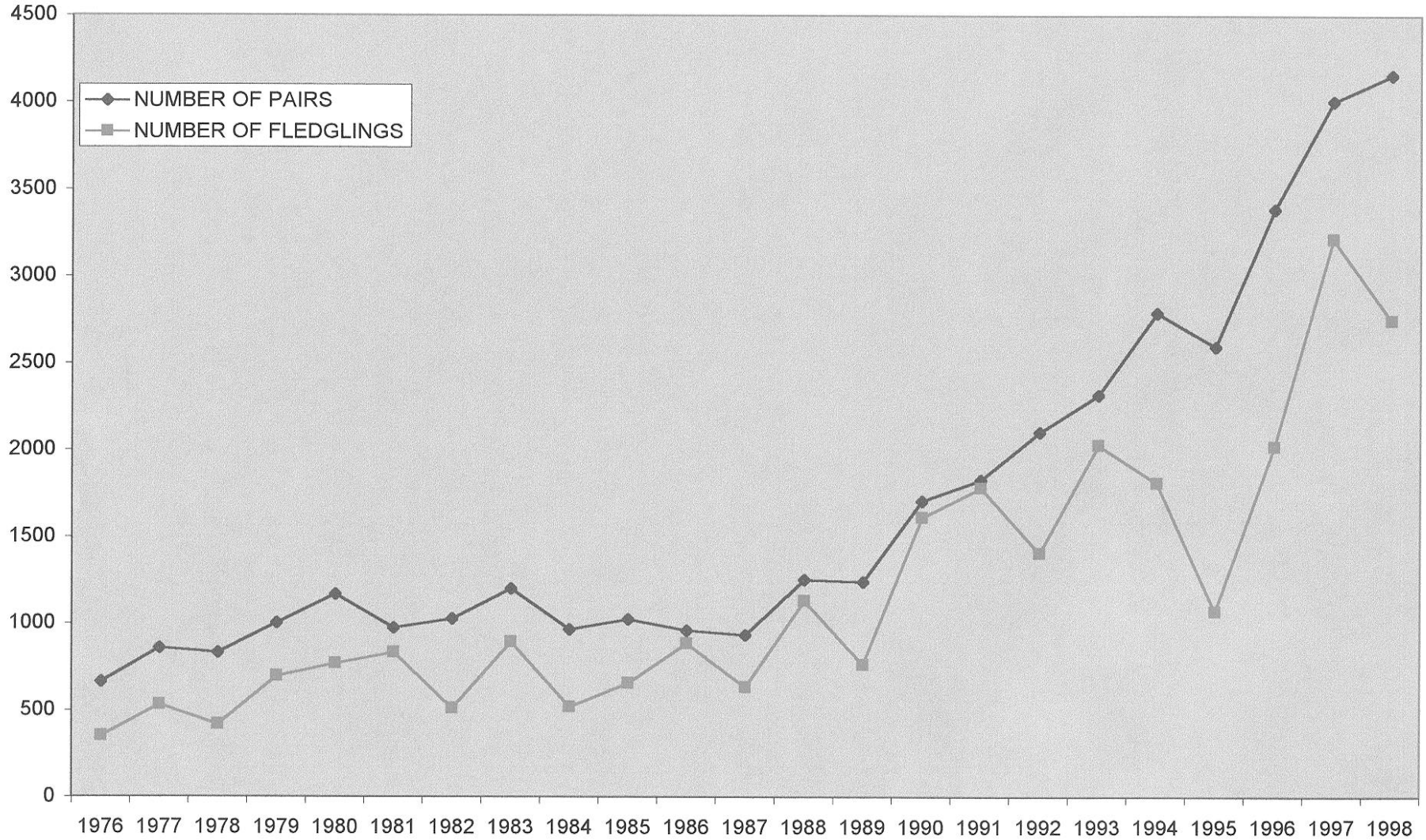

Figure 2. California Least Tern Pairs and Fledglings, 1976 to 1998

Table 1. California Least Tern Site Preparation and Monitor Information, 1998

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	40	NO	NO	3	fill holes	PG&E
NAS Alameda	1	1	Laura Collins	Leory Feeney	YES	170 minimum	NO	YES	4	cover holes; clean shelters; add 26 tons gravel	Navy
Oceano Dunes SVRA	1	large	Ann Marie Tipton	Gary Palkovic	YES	NO	NO	NO		large seasonal ex.	NA
Mussel Rock/Guad. Dn	1	N/A	M. Paloma Nieto	N/A	NO	NO	NO	NO	NO	none	N/A
Vandenberg AFB: Purisima	2	1	Sandra J. Schultz	Thomas E. Applegate	NO	NO	NO	NO	NO	NO	NA
Kettleman City	1	4	Luke Cole		NO	NO	NO	NO	NO	none	
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
Ormond Beach	2	3 (&4)	Cynthia Plummer	Walter Wehtje	YES	NO	NO	NO	7	-	-
NAWS Point Mugu	1		Tom Keeney	Daniel Gautier, Lyn Perry	NO	?	?	?	?	?	
NAWS Pt Mugu Nesting Isl	2		Tom Keeney		NO	?	YES	?	?	?	
Venice Beach	1	2	Rodd Kelsey	Mike Taylor	YES	NO	NO	YES	7	Fence maintenance	Rodd Kelsey
LA Harbor Pier 400	1	1	K. Keane	N. Mudry; W. Ross, N. Liberato	NO	YES	YES	YES	6	YES; flagging and contractor employee education programs	Port of Los Angeles (POLA)

Table 1. California Least Tern Site Preparation and Monitor Information, 1998

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.	NO	NO	NO	NO	6	YES, same as above	POLA
Seal Beach	1	1	John Bradley	Charlie Collins, Pat Collins, Jeff Johnson, Wally Ross	NO	168	NO	YES	4	Electric fence maintenance and preseason predator management	USFWS personnel and contracted predator control specialist - Wally Ross
Bolsa Chica	1	4	Gary Gillis	Jill Frayne	NO	20	NO	YES	1	No	Gary Gilis, volunteers
Huntington Beach	1	2	Doreen Stadtlander	Wally Ross	YES	YES	NO	YES	1	?	State Parks, David Pryor, Wally Ross
Upper Newport Bay	1	4		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	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
Batiquitos Lagoon W-1	1	1	Kathy Keane	John Konecny, Nathan Mudry, Carol Hertzog, Jennifer Price, Seth Shulberg	YES	YES	YES	YES	NONE	some chick fence repair at W-2	N/A
Batiquitos Lagoon W-2	1	1	Kathy Keane		YES	YES	YES	YES	6		CDFG
Batiquitos Lagoon E-1	1	1	Kathy Keane		YES	YES	NO	YES	6		CDFG
Batiquitos Lagoon E-2	1	1	Kathy Keane		YES	YES	YES	YES	1		CDFG
Batiquitos Lagoon E-3	1	1	Kathy Keane		YES	YES	YES	YES	2, minimal		CDFG

Table 1. California Least Tern Site Preparation and Monitor Information, 1998

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	NA	yes	no	no	yes, but only on island (30 m grid with ceramic tiles at intersecti ons)	6 (veg clearing needed on islands; no veg management other than water level manage-ment to flood the east basin in winter)	a double-strand, smooth wire on T-post fence is maintained, signs posted, and attempts made a water level management	San Diego County Parks Department and San Elijo Lagoon Conservancy staff and volunteers
Mission Bay FAA Island	1	1	Jennifer Price	none	YES	YES	NO	YES	2	New grid	FAA, USFWS
Mis. Bay Mariner's Pt	1	1	Jennifer Price	Ginger Johnson	YES	YES	NO	YES	4	Keep-out signs visible from water	City of San Diego
Mis. Bay N. Fiesta Isl.	1	1	Jennifer Price	none	NO	NO	NO	NO	4	NO	City of San Diego, Audubon Soc.
Mission Bay South Shores	1	3	Jennifer Price	R. Collins	NO	NO	NO	NO	7	NO	

Table 1. California Least Tern Site Preparation and Monitor Information, 1998

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	Brian Foster, Elizabeth Copper, Shauna Wolf, Chris Hutcherson, Susan Euing	yes	no	no	yes (30 m grid squares marked by rock cairns and spray-painted coordinates at intersections)	4	8-10" tall plastic mesh chick barrier installed, stormdrains covered with plastic mesh fabric, grid system surveyed and coordinates spray-painted on the asphalt and 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 Wildlife Reserve	1	3	Robert Patton	Brian Foster, Elizabeth Copper, Shauna Wolf, Susan Euing,	yes	yes	yes	yes, (30 m squares marked by tiles at intersections)	4	San Diego Unified Port District had sand-shell dredge spoil cap	Zoological Society of San Diego staff, volunteers, and contractors

Table 1. California Least Tern Site Preparation and Monitor Information, 1998

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	Shauna Wolf, Susan Euing,	yes	yes	yes	yes, (30 m squares marked by tiles at intersections)	4	grid system established; tiles & decoys placed; rocks, debris, & trash removed; derelict boats on shoreline removed.	Zoological Society of San Diego staff, volunteers, and contractors, San Diego Univied Port District and USFWS refuge staff
Saltworks	1	4	Elizabeth Copper	Mark Pavelka	NO	few tiles	NO	NO	NO	barricade of one dike	Saltworks
Tijuana Estuary	1	3	Robert Patton	Brian Collins, Shannon Smith, Nick George, Shauna Wolf	YES	NO	NO	NO	7	signs erected & fence repairs made prior to season; additional signs & twine barricades placed around nesting areas & maintained through season.	USFWS refuge personnel assisted by State Parks staff and CDF correction camp crew

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.
Reported California Least Tern Pairs and Fledglings by Nesting Site, 1998

SITE NAME	1998 Pairs - low	high	1997 Pairs	% + or - from 1997	1998 Nests	1998 Fledglings low	high	1997 Fledg-lings	% + or - from 1997	1998 Fledglings per Pair low	high
SAN FRANCISCO BAY											
PGE, Pittsburgh	11	11	4	175%	13	8	8	2	300.0%	0.73	0.73
NAS Alameda	243	243	244	0%	248	90	90	316	-71.5%	0.37	0.37
SAN LUIS OBISPO/SANTA BARBARA COUNTIES:											
Oceano (Pismo) Dunes	37	37	6	517%	40	25	25	4	525.0%	0.68	0.68
Guadalupe/Mussel Rock	2	2	30	-93%	2	0	0	23	-100.0%	0.00	0.00
Vandenberg AFB - Beach 2	0	0	3	N/A	0	0	0	0	N/A	0.00	0.00
Vandenberg AFB - Purisima Pt	19	19	25	-24%	20	14	14	0	N/A	0.74	0.74
KINGS COUNTY:											
Kettleman City	1	1	0	100%	1	1	1	0	100.00%	1.00	1.00
VENTURA COUNTY:											
Santa Clara River	38	38	43	-12%	38	22	22	37	-40.5%	0.58	0.58
Ormond Beach	86	86	63	37%	86	50	62	51	-2.0%	0.58	0.72
NAWS Point Mugu	274	274	74	270%	274	165	165	16	931.3%	0.60	0.60
L.A./ORANGE COUNTIES:											
Venice Beach	383	383	375	2%	387	200	200	263	-24.0%	0.52	0.52
L.A. Harbor Pier 400	143	143	73	96%	178	148	148	105	41.0%	1.03	1.03
L.A. Harbor TC2	29	29	3	867%	40					0.00	0.00
Seal Beach	167	167	178	-6%	180	94	104	113	-16.8%	0.56	0.62
Bolsa Chica	136	136	141	-4%	154	74	74	61	21.3%	0.54	0.54
Huntington Beach	319	319	373	-14%	320	249	249	325	-23.4%	0.78	0.78
Upper Newport Bay	26	26	82	-68%	31	20	20	25	-20.0%	0.77	0.77
SAN DIEGO COUNTY:											
White Beach	33	33	17	94%	34	15	20	18	-16.7%	0.45	0.61
SM River - North Beach	644	644	728	-12%	665	265	265	930	-71.5%	0.41	0.41
SM River - Salt Flats	43	43	41	5%	43	10	15	30	-66.7%	0.23	0.35
SM River - Salt Flats Is.	40	40	39	3%	40	10	15	15	-33.3%	0.25	0.38
Batiquitos Lagoon W-1	12	12	83	-86%	15						
Batiquitos Lagoon W-2	81	81	59	37%	86						
Batiquitos Lagoon E-1	2	2	25	-92%	6	16	40	254	-88.9%	0.08	0.22
Batiquitos Lagoon E-2	9	9	0	n/a	16						
Batiquitos Lagoon E-3	75	75	104	-28%	88						
San Elijo Lagoon	1	2	9	-89%	2	1	1	7	-85.7%	0.50	1.00
Mission Bay FAA Island	31	31	20	55%	48	25	25	10	150.0%	0.81	0.81
Mission Bay Mariner's Point	528	528	268	97%	584	596	596	165	261.2%	1.13	1.13
Mission Bay North Fiesta Isl.	21	21	76	-72%	23	13	13	20	-35.0%	0.62	0.62
Mission Bay South Shores	9	9	0	N/A	9	1	1	0	N/A	0.11	0.11
Lindbergh Field	17	18	102	-83%	18	18	23	50	-64.0%	1.00	1.35
North Island NAS	59	59	22	168%	77	62	87	13	376.9%	1.05	1.47
Delta Beach North	284	284	310	-8%	337	200	200	300	-33.3%	0.70	0.70
Delta Beach South	60	60	15	N/A	81	60	75	10	500.0%	1.00	1.25
NAB Ocean	151	151	85	78%	184	175	175	45	288.9%	1.16	1.16
Chula Vista Wildlife Refuge	2	3	0	n/a	3	3	3	0	0.00%	1.00	1.50
D Street Fill	5	7	38	-87%	7	8	10	0	N/A	1.14	2.00
Saltworks	39	39	36	8%	39	3	3	7	-57.1%	0.08	0.08
Tijuana River	81	117	211	-62%	124	45	61	3	1400.0%	0.38	0.75
TOTALS	4141	4182	4005	3.9%	4541	2686	2810	3218	-14.6%	0.64	0.68

[a] see text and Table 3B. For sites where no data were provided for this method, the same number as for traditional pair calculation was used.

Table 2B. California Least Tern Pairs and Fledglings by Region, 1998

REGION	1998 Pairs[a]	% of 1998 Statewide Population	1997 Pairs	% + or - from 1997	1998 Fledglings low	1998 Fledglings high	% of 1998 Statewide Fledglings	1997 Fledglings	% + or - from 1997
San Francisco Bay	254	6%	248	2.4%	98	98	4%	318	-69%
San Luis Obispo & Santa Barbara Counties	58	1%	64	-9.4%	39	39	1%	27	44%
Kings County	1	0%	0	n/a	1	1	0%	0	n/a
Ventura County	400	10%	188	112.8%	237	249	9%	104	133%
Los Angeles & Orange Counties	1203	29%	1229	-2.1%	785	795	29%	892	-11%
San Diego County	2247	54%	2288	-1.8%	1526	1628	59%	1877	-16%

[a] average of low and high values, Table 2A

Table 3A. California Least Tern Pair and Nest Data, 1998

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 1998	TOTAL PAIRS 1998	Date of Last New Nest
PGE, Pittsburgh	19-May	23-Jun	7	1	6	6	1	5	13	11	6-Jul
NAS Alameda	15-May	25-Jun	244	5	239	4	0	4	248	243	7-Jul
Oceano (Pismo) Dunes	08-Jun	19-Jul	38	3	35	2	0	2	40	37	19-Jul
Mussel Rock/Guad. Dn	26-Jul	N/A	0		0	2		2	2	2	26-Jul
Vandenberg AFB: Purisima	13-Jun	N/A	4	0	4	16	1	15	20	19	28-Jun
Kettleman City	?	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	1	?
Santa Clara River	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	38	38	No Data
Ormond Beach	24-May	N/A	86	0	86	0	0	0	86	86	10-Jul
NAWS Point Mugu	5-7 May	No Data	No Data	No Data	No Data	No Data	No Data	No Data	266	266	27-Jul
NAWS Pt Mugu Nesting Isl	08-Jun	No Data	No Data	No Data	No Data	No Data	No Data	No Data	8	8	?
Venice Beach	10-May	None	365	2	363	22	2	20	387	383	01-Aug
L.A. Harbor Pier 400	08-May	none	140	20	120	38	15	23	178	143	20-Jul
L.A. Harbor TC2	18-May	01-Jun	20	3	17	20	8	12	40	29	01-Jul
Seal Beach	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	180	167	No Data
Bolsa Chica	07-May	None	143	10	133	11	8	3	154	136	07-Jul
Huntington Beach	08-May	No Data	No Data	No Data	No Data	No Data	No Data	No Data	320	319	?
Upper Newport Bay	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	31	No Data	No Data
White Beach	09-May	No Data	No Data	No Data	No Data	No Data	No Data	No Data	34	33	3-Jul
SM River North Beach	07-May	No Data	No Data	No Data	No Data	No Data	No Data	No Data	665	644	9-Jul
SM River Salt Flats	09-May	No Data	No Data	No Data	No Data	No Data	No Data	No Data	43	43	16-Jun
SM River Salt Flats Is.	09-May	No Data	No Data	No Data	No Data	No Data	No Data	No Data	40	40	26-Jun
Batiquitos Lagoon W-1	20-May	6-Jun	12	0	12	3	3	0	15	12	29-Jun
Batiquitos Lagoon W-2	17-May	6-Jun	64	0	64	22	5	17	86	81	20-Jul
Batiquitos Lagoon E-1	20-May	6-Jun	2	0	2	4	4	0	6	2	21-Jul
Batiquitos Lagoon E-2	21-May	6-Jun	5	0	5	11	7	4	16	9	7-Jul
Batiquitos Lagoon E-3	14-May	6-Jun	48	0	48	40	13	27	88	75	27-Jun
San Elijo Lagoon	27-May	none	2	0-1	1-2	0	0	0	2	1-2	9-Jun
Mission Bay FAA Island	20-May	18-Jun	14	0	14	34	17	17	48	31	14-Jul
Mis. Bay Mariner's Pt	13-May	19-Jun	524	0	524	60	56	4	584	528	10-Aug
Mis. Bay N. Fiesta Isl.	19-May	28-Jun	19	0	19	4	2	2	23	21	8-Jul
Mis. Bay South Shores	17-May	None	9	0	9	0	0	0	9	9	31-May

Table 3A. California Least Tern Pair and Nest Data, 1998

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 1998	TOTAL PAIRS 1998	Date of Last New Nest
Lindbergh Field	12-May	23-Jun	17	0	17	1	0-1	0-1	18	17-18	23-Jun
North Island NAS	13-May	No Data	No Data	No Data	No Data	No Data	No Data	No Data	77	59	1-Jul
Delta Beach North	06-May	No Data	No Data	No Data	No Data	No Data	No Data	No Data	337	284	13-Jul
Delta Beach South	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	81	60	No Data
NAB Ocean	06-May	No Data	No Data	No Data	No Data	No Data	No Data	No Data	184	151	27-Jul
Chula Vista WR	20-May	3-Jul	2	0-1	1-2	1	0-1	1	3	2-3	3-Jul
D Street Fill	12-May	18-Jun	6	0-1	5-6	1	0-1	1	7	5-7	18-Jun
Saltworks	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	39	39	No Data
Tijuana Estuary	8-May	23-Jun	85	1-4	81-84	39	6-39	0-33	124	81-117	30-Jul
TOTALS[b]									**4541**	**4163**	

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

b Totals are not provided for nests and pairs first and second wave as data were not provided for many sites

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

Table 3B. California Least Tern Pair Data Using New Pair Calculation, 1998

Site Name	Total Nests	Number of Unsuccessful Nests before June 20	Estimated Broods Lost before June 20	Total Pairs Not Renesting[a]
PGE, Pittsburgh	13	2	0	11
NAS Alameda	248	7	0	241
Oceano (Pismo) Dunes	40	1	0	39
Mussel Rock/Guad. Dn	2	none	none	2
Vandenberg AFB: Purisima	20	1	0	19
Kettleman City	1	0	0	1
Santa Clara River	NO DATA	NO DATA	NO DATA	*32*
Ormond Beach	86	11	0	75
NAWS Point Mugu	266	NO DATA	NO DATA	*232*
NAWS Pt Mugu Nesting Isl	8	NO DATA	NO DATA	
Venice Beach	387	100	65	222
L.A. Harbor Pier 400	178	5	20	153
L.A. Harbor TC2	40	7	4	29
Seal Beach	NO DATA	NO DATA	NO DATA	*140*
Bolsa Chica	154	5	15	134
Huntington Beach	320	NO DATA	NO DATA	*268*
Upper Newport Bay	NO DATA	NO DATA	NO DATA	*22*
White Beach	NO DATA	NO DATA	NO DATA	*28*
SM River North Beach	NO DATA	NO DATA	NO DATA	*541*
SM River Salt Flats	NO DATA	NO DATA	NO DATA	*36*
SM River Salt Flats Is.	NO DATA	NO DATA	NO DATA	*34*
Batiquitos Lagoon W-1	15	7	5	3
Batiquitos Lagoon W-2	86	12	60	14
Batiquitos Lagoon E-1	6	1	4	1
Batiquitos Lagoon E-2	16	2	8	6
Batiquitos Lagoon E-3	88	3	75	10
San Elijo Lagoon	2	1	0	1
Mission Bay FAA Island	48	6	2	40
Mis. Bay Mariner's Pt	584	56	48	480
Mis. Bay N. Fiesta Isl.	23	2	1	20
Mis. Bay South Shores	9	1	2	9
Lindbergh Field	18	1	0	17
North Island NAS	NO DATA	NO DATA	NO DATA	*50*
Delta Beach North	NO DATA	NO DATA	NO DATA	*239*
Delta Beach South	NO DATA	NO DATA	NO DATA	*50*
NAB Ocean	NO DATA	NO DATA	NO DATA	*127*
Chula Vista WR	3	1	0	2
D Street Fill	7	1	0	6
Saltworks	NO DATA	NO DATA	NO DATA	*33*
Tijuana Estuary	124	5	0-4	116
TOTALS	**2792**	**238**	**309**	**3483**

a for sites with data provided for this table, pair estimates from Table 3 were compared with those derived by the new method, and the average ratio for new method:old method estimates (0.84:1) was used to estimate pair numbers via the new method for sites with no data for this table; these extrapolated estimates are shown in parentheses.

Table 4. California Least Tern Productivity Data, 1998

Site Name	Total Nests	Total Eggs	Mean Clutch Size[a]	# Eggs Hatched[b]	% Hatching[c]	Fledgling estimate method[d]	Total Fledglings
PGE, Pittsburgh	13	23	1.77	16	0.65 - 0.74	day counts	8
NAS Alameda	248	456	1.84	390	0.83 - 0.89	early a.m. counts	90
Oceano (Pismo) Dunes	40	60	1.50	40	0.7	single count	25
Mussel Rock/Guad. Dn	2	3	1.50	0	0.00	N/A	0
Vandenberg AFB: Purisima	20	37	1.85	23	0.6	3W DUSK, & day counts	14
Kettleman City	1	2	2.00	2	1.0	N/A	1
Santa Clara River	38	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	22
Ormond Beach	86	172	2.00	107	0.33 to 0.62	3W DUSK	unknown
NAWS Point Mugu	266	380	1.43	227	0.60	3W DUSK	41
NAWS Pt Mugu Nesting Isl	8	NO DATA	NO DATA	NO DATA	NO DATA	3W DUSK	?
Venice Beach	387	625	1.61	575	0.92	3W DAY	200
L.A. Harbor Pier 400	178	319	1.79	295	0.92	3W DUSK	132
L.A. Harbor TC2	40	74	1.85	55	0.74	3W DUSK	16
Seal Beach	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	3W DUSK	94 - 104
Bolsa Chica	154	277	1.80	227	0.80	3W DUSK	74
Huntington Beach	320	498	1.56	428	0.86	3W DUSK	249
Upper Newport Bay	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	20
White Beach	34	48	1.41	35	0.73	NO DATA	15
SM River North Beach	665	1002	1.51	808	0.81	NO DATA	265
SM River Salt Flats	43	69	1.60	52	0.75	NO DATA	10
SM River Salt Flats Is.	40	64	1.60	50	0.78	NO DATA	10
Batiquitos Lagoon W-1	15	28	1.87	6	0.21	3W DAY	
Batiquitos Lagoon W-2	86	136	1.58	112	0.82	3W DAY	
Batiquitos Lagoon E-1	6	10	1.67	5	0.50	3W DAY	16
Batiquitos Lagoon E-2	16	30	1.88	24	0.80	3W DAY	
Batiquitos Lagoon E-3	88	151	1.72	95	0.63	3W DAY	
San Elijo Lagoon	2	3	1.50	1	0.33	C	1
Mission Bay FAA Island	48	74	1.54	45	0.61	3W DAY	25
Mis. Bay Mariner's Pt	584	1014	1.74	885	0.87	Mortality	596
Mis. Bay N. Fiesta Isl.	23	41	1.78	33	0.80	3W DAY	13
Mis. Bay South Shore	9	18	2.00	14	0.78	3W DAY	1
Lindbergh Field	18	33	1.83	31	0.94	C	18-23
North Island NAS	77	136	1.77	118	0.87	NO DATA	62 - 87
Delta Beach North	337	586	1.74	535	0.91	NO DATA	200
Delta Beach South	81	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	60
NAB Ocean	184	312	1.70	256	0.82	NO DATA	175
Chula Vista WR	3	6	2.00	3	0.50	C	3
D Street Fill	7	13	1.86	11	0.85	C	8-10
Saltworks	39	70	1.79	5	0.13	3W DUSK	3
Tijuana Estuary	124	210	1.69	108	0.43 to 0.60	C	45-61
TOTALS	**4330**	**6980**	**1.66[e]**	**5617**	**0.80**		**see Table 2**

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

b When monitors provided a range, the average was calculated and is presented in this column

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

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

e calculated only for sites with reported egg numbers

Table 5. California Least Tern Non-Predator Mortality, 1998

Site Name	Total Eggs	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	23	0	0	3	0.13	2	1	0	1
NAS Alameda	456	2 to 4	0	48	0.11	78	216	1	1
Oceano (Pismo) Dunes	60	0	0	2	0.03	9	3	0	0
Mussel Rock/Guad. Dn	3	0	0	0	0.00	3	0	0	0
Vandenberg AFB: Purisima	37	0	0	3	0.08	11	4	0	1
Kettleman City	2	0	0	0	0.00	0	0	0	0
Santa Clara River	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
Ormond Beach	172	2	14	22	0.13	22	0	0	0
NAWS Point Mugu	380	0	32	21	0.06	0	10	6	3
NAWS Pt Mugu Nesting Isl	?	0	0	0	0.00	0	2	0	0
Venice Beach	625	0	0	40	0.06	50-60	198	3	3
L.A. Harbor Pier 400	178	0	0	18	0.10	0	5	2	0
L.A. Harbor TC2	40	0	0	8	0.20	0	0	1	1
Seal Beach	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
Bolsa Chica	277	0	4	13	0.05	35	28	3	3
Huntington Beach	498	0	0	63	0.13	3	?	?	?
Upper Newport Bay	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
White Beach	48	0	0	8	0.17	0	5	1	0
SM River North Beach	1002	0	9	148	0.15	0	177	4	2
SM River Salt Flats	69	0	1	11	0.16	0	3	0	1
SM River Salt Flats Is.	64	0	0	11	0.17	0	13	0	0
Batiquitos Lagoon W-1	28	0	0	1	0.04	8	0	0	0
Batiquitos Lagoon W-2	136	0	0	10	0.07	14	1	0	1
Batiquitos Lagoon E-1	10	0	0	2	0.20	3	0	0	0
Batiquitos Lagoon E-2	30	0	0	6	0.20	0	0	0	0
Batiquitos Lagoon E-3	151	0	0	20	0.13	34	0	0	0
San Elijo Lagoon	3	0	0	0	0.00	0	0	0	0
Mission Bay FAA Island	48	0	0	25	0.52	0	6	0	0
Mis. Bay Mariner's Pt	584	0	0	118	0.20	0	159	0	0
Mis. Bay N. Fiesta Isl.	23	0	0	8	0.35	0	1	0	1
Mis. Bay South Shores	9	0	0	4	0.44	1	4	0	0

Table 5. California Least Tern Non-Predator Mortality, 1998

Site Name	Total Eggs	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
Lindbergh Field	33	0	0	1	0.00	1	0	0	1
North Island NAS	136	0	0	17	0.13	0	2	1	0
Delta Beach North	586	0	2	37	0.06	0	51	1	0
Delta Beach South	NO DATA	0	NO DATA	NO DATA	NO DATA	0	NO DATA	NO DATA	NO DATA
NAB Ocean	312	0	0	41	0.13	0	9	0	1
Chula Vista WR	6	0	0	0	0.00	0	0	0	0
D Street Fill	13	0	0	0	0.00	0	1	0	0
Saltworks	70	NO DATA	NO DATA	NO DATA	NO DATA	5	NO DATA	NO DATA	NO DATA
Tijuana Estuary	210	2	2	22	0.10	34	1	0	3
TOTALS	**6980**	**6 - 8**	**64**	**731**	**0.10**	**263**	**900[b]**	**23**	**23**

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

b This represents 16% of the 5,617 estimated hatched eggs (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, 1998

Predator	Site Name	Suspected or Documented?[a]	Number of Eggs Lost	Number of Chicks Lost	Number of Fledglings Lost	Number of Adults Lost	Predator Management for this Species?	Was it Effective?	If not, why?
AMERICAN CROW	Venice Beach	D	2 to 5				yes	Yes	
	PGE, Pittsburgh	S	3 minimum	?			yes	no	none caught
AMERICAN KESTREL	NAS Alameda	D		1 min.			yes	yes	
	LA Harbor Pier 400	S		30	unknown		no	N/A	not observed until end of season; could have preyed upon chicks before
	LA Harbor TC2	S		unknown			no	N/A	observed & never seen near site but low fledgling count indicates some predation possible
	Bolsa Chica	S		30	6	0-10	Yes	?	appeared towards the end of the season; all of the last 15 nests were destroyed by the
	Huntington Beach	S		unknown			yes	yes	One at site June 19 & trapped June 20. Four at site July 14 & trapped same day.
	Batiquitos Lagoon W-1	S		unknown			no	N/A	pred mngt claims never saw kestrels
	Batiquitos Lagoon W-2	S		unknown			no	N/A	
	Lindbergh Field	S		unknown	unknown		yes	yes	NA
	Tijuana Estuary	D		1			yes	yes	NA

Table 6. California Least Tern Losses to Predators, 1998

Predator	Site Name	Suspected or Documented?[a]	Number of Eggs Lost	Number of Chicks Lost	Number of Fledglings Lost	Number of Adults Lost	Predator Management for this Species?	Was it Effective?	If not, why?
ANTS	Mis. Bay Mariner's Point	D	8	16			yes	no	reinfestation after 30 days
	Mis. Bay FAA Island	D	3	4			no		no proactive ant control as site was not used by the terns until late in the season
BARN OWL	Alameda NAS	S		5 min.	?	?	yes	yes	
	Tijuana Estuary	S	unknown	unknown	unknown		yes	yes,	NA
BURROWING OWL	Tijuana Estuary	S	unknown	unknown	unknown		yes	yes	NA
COMMON RAVEN	NAS Alameda	S	1				no	not needed	
	LA Harbor TC2	D	13	20			yes	yes	yes, effective
	Batiquitos Lagoon E-1	S	unknown	unknown			yes	no	mngt early in the season; not
	Batiquitos Lagoon E-3	S	unknown	unknown			yes	no	
	D Street Fill	D	2				yes, as-needed	individuals removed and additional losses	NA
COYOTE	Oceano Dunes SVRA	3S, 5D	8				yes	no	coyotes jumped
	San Elijo	S			1	1	no	no	no predator management available
	Tijuana Estuary	D	2	unknown			yes, as-needed	individuals removed and additional	by Border patrol personnel, depredated eggs,

Table 6. California Least Tern Losses to Predators, 1998

Predator	Site Name	Suspected or Documented?[a]	Number of Eggs Lost	Number of Chicks Lost	Number of Fledglings Lost	Number of Adults Lost	Predator Management for this Species?	Was it Effective?	If not, why?
FERAL OR DOMESTIC DOG OR CAT	NAS Alameda	S		3 to 5	1	1	yes	no	too late
	Lindbergh Field	S	0-1	unknown			needed	yes	NA
	Tijuana Estuary	D	4	unknown			yes, as-needed	yes	owner retrieved and re-released in area
	Tijuana Estuary	S	4	unknown			yes, as-needed	individuals removed and additional	owner retrieved and re-released in area
GRAY FOX	Chula Vista WR	S	3				yes; as-	yes,	NA
GREAT BLUE HERON	PGE, Pittsburgh	S	?	4 minimum			no		
	LA Harbor TC2	S		4?			no	N/A	not seen in area
GREAT HORNED OWL	Vandenberg AFB-Purisima	S		0-2			yes	yes	
GULL SPECIES	Venice Beach	S	unknown	unknown			No	N/A	
	L.A. Harbor Pier 400	D	5				no	N/A	too many gulls
	Guadalupe/Mussel Rock	S	3				No	N/A	N/A
	Lindbergh Field	S	0-1	unknown			yes	individuals	NA
	Mis. Bay Mariner's Point	D	4				yes	yes	
	Mis. Bay FAA Island	D	11	2			yes	yes	see summary
	Tijuana Estuary	D	2	unknown			yes	yes	NA
LOGGERHEAD SHRIKE	Oceano Dunes SVRA	2S, 1D	2	1			no		
	Tijuana Estuary	S		?					

Table 6. California Least Tern Losses to Predators, 1998

Predator	Site Name	Suspected or Documented?[a]	Number of Eggs Lost	Number of Chicks Lost	Number of Fledglings Lost	Number of Adults Lost	Predator Management for this Species?	Was it Effective?	If not, why?
NORTHERN HARRIER	NAS Alameda	D	?	4 to 6 min			yes	yes	
	Tijuana Estuary	S	unknown	unknown	unknown		only as-needed	no, none removed and losses not reduced	sensitive status of species
PEREGRINE FALCON	LA Harbor TC2	S		unknown	unknown	unknown	no; only	N/A	sensitive status of
	Vandenberg AFB-Purisima				2	1	no	NA	inconsistent observed presence
	Mis. Bay South Shores	S				2 - 4	no		
	Lindbergh Field	S		unknown	2+	unknown	no	no, none removed and losses not reduced	sensitive status of species
	Tijuana Estuary	D		unknown	unknown	1	no	no, none	sensitive status of
	Tijuana Estuary	S				?			

Table 6. California Least Tern Losses to Predators, 1998

Predator	Site Name	Suspected or Documented?[a]	Number of Eggs Lost	Number of Chicks Lost	Number of Fledglings Lost	Number of Adults Lost	Predator Management for this Species?	Was it Effective?	If not, why?
RED-TAILED HAWK	Seal Beach	S		2			YES	YES	
	Bolsa Chica	S	?	?	?	?	No		Red tailed Hawk was found dead hanging from an electrical wire around the same time the Kestrels were caught and may have contributed to some of the damage on this colony.
	Batiquitos Lagoon all sites	S		unknown	unknown		limited	no	implicated individuals were not effectively targeted
OTHER SPECIES:									
Black-bellied Plover	Venice Beach	S	unknown				No	N/A	
Calif. ground squirrel	Batiquitos Lagoon W-1	S	12				no		pred mngt did not conduct control on this sp.
Calif. ground squirrel	Tijuana Estuary	D	1	unknown			yes, as-needed	yes, individuals removed and additional losses limited	additional individuals in area possibly inflicted additional losses
Gull-billed tern	Tijuana Estuary	S	unknown	unknown			needed for this	removed and losses not	sensitive status of species

Table 6. California Least Tern Losses to Predators, 1998

Predator	Site Name	Suspected or Documented?[a]	Number of Eggs Lost	Number of Chicks Lost	Number of Fledglings Lost	Number of Adults Lost	Predator Management for this Species?	Was it Effective?	If not, why?
OTHER SPECIES (continued):									
Opossum	Tijuana Estuary	S	unknown	unknown			yes, as-needed	yes, individuals removed and additional losses limited	additional individuals in area possibly inflicted additional undocumented losses
Raccoon	San Elijo Lagoon	S	2				not available	no	
Short-eared Owl	Tijuana Estuary	S		unknown	unknown		yes	yes	NA
Striped Skunk	Chula Vista WR	S	3				yes	yes	NA
rats	Chula Vista WR	S	3				yes	yes	NA
unidentified rodent	Alameda NAS	S			1		no	NA	NA
unidentified avian	PGE, Pittsburgh	S		2			no	NA	NA
unidentified owl	Batiquitos Lagoon E-3	S	2				no	NA	NA
unidentified avian	Mis. Bay Mariner's Point	S			6	1	yes	yes	
unidentified avian	Tijuana Estuary	D	1	unknown			yes	yes	NA
unidentified avian	Ormond Beach	S	1						broken eggshell
unidentified avian	LA Harbor Pier 400	S	1	unknown			no	N/A	cracked egg
OTHER LOSSES NOT REPORTED BY PREDATOR TYPE	White Beach	D	3	1			NO DATA	NO DATA	NO DATA
	SM River North Beach	D	7	14		18	NO DATA	NO DATA	NO DATA
	SM River Salt Flats	D	3				NO DATA	NO DATA	NO DATA
	SM River Salt Flats Is.	D	3	5			NO DATA	NO DATA	NO DATA
	North Island NAS	D		7 to 8	3 to 5	5 to 6	NO DATA	NO DATA	NO DATA
	Delta Beach North	D	6	2	1	2	NO DATA	NO DATA	NO DATA
	Delta Beach South	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
	NAB Ocean	D	14		1		NO DATA	NO DATA	NO DATA

	eggs	chicks	fledglings	adults
TOTAL MINIMUM LOSSES[b]	147	165	26	45

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

b When a range is provided, the upper end of the range was used to calculate these totals, as reported losses are likely minimal