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CALIFORNIA LEAST TERN BREEDING SURVEY

1999 SEASON

by
Kathy Keane

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ABSTRACT

An estimated 3,451 to 3,674 pairs of California least terns nested at 36 nesting sites in 1999 and produced an estimated 671 to 711 fledglings. These estimates result in 0.18 to 0.21 fledglings per pair, the lowest productivity recorded since statewide censuses were initiated in 1976. Statewide pair estimates decreased 11% from 1998 values, but fledgling estimates declined by 74.9% due to exceedingly high predation and chick mortality at many sites. Over 30% of the nesting population was concentrated at two sites (Mission Bay Mariner's Point and Santa Margarita North Beach); ten sites supported a combined total of 76.6% of statewide pairs. One site (Los Angeles Harbor) contributed nearly 24% of the state's fledglings in 1999; Los Angeles Harbor and three other sites (NAS Alameda, Ormond Beach and Mission Bay Mariner's Point) produced over 50% of 1999 statewide fledglings.

Four sites that supported least tern pairs in 1998 reported no nesting in 1999 (Batiquitos Lagoon W-1 and E-2; Mission Bay Fiesta Island, Mission Bay South Shores); four additional sites (Venice Beach, Seal Beach, Bolsa Chica, Chula Vista Wildlife Refuge) supported nesting but had no productivity in 1999.

1999 pair estimates were 18% lower than corresponding statewide nest numbers; in 1998 they differed by only 9%. Renesting may have occurred far less frequently in 1999 than in 1998 due to far higher predation (16.5% of all eggs and 7.7% of chicks hatched) and other factors contributing to chick mortality (26.5% of all hatched eggs) in 1999. The greatest egg losses in 1999 were attributed to coyotes, crows and ravens; highest chick/fledgling losses were to American kestrels, coyotes and peregrine falcons. Chick mortality due to factors other than predation was 26.5%, higher than 1997 and 1998 and is believed to be related to prey deficiencies and unknown factors.

[1] Keane, K. 2001. California least tern breeding survey, 1999 season. Calif. Dep. Fish and Game, Habitat Conservation Planning Branch Report 01-X , Sacramento, CA 15pp. + appendices

INTRODUCTION

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

California least terns historically nested in several small, scattered aggregations on sandy beaches and salt flats along the coast (Chambers 1908). The progressive loss of undisturbed sandy beaches during the early part of this century 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 the San Francisco Bay (Small 1994). Following listing under the federal and state endangered species acts, the number of least tern nesting sites gradually increased from 19 in 1973, when statewide censuses were initiated, to 38 in 1998. Estimated numbers of nesting pairs have also escalated from 624 in 1973 to over 4,000 in 1998. Protection of nesting sites with fencing and signage has effectively limited human disturbance at most nesting sites.

Various factors affect least tern populations. Both native and non-native predators have been implicated in major losses of eggs, chicks and occasionally adults at several sites (see Appendix A, Tijuana River) 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

[2] According to A. I. McCormick, quoted in Bent (1921), the beaches of Los Angeles County in 1899 "from Santa Monica southward, afford excellent breeding grounds for numberless birds of this species." By 1943, "breeding stations [are] few, owing to almost complete human use of suitable beaches" (Grinnell and Miller 1944). In 1999, Los Angeles County supported only three least tern nesting sites.

monitoring, predator management and habitat enhancement at nesting sites will be required to ensure its long-term survival.

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 who conduct surveys within nesting sites, marking and checking nests during each visit, are authorized to do so through 10(a)(1)(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 1998 are summarized in annual reports compiled by the CDFG. This report summarizes least tern data collected in 1999. However, because no statewide monitoring coordinator was appointed by CDFG in 1999, data collection and reporting was not standardized; thus, the results in this report are less detailed than for the 1997 and 1998 reports.

METHODS

Monitors

Site monitors were selected by CDFG 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).

No diskettes for reporting data in Microsoft Excel format, as had been provided in 1997 and 1998, were sent to monitors in 1999. However, many monitors provided 1999 data in the Excel file format used in the past. Other data were obtained from site managers' reports and incorporated into the tables presented at the end of this report.

Site Preparation and Protection

Site preparation methods are summarized in Table 1. Included in this table are types of fence used (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 arrival in 1999. 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 predator management are used prior to and during least tern nesting at many sites. In 1999, Wildlife Services, a division of the United States Department of Agriculture, provided predator management services at these

sites: Naval Air Station (NAS) Alameda; NAWS Point Mugu; Batiquitos Lagoon; San Diego County sites administered by the U.S. Navy (White Beach, Santa Margarita River sites, Naval Training Center, North Island NAS, Delta Beach North and South, and Naval Amphibious Base [NAB]- Ocean), by the City of San Diego (Mariner's Point), 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 (McGrath State Beach, Ormond Beach, Oceano Dunes) may not receive any predator management. All predator managers operate under 10(a)(1)(A) permits that authorize access within least tern nesting sites, and possess depredation permits that authorize the 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, thus requiring intensive management in the form of herbicides or mechanical removal (Table 1). Chick shelters, often in the form of ceramic roof tiles, are used at some sites with little to no vegetation, although chick use of such shelters has been observed at sites where vegetation cover is present (e.g., L.A. Harbor).

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 1999 were considered Type 1 sites. This type of monitoring allows for the collection of more detailed data than for Type 2. Type 2 sites are monitored from the outside only, with monitors counting birds observed in incubating posture to estimate nest numbers. Monitors at Type 1 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, the number of pairs 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.

Monitors were asked to estimate total pairs using a new method that 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 counted only 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). However, most monitors did not use this method in 1999.

Nesting Waves

Massey and Atwood (1981) 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, early nests 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 similar to the number of "first wave" nests. The number of late-season ("second wave") nests, minus the estimated number of renesters, provides an estimate of "second wave" pairs. During years when recruitment is expected to be high (i.e., 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, more "second wave" nests are likely 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, is problematic, as it is 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 or "second wave" of nesting from mid-June into early July (e.g., 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 nesting peak 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. The most accurate method for estimating fledglings is by recapture studies, banding chicks when they hatch and conducting weekly chick "round-ups" by corralling chicks into corners of sites surrounded by chick fencing and reading their band numbers or measuring their wing length to assess age in days. Chicks within four days of fledging (17 days or older) are counted as fledglings; Kathy Keane prepared and presented a paper on this method at a Western Bird Banding conference in 1990, and this method is used at many San Diego County nesting sites. However, banding is not conducted at most other sites, as the majority of monitors lack permits to band least terns. Also, the expansiveness of many sites and availability of vegetation for chick refuge diminishes the probability of chick recapture. Thus, at most nesting sites, fledgling censuses are conducted. Because fledglings may be away from the site learning foraging skills during the day, the recommended census time is just prior to dusk. However, 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 were 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 were cautioned that fledglings might roost, particularly after departing from nesting sites, at sites other than their natal nesting site (e.g., terns banded at Santa Margarita River seen at Batiquitos Lagoon W-2; NAWS Point Mugu and Ormond Beach terns fly between sites). Thus, monitors were encouraged to communicate with monitors of nearby sites to coordinate simultaneous fledgling counts to minimize double counting.

Monitors had been asked in 1998 to also use a new method for estimating fledglings. The method entails counting adults as well as fledglings during dusk censuses[4], and the ratio of fledglings to adults for each census 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 fledglings for the season. For example, if fledglings 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, since so few monitors made use of this method in 1999, a separate statewide fledgling total obtained via this method was not calculated.

[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.

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 signs are 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) and observed mortality of chicks, fledglings or adults not directly related to predators.

Nesting Site Names

Caffrey (1997 and 1998) defined a nesting site as the location for a contiguous group of nesting birds, and a colony as the general location used for roosting and foraging by birds from the same or separate but geographically-related nesting sites. However, in ornithological literature, the term "colony" 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 rather than "colony," unless the discussion refers to a group of nesting terns, although site names are the same as those used for "colonies" in monitoring reports for years prior to 1997 and are the same as those used for nesting sites in 1997 and 1998 reports (Keane 1998; Keane 1999).

Monitors generally reported data for non-contiguous nesting sites separately, except that data for nesting sites north and south of the river for the Tijuana Estuary site were combined in 1999 (as in 1997 and 1998). At the Santa Clara River, data for the nesting site north of the river and at McGrath Lake were combined in previous years but reported separately in 1999.

Data Analysis and Report Compilation

Information from reports submitted to Kathy Keane by monitors and by Terri Stewart (CDFG) was entered into a Microsoft Excel file format used to prepare the tables following the text in this report. When data on nest site preparation was lacking, information was assumed to be similar to what was reported for 1998. Reproductive success for each site was calculated by dividing the reported estimate of fledglings for the season by the reported estimate of pairs at that site. Mean clutch size was calculated by dividing the total number of eggs by the total number of nests. Hatching success was calculated by dividing the number of eggs hatched by the total number of eggs. Sites without reported egg numbers (such as Type 2 sites) were not used in calculating a statewide clutch size or hatching success. No statistical analyses were conducted.

RESULTS AND DISCUSSION

Changes in Nesting Site Use from 1998

No nesting sites used in 1999 were unused by least terns in 1998. Four sites used in 1998 supported no nesting in 1999: Batiquitos Lagoon W-1 and E-2, Mission Bay North Fiesta Island, and Mission Bay South Shores. Mission Bay South Shores was unused by least terns since the late-1980s and was again unsuitable for nesting in 1999. It is not known if the evaporation pond near Kettleman City in California's Central Valley supported a nesting least tern pair as it had in 1998. Summaries that discuss nest site preparation, reproductive success and/or predator information during 1999 were provided by some monitors for their nesting sites and are included in Appendix A.

Distribution and Productivity by Region

An estimated 3,451 to 3,674 pairs of California least terns nested at 36 nesting sites (Table 2A and Figure 1) along the coast of California in 1999 and produced an estimated 671 to 711 fledglings (Table 2A). These estimates result in 0.18 to 0.21 fledglings per pair, the lowest productivity recorded since statewide, annual productivity rates have been determined, beginning in 1978. Compared with 1998 estimates, statewide pairs decreased by only 11%, although fledglings decreased by 74.9% (Table 2A), likely due to high predator pressure and high chick mortality at many sites.

Over 30% of the nesting population was concentrated at two sites (Mission Bay Mariner's Point and Santa Margarita River North Beach – Figure 2). Ten sites supported a combined total of 76.6% of statewide pairs ((Mission Bay Mariner's Point, Santa Margarita River North Beach, NAB Ocean, NAS Alameda, Huntington Beach, Delta Beach North, L.A. Harbor Pier 400 & TC2 [combined], NAWS Point Mugu, Batiquitos Lagoon W-2 and Tijuana River) – Figure 2). One site (Los Angeles Harbor) contributed over 20% of the state's fledglings in 1999. Los Angeles Harbor, NAS Alameda, Ormond Beach and Mission Bay Mariner's Point produced over 50% of 1999 statewide fledglings (Figure 2).

The two nesting sites in the San Francisco Bay region, primarily NAS Alameda, supported 7.3% of statewide pairs and produced approximately 13% of statewide fledglings (Table 2B and Figure 3). Pair estimates in the San Francisco Bay region changed little (a 2.8% increase) from 1998 numbers, although fledgling estimates in 1999 were 7.1% lower than in 1998 (Table 2B and Figure 3), largely due to a high number of dead chicks at NAS Alameda (Table 5).

The three nesting sites in San Luis Obispo/Santa Barbara region supported only 1.9% of the state's nesting pairs but 5% of statewide fledglings in 1999 (Table 2B and Figure 3). Pair estimates increased by 13.8% from 1998 estimates, primarily due to increases at Guadalupe Mussel Rock Dunes (Table 2A). However, fledgling estimates declined by 12.8% from 1998 values (Table 2B) due a reduction in fledglings at Oceano (Pismo) Dunes (Table 2A), despite higher productivity at Guadalupe Mussel Rock Dunes (up from zero fledglings in 1998).

The five Ventura County sites supported only 6.8% of statewide pairs but 18% of statewide fledglings in 1999 (Table 2B and Figure 3). However, substantial decreases from 1998 values at NAS Point Mugu resulted in a 38.7% decline in pairs and a 47.7% decline in fledglings for the county (Table 2B). At Ormond Beach, there was a 19% decline in pairs but a 12.5% increase in fledglings. Values for other Ventura County nesting sites remained fairly stable (Table 2A).

The seven Los Angeles/Orange County nesting sites supported 19% of statewide pairs but 27% of fledglings for the state (Table 2B and Figure 3). The high fledgling percentage is primarily due to 165 fledglings at Los Angeles Harbor (Table 2A). However, because of site abandonment due to predation at Venice Beach, pair values for the region declined by 43.6% (Table 2B). Reproductive failure at Venice Beach and substantial chick losses at Huntington Beach (Table 2A) resulted in a decrease in fledgling numbers by 75.3% from 1998 (Table 2B).

The 19 nesting sites in San Diego County (down from 23 in 1998) harbored 64.9% of statewide least tern pairs but generated only 35% of statewide fledglings in 1999 (Table 2B and Figure 3). Pair estimates for the San Diego County region increased slightly (by 3%) from 1998 (Table 2B) due to higher pair numbers at several sites (White Beach, Batiquitos Lagoon W-2, Mission Bay Mariner's Point, Mission Bay FAA Island, Lindbergh Field, North Island NAS, NAB Ocean and D Street Fill). Those increases were offset by decreases at most other sites (Table 2A). Fledgling estimates in 1999 reflected an 84.5% decrease from 1998 values (Table 2B).

Chronology; Pair and Nest Numbers

Table 3 summarizes information provided by monitors on dates for first and last nests and nesting waves. Few monitors provided information on nesting waves, so this subject is not discussed further here. The earliest nests initiated in 1999 (May 10 through 12) were reported at Los Angeles Harbor, Huntington Beach, North Island NAS, Delta Beach North and South, and D Street Fill. In previous years, Seal Beach has reported the earliest nesting (e.g., May 1—Keane 1998 Table 3A), but data on nest dates was not provided for this site in 1999. Initiation dates for latest nests (July 24 through 28) were reported for Los Angeles Harbor, Santa Margarita River North Beach, Mission Bay FAA Island, Mission Bay Mariner's Point, and Delta Beach North. Nesting at most sites ended in June, which was earlier in 1999 than in 1998 (in July—Keane 2000 Table 3A). The last reported nest initiation date was July 28, which was earlier than for 1998 (August 10– Keane 2000 Table 3A). This is due to high predation pressure at many sites.

Clutch Size and Hatching Success

Table 4 summarizes productivity statewide and for each nesting site. 4,348 nests were reported statewide. Total reported egg numbers were 7,129; excluding nests without reported egg numbers (for Type 2 sites or sites where predation rendered egg counts difficult), average statewide clutch size was 1.56, a reduction from 1998 (1.66—Keane 2000 Table 4) and from 1997 (1.86—Keane 1998 Table 4). Reported egg hatches were 4,175 for a statewide hatching success of 62.1% compared with 80% for 1998 (Keane 2000 Table 4) and 79.8% for 1997 (Keane 1998 Table 4). Low hatching success in 1999 is primarily due to substantial predator losses, but also to higher incidences of flooding and egg abandonment, as discussed below.

Causes of Reproductive Failure

Reproductive Losses to Factors other than Predation

Table 5 summarizes reported causes of reproductive failure to factors other than predators. Nineteen eggs were reported lost to vandalism, trespassing by humans or monitor accident; losses occurred at Mussel Rock Guadalupe Dunes, Upper Newport Bay, White Beach, Santa Margarita River North Beach, NAB Ocean and Tijuana Estuary. Documented egg losses to humans were higher in 1999 than 1998 (6 to 8 eggs—Keane 1999 Table 5) but similar to 1997 (20 eggs—Keane 1998 Table 5). In 1999, 278 eggs (4% of the total) was reported lost to flooding, likely due to early summer storms. This loss was much higher than in 1998 (64 eggs, 0.9%—Keane 2000 Table 5 and Figure 4 this report) and in 1997 (75 eggs, 0.9% of the total—Keane 1998 Table 5 and Figure 4 this report).

Reported egg abandonment was also higher in 1999 than for the previous two years. 1,153 eggs, or 16.4% of total eggs, were reported abandoned in 1999, compared with 731 eggs or 10% of the total in 1998 (Keane 1998) and 725 eggs or 9% of the total in 1997 (Keane 1999) (Figure 4). Sites with highest egg abandonment values in terms of percentages of total eggs (over 20% abandonment) were Batiquitos Lagoon W-2, Delta Beach North and South, NAB Ocean, San Elijo Lagoon, and Santa Margarita River North Beach. Batiquitos Lagoon W-2 had 50.2% abandonment, possibly a result of high predation pressure and frequent disturbances by fishermen.

Eggs of unknown outcome were also higher in 1999 (712 eggs, 10% of the total) than in 1998 (263 eggs, 3.8% of the total—Keane 1999 Table 5) but not much higher than in 1997 (649 eggs, 8.2% of the total—Keane 1998 Table 5). The 1999 increase from 1998 in undocumented egg outcomes is possibly due to undocumented predator losses. Sites with the highest numbers of eggs of unknown outcome were Ormond Beach (a Type 2 site), Upper Newport Bay (visited irregularly as a Type 1 site) and Mission Bay Mariner's Point (possibly because of high nest numbers, dense nesting and generally only one monitor).

Reported chick mortality in 1999 was also very high. 1,108 dead chicks (26.5% of total hatched eggs) were reported, although factors believed by monitors to be the cause of death were not generally provided. At Mission Bay Mariner's Point and NAS Alameda, some losses were believed to be related to prey insufficiencies. In addition, high predation pressure at these and other sites may have resulted in early site abandonment and/or affected the ability of parents to provide adequate prey for young. Highest chick losses to factors other than predators, in terms of percentages of hatched eggs (over 30% loss), were at White Beach, Santa Margarita River North Beach, Santa Margarita River Salt Flats Island, and Batiquitos Lagoon W-2. Chick mortality in 1999 was higher than in 1998 (900 dead chicks or 16% of total eggs—Keane 1999 Table 5) and in 1997 (361 dead chicks or 5.7% of total eggs—Keane 1998 Tables 4 and 5). Although chick mortality was far higher in 1999 than the previous two years (Figure 4), reported fledgling mortality in 1999 (14 fledglings) was lower than in both 1998 (23 fledglings—Keane 2000 Table 5 and Figure 4 this report) and 1997 (69 fledglings—Keane 1998 Table 5 and Figure 4 this report). Adult mortality was lower in 1999 than previous years (11 dead adults in 1999, versus 23 in 1998 and 15 in 1997).

Reproductive Losses Attributed to Predation

Table 6 summarizes reported losses to predation by documented and suspected predators (see also Methods), although some monitors did not provide data on predator losses other than what could be gleaned from annual reports provided to the USFWS as part of permit requirements. Total observed[5] and reported losses to predators in 1999 included 1,267 eggs, 340 chicks, 30 fledglings and 21 adults. Highest observed and reported losses were 495 eggs to coyotes at the Santa Margarita River site. High egg losses were also attributed to coyotes at Vandenberg AFB (28 to 32 eggs) and D Street Fill (44 eggs). Common ravens and American crows (corvids) also preyed upon large numbers of eggs at Venice Beach (minimum 80 eggs), LA Harbor Pier 400 (73 eggs), Seal Beach (60 eggs) and Mission Bay FAA Island (104 eggs, including documented and suspected). Corvids were also at least partially accountable for early site abandonment at Venice Beach (Nathan Mudry, pers. comm.) and Seal Beach (John Bradley, pers. comm.). Egg losses to unknown predators were also high at Santa Margarita River sites (81 eggs – predator type unreported by the monitor), Tijuana Estuary (26 eggs), Delta Beach North (22 eggs), and Batiquitos Lagoon E-1 (21 eggs).

Highest observed and reported chick losses in 1999 were attributed to coyotes at Vandenberg AFB (33 chicks), to red-tailed hawks at Upper Newport Bay (30 to 45 chicks), to peregrine falcons at Upper Newport Bay (30 chicks) and at Mission Bay FAA Island (22 chicks), and to American kestrels at Lindbergh Field (17 to 20 chicks). Unknown or unidentified predators also preyed upon 21 chicks at NAS Alameda and 22 to 74 chicks at Tijuana Estuary.

Highest observed and reported fledgling losses in 1999 were to American kestrels at Mission Bay FAA Island (2 to 10 fledglings) and to burrowing owls at Tijuana Estuary (5 to 7 fledglings). Predation on adult terns in 1999 was attributed to burrowing owls at Delta Beach North (6 adults), NAB Ocean (2 adults), and Tijuana Estuary (2 adults). Peregrine falcons took four adults at Seal Beach, and unknown predators killed 4 adults at Huntington Beach in 1999.

In terms of losses as a percentage of total reproductive effort, Figure 4 shows that egg loss to abandonment and infertility was only slightly lower than loss to predators in 1999, and that egg loss to predators was far lower than to abandonment and infertility in both 1998 and 1997. In addition, chick mortality to factors other than predators represented a far higher proportion of total eggs hatched than chick loss to predators in 1999; the same is true for 1998 and 1997 (Figure 4). The proportion of total fledglings lost to predators was higher than to non-predator mortality of fledglings in 1999, but the proportion of fledgling mortality related to predators was similar to fledgling loss unrelated to predators in 1997 and 1998 (Figure 4).

Observed and reported predators with the greatest effect on egg survival in 1999 were coyotes (over 8% of total eggs laid), followed by crows (3%), ravens (2.8%), and unknown predators (2%)(Figure 5). Highest observed and reported chick losses were to unknown predators (2%), peregrine falcon (1.5% of total eggs hatched), coyote (1%) and red-tailed hawk (1%). Observed and reported chick losses to burrowing owls, northern harriers and gull-billed terns were less than 1% of total hatches in 1999 (Figure 5). Observed and documented fledgling losses were highest (greater than 1% of total fledglings) owing to American kestrels and burrowing owls (Figure 5).

[5] Includes documented and suspected predation; potential predation was not included (see Methods).

Population Trends

Figure 6 summarizes increases and decreases in least tern pairs and fledglings from 1976 through 1999. After a 54% increase in least tern pairs and a 200% increase in fledglings between 1995 and 1997, pair numbers increased only 3.8% from 1997 to 1998, and fledgling numbers decreased by 14%. The decrease between 1997 and 1998 is likely related to limitations in prey availability during 1998, as evidenced by high chick mortality, poor nest attendance, abnormal chick feeding and kleptoparasitism (Keane 1999). Further and substantial declines in both pair and fledgling estimates occurred in 1999 (Figure 6) as a result of high predation on eggs and chicks and abnormally high chick mortality, as described above. The decline in pair estimates from 1998 values was only 14.3% but the decrease in fledgling production was 74.9% between 1998 and 1999 (Table 2A). The estimated number of statewide fledglings per pair in 1999 was the lowest value since 1976 (Figure 7). Results of the 1999 least tern season, in addition to the instability in least tern productivity over time (Figure 7), are indicative of the need to continue least tern management, despite the general increase in nesting pairs from 1989 through 1998 and the general increase in fledglings from 1989 through 1991 and 1995 through 1997 (Figure 6).

RECOMMENDATIONS

Funding

Funding for least tern monitoring and predator management has always been an issue of concern. It is likely the recent declines in pair and fledgling numbers would continue 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 who are responsible for making funding decisions.

In 1999, most monitors with only CDFG funding were provided sufficient reimbursement to visit their sites for 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 and Batiquitos Lagoon 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, 1998 and 1999 for predator management at Venice Beach. Several sites, particularly those in Ventura and San Luis Obispo counties, have no predator management at all.

Nesting Sites

Site managers are appreciated for their ambitious efforts in site preparation and maintenance. However, several sites would benefit from better site preparation, including the Venice Beach and Batiquitos Lagoon sites. USFWS and CDFG should meet with Venice Beach site management (Los Angeles County Harbors and Beaches) and the site owner (California State Parks) to designate responsibilities for future site maintenance. Funds designated for Batiquitos Lagoon management should be made available on a timely basis, and consultations with successful site preparation specialists should be conducted, so that proper site preparation can occur. Many other sites (e.g., Ormond Beach) could benefit from 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 in 1992 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 and 1998 reports (Keane 1998 and 2000) 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 in 1998 to use a new method based upon the number of renesting pairs a given site may generate, rather than estimating the number of renesters at a given site. However, monitors may still be underestimating renesters.

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

Monitors were requested in 1998 to try estimating fledglings using the ratio of adults to fledglings during each count. This was further described in the Methods section of the 1998 report (Keane 1999), but few monitors used the method in 1998 or 1999. 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), Caffrey stated, "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 added, "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 comprehensive and rational least tern predator management plan should be considered a top priority by both CDFG and USFWS. The predator management plan should examine losses due to predators with small and/or declining populations in the coastal region (northern harriers, gull-billed terns, burrowing owls) and compare these losses with those attributed to predators such as coyotes, crows, ravens, gulls, and kestrels. It will become apparent, when comparing these losses, that predation by northern harriers, gull-billed terns, burrowing owls, peregrine falcons, and other predators uncommon in the southern California coastal zone can generally be tolerated, and that future predator management activities should focus on those predators (coyotes, crows, ravens, kestrels) responsible for the majority of predation on least terns.

ACKNOWLEDGEMENTS

I would like to recognize those who assisted in the successful fulfillment of this contract, including Seth Shulberg of the Batiquitos Lagoon Foundation and Tim Dillingham of CDFG. Jack Fancher of USFWS and Barbara Massey are appreciated for their willingness to address my many questions or concerns; Jack Fancher is also belatedly acknowledged for the comprehensive and useful least tern bibliography he compiled and maintains.

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 1999.

Similarly, I do not know by name many of the personnel of USDA. 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 1999. 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 Eileen 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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INSERT FIGURE 1 AND EXCEL TABLES and FIGURES HERE (pages XX – XX)

FIGURES AND TABLES

Tables

Figures

Table 1. California Least Tern Site Preparation and Monitor Information[a], 1999

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Site Name	Site Type[b]	Fence Type[c]	Name of Primary Monitor	Names of Other Monitors	Inter-pretive signs?	Chick shelters?	Decoys?	Grid System?	Vegetation Manage-ment[d]?	Other Site Preparation?	By Whom?
PGE, Pittsburgh	1	2	Laura Collins	N/A	YES	YES	NO	NO	3	fill holes	PG&E
NAS Alameda	1	1	Laura Collins	Leory Feeney	YES	YES	NO	YES	4	cover holes; clean shelters	Navy
Oceano Dunes SVRA	1	large	Ann Marie Tipton	Gary Palkovic	YES	NO	NO	NO	unknown	unknown	NA
Mussel Rock/Guad. Dn	1	N/A	Paloma Nieto	N/A	NO	NO	NO	NO	NO	NO	N/A
Vandenberg AFB: Purisima	1-2	1	Sandra J. Schultz	Thomas E. Applegate	NO	NO	NO	NO	NO	NO	NA
Santa Clara River North	1	Temp	Don Davis	A. Marshall, J. Lewison, L. & T. O'Neil, J. Davis	YES	NO	NO	NO	Yes (Arundo Removal Only)	unknown	Ventura Audubon
McGrath Lake	1	Temp	Don Davis	above	YES	NO	NO	NO	unknown	unknown	Ventura Audubon
Ormond Beach	2	3 (&4)	Amanda Miner	Walter Wehtje	YES	NO	NO	NO	7	NO	-
NAWS Point Mugu	1	unknown	Tom Keeney	Daniel Gautier,	NO	unknown	unknown	unknown	unknown	unknown	NAWS
NAWS Pt Mugu Nesting Isl	1	unknown			NO	unknown	YES	unknown	unknown	unknown	NAWS
Venice Beach	1	2	Nathan Mudry	Kathy Keane	YES	YES	NO	YES	1	Fence maintenance	Nathan Mudry
LA Harbor Pier 400	1	1	K. Keane	N. Mudry; W. Ross, N. Liberato	NO	YES	YES	YES	6	contractor education programs	Port of Los Angeles
LA Harbor TC2	1	4	K. Keane	N. Mudry; W. Ross, N. Liberato	NO	NO	NO	NO	6	contractor education programs	POLA
Seal Beach	1	1	John Bradley	C. Collins, J. Johnson, W. Ross	NO	YES	NO	YES	4	Electric fence maint.	USFWS Refuges
Bolsa Chica	1	4	Donise Dibley	Eric Burress	NO	YES	NO	YES	1	NO	Amigos de Bolsa Chica
Huntington Beach	1	2	Doreen Stadtlander	Wally Ross	YES	YES	NO	YES	1	unknown	State Parks, David Pryor, Wally Ross
Upper Newport Bay	1-2	4	Donise Dibley	Alison Halpern	YES	YES	YES	NO	4 but little in 1999	NO	CDFG

Table 1. California Least Tern Site Preparation and Monitor Information[a], 1999

page 2 of 3

Site Name	Site Type[b]	Fence Type[c]	Name of Primary Monitor	Names of Other Monitors	Inter-pretive signs?	Chick shelters?	Decoys?	Grid System?	Vegetation Manage-ment[d]?	Other Site Preparation?	By Whom?
White Beach	1	unknown	Brian Foster	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown
SM River North Beach	1	unknown	Brian Foster	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown
SM River Salt Flats	1	unknown	Brian Foster	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown
SM River Salt Flats Is.			Brian Foster	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown
Batiquitos Lagoon W-1	1	1	Kathy Keane	J. Konecny	YES	YES	YES	YES	8	some chick	N/A
Batiquitos Lagoon W-2	1	1		N. Mudry	YES	YES	YES	YES	6		CDFG
Batiquitos Lagoon E-1	1	1		J. Price	YES	YES	NO	YES	6		CDFG
Batiquitos Lagoon E-2	1	1		C. Hertzog	YES	YES	YES	YES	8		CDFG
Batiquitos Lagoon E-3	1	1		S. Shulberg	YES	YES	YES	YES	8		CDFG
San Elijo Lagoon	1	3	Robert Patton	Warren Wong, Susan Welker	YES	NO	NO	YES (one island)	2	fence maint.; water level mngt	CDFG, San Diego County Parks, San Elijo Lagoon Conservancy
Mission Bay FAA Island	1	1	Jennifer Price	none	YES	YES	NO	YES	8	unknown	FAA, USFWS
Mis. Bay Mariner's Pt	1	1	Ginger Johnson	Jennifer Price	YES	YES	NO	YES	2	Keep-out signs visible from water	Audubon Soc.
Mis. Bay N. Fiesta Isl.	1	1	Jennifer Price	none	NO	NO	NO	NO	7	NO	City of San Diego, Audubon Soc.
Mission Bay South Shores	1	3	Jennifer Price	none	NO	NO	NO	NO	NO	NO	City of San Diego mulched site to discourge nesting
Lindbergh Field	1	3	Robert Patton	B. Foster, E. Copper, S. Wolf, S. Euing, M. Bache, M. Alfaro, B. Collins	YES	NO	NO	YES	4	plastic mesh covers over storm drains, 8" tall chick fencing	San Diego Unified Port District
North Island NAS	1	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown
Delta Beach North	1	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown
Delta Beach South	1	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown
NAB Ocean	1	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown

Table 1. California Least Tern Site Preparation and Monitor Information[a], 1999

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Site Name	Site Type[b]	Fence Type[c]	Name of Primary Monitor	Names of Other Monitors	Inter-pretive signs?	Chick shelters?	Decoys?	Grid System?	Vegetation Manage-ment[d]?	Other Site Preparation?	By Whom?
Chula Vista Wildlife Reserve	1	3	Robert Patton	B. Foster, E. Copper, S. Wolf, S. Euing, M. Bache, M. Alfaro, B.	YES	YES	YES	YES	4	NO	Zoological Society of San Diego
D Street Fill	1	3	Robert Patton	B. Foster, E. Copper, S. Wolf, S. Euing, M. Bache, M. Alfaro, B. Collins	YES	YES	YES	YES	4	removed derelict boats and debris; ant control bait experiments	Zoological Society of San Diego & USFWS Refuges
Saltworks	1	4	Elizabeth Copper	Mark Pavelka	NO	few tiles	NO	NO	NO		
Tijuana Estuary	1	3	Robert Patton	B. Collins, M. Alfaro, N. Ramos, B. Bonesteel	YES	NO	NO	NO	7	fence repairs; twine barricades	USFWS Refuges, State Parks and CDF corrections crew

a Site preparation

b Type 1 sites: monitors

c 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

d 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 removed by other means; 6) vegetation management not necessary; 7) vegetation management necessary but was not conducted; 8) vegetation management was necessary but not sufficient.

Table 2A.
Reported California Least Tern Pairs and Fledglings by Nesting Site, 1999

SITE NAME	1999 Pairs: low	high	1998 Pairs	% + or - from 1998	1999 Nests	1999 Fledglings: low	high	1998 Fledglings	% + or - from 1998	1999 Fledglings per Pair: low	high
SAN FRANCISCO BAY											
PGE, Pittsburgh	**11**	**11**	11	*0%*	12	**14**	**14**	8	*75.0%*	**1.27**	**1.27**
NAS Alameda	**250**	**250**	243	*3%*	276	**77**	**77**	90	*-14.4%*	**0.31**	**0.32**
SAN LUIS OBISPO/SANTA BARBARA COUNTIES:											
Oceano (Pismo) Dunes	**24**	**24**	37	*-35%*	34	**7**	**7**	25	*-72.0%*	**0.29**	**0.19**
Guadalupe/Mussel Rock Dunes	**15**	**15**	2	*650%*	19	**12**	**12**	0	*N/A*	**0.80**	**6.00**
Vandenberg AFB - Purisima Pt	**27**	**27**	19	*42%*	44	**15**	**15**	14	*7.1%*	**0.56**	**0.79**
VENTURA COUNTY:											
Santa Clara River Mouth	**13**	**18**	38	*5%*	22	**24**	**24**	22	*9.1%*	**1.33**	**1.85**
McGrath Lake	**17**	**22**			28						
Ormond Beach	**70**	**70**	86	*-19%*	85	**63**	**63**	56	*12.5%*	**0.90**	**0.90**
NAWS Point Mugu	**110**	**150**	266	*-59%*	176	**28**	**28**	165	*-83.0%*	**0.19**	**0.25**
NAWS Point Mugu Islands	**8**	**10**	8	*N/A*	36	**12**	**12**	0	*N/A*	**N/A**	**N/A**
L.A./ORANGE COUNTIES:											
Venice Beach	**43**	**43**	383	*-89%*	50	**0**	**0**	200	*-100.0%*	**0.00**	**0.00**
L.A. Harbor Pier 400	**235**	**235**	172	*37%*	367	**165**	**165**	148	*11.5%*	**0.70**	**0.70**
L.A. Harbor TC2											
Seal Beach	**30**	**60**	167	*-82%*	74	**0**	**0**	99	*-100.0%*	**0.00**	**0.00**
Bolsa Chica	**42**	**55**	136	*-69%*	65	**0**	**0**	74	*-100.0%*	**0.00**	**0.00**
Huntington Beach	**250**	**250**	319	*-22%*	303	**25**	**25**	249	*-90.0%*	**0.10**	**0.10**
Upper Newport Bay	**53**	**60**	26	*104%*	60	**5**	**5**	20	*-75.0%*	**0.08**	**0.09**
SAN DIEGO COUNTY:											
White Beach	**53**	**53**	33	*61%*	56	**48**	**52**	17	*182.4%*	**0.91**	**0.98**
SM River - North Beach	**559**	**559**	644	*-13%*	661			265	*-100.0%*	**0.00**	**0.00**
SM River - Salt Flats	**25**	**25**	43	*-42%*	39			13	*-100.0%*	**0.00**	**0.00**
SM River - Salt Flats Is.	**35**	**35**	40	*-13%*	40			13	*-100.0%*	**0.00**	**0.00**
Batiquitos Lagoon W-1	**0**	**0**	12	*-100%*	0	**10**	**12**	28	*-88.9%*	**0.00**	**0.00**
Batiquitos Lagoon W-2	**115**	**125**	81	*42%*	140						
Batiquitos Lagoon E-1	**11**	**11**	2	*450%*	11						
Batiquitos Lagoon E-2	**0**	**0**	9	*n/a*	0						
Batiquitos Lagoon E-3	**20**	**20**	75	*-73%*	25						
San Elijo Lagoon	**8**	**8**	1	*700%*	11	**2**	**2**	1	*100.0%*	**0.25**	**0.25**
Mission Bay FAA Island	**66**	**66**	31	*113%*	79	**2**	**2**	25	*-92.0%*	**0.03**	**0.03**
Mission Bay Mariner's Point	**562**	**562**	528	*6%*	620	**60**	**60**	596	*-89.9%*	**0.11**	**0.11**
Mission Bay North Fiesta Isl.	**0**	**0**	21	*-100%*	0	**0**	**0**	13	*-100.0%*	**N/A**	**N/A**
Mission Bay South Shores	**0**	**0**	9	*N/A*	0	**0**	**0**	1	*N/A*	**N/A**	**N/A**
Lindbergh Field	**20**	**20**	17	*18%*	20	**0**	**0**	21	*-100.0%*	**0.00**	**0.00**
North Island NAS	**75**	**85**	59	*27%*	102	**30**	**40**	75	*-60.0%*	**0.35**	**0.53**
Delta Beach North	**240**	**260**	284	*-15%*	344	**25**	**25**	200	*-87.5%*	**0.10**	**0.10**
Delta Beach South	**60**	**70**	60	*0%*	80	**3**	**5**	68	*-95.6%*	**0.04**	**0.08**
NAB Ocean	**270**	**320**	151	*79%*	278	**17**	**30**	175	*-90.3%*	**0.05**	**0.11**
Chula Vista Wildlife Refuge	**2**	**2**	2	*n/a*	2	**0**	**0**	3	*0.00%*	**0.00**	**0.00**
D Street Fill	**30**	**30**	6	*400%*	36	**2**	**2**	9	*N/A*	**0.07**	**0.07**
Saltworks	**15**	**20**	39	*-62%*	25	**6**	**6**	3	*100.0%*	**0.30**	**0.40**
Tijuana River	**87**	**103**	99	*-12%*	128	**19**	**28**	53	*-64.2%*	**0.18**	**0.32**
TOTALS	**3451**	**3674**	4159	*-14.3%*	4348	**671**	**711**	2749	*-74.9%*	**0.18**	**0.21**
AVERAGES	**3562.5**					**691**				**0.19**	

Table 2B. California Least Tern Pairs and Fledglings by Region, 1999

REGION	1999 Pairs[a]	% of 1999 Statewide Pairs	1998 Pairs	% + or - from 1998	1999 Fledg-lings	% of 1999 Statewide Fledglings[a]	1998 Fledg-lings	% + or - from 1998
San Francisco Bay	261	7.3%	254	2.8%	91	13%	98	-7.1%
San Luis Obispo & Santa Barbara Counties	66	1.9%	58	13.8%	34	5%	39	-12.8%
Ventura County	244	6.8%	398	-38.7%	127	18%	243	-47.7%
Los Angeles & Orange Counties	678	19.0%	1203	-43.6%	195	28%	790	-75.3%
San Diego County	2313	64.9%	2246	3.0%	244	35%	1579	-84.5%

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

Table 3A. California Least Tern Pair and Nest Data, 1999

page 1 of 2

Site Name	Date of First Nest	Date of "Second Wave" Start[a]	Total NESTS "First Wave"[a]	Minus Estimated Renesters "First Wave"	TOTAL PAIRS "First Wave"	Total NESTS "Second Wave"	Minus Estimated Renesters "Second Wave"	TOTAL PAIRS "Second Wave"	TOTAL NESTS 1999	TOTAL PAIRS 1999[b]	Date of Last New Nest
PGE, Pittsburgh	19-May	unknown	11	0	11	1	1	0	12	11	11-Jul
NAS Alameda	17-May	18-Jun	218			58			276	250	
Oceano (Pismo) Dunes	31-May	unknown	unknown	unknown	unknown	unknown	unknown	unknown	34	24	4-Jul
Mussel Rock/Guad. Dn	30-May	unknown	unknown	unknown	unknown	unknown	unknown	unknown	19	15	3-Jul
Vandenberg AFB: Purisima	18-May	unknown	unknown	unknown	unknown	unknown	unknown	unknown	44	27	27-Jun
Santa Clara River North	27-May	unknown	unknown	unknown	unknown	unknown	unknown	unknown	22	15	18-Jun
McGrath Lake	27-May	unknown	unknown	unknown	unknown	unknown	unknown	unknown	28	19	9-Jul
Ormond Beach	< June 10	unknown	85	unknown	unknown	0	unknown	unknown	85	70	6-Jul
NAWS Point Mugu	27-May	unknown	unknown	unknown	unknown	unknown	unknown	unknown	176	130	15-Jul
NAWS Pt Mugu Nesting Isl	24-May	unknown	unknown	unknown	unknown	unknown	unknown	unknown	36	9	27-Jun
Venice Beach	unknown	none	55	0	43	0	0	0	50	43	unknown
L.A. Harbor Pier 400	12-May	unknown	unknown	100	unknown	unknown	7	unknown	297	190	26-Jul
L.A. Harbor TC2	14-May	unknown	unknown	20	unknown	unknown	5	unknown	70	45	19-Jul
Seal Beach		none	74	unknown	30 - 60	0	0	0	74	45	
Bolsa Chica	< May 26	unknown	unknown	unknown	unknown	unknown	unknown	unknown	65	48	unknown
Huntington Beach	11-May	unknown	unknown	unknown	unknown	unknown	unknown	unknown	303	303	unknown
Upper Newport Bay	17-May	13-Jun	48	1	47	12	2	10	60	57	2-Jul
White Beach	13-May	unknown	unknown	unknown	unknown	unknown	unknown	unknown	56	53	4-Jun
SM River North Beach	13-May	unknown	unknown	unknown	unknown	unknown	unknown	unknown	661	559	24-Jul
SM River Salt Flats	18-May	unknown	unknown	unknown	unknown	unknown	unknown	unknown	39	25	17-Jul
SM River Salt Flats Is.	18-May	unknown	unknown	unknown	unknown	unknown	unknown	unknown	40	35	18-Jul
Batiquitos Lagoon W-1	no nesting in 1999										
Batiquitos Lagoon W-2	17-May	unknown	unknown	unknown	unknown	unknown	unknown	unknown	140	120	2-Aug
Batiquitos Lagoon E-1	22-May	unknown	unknown	unknown	unknown	unknown	unknown	unknown	11	11	31-May
Batiquitos Lagoon E-2	no nesting in 1999										
Batiquitos Lagoon E-3	20-May	unknown	unknown	unknown	unknown	unknown	unknown	unknown	25	20	5-Jun
San Elijo Lagoon	23-May	20-Jun	8	0 - 1	8	3	3	0 - 3	11	8	11-Jul
Mission Bay FAA Island	20-May	unknown	unknown	unknown	unknown	unknown	unknown	unknown	79	66	26-Jul
Mis. Bay Mariner's Pt	17-May	23-Jun	428	28	400	192	50	142	620	542	28-Jul
Mis. Bay N. Fiesta Isl.	no nesting in 1999										
Mis. Bay South Shores	no nesting in 1999										

Table 3A. California Least Tern Pair and Nest Data, 1999

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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 1999	TOTAL PAIRS 1999[b]	Date of Last New Nest
Lindbergh Field	18-May	unknown	unknown	unknown	unknown	unknown	unknown	unknown	20	20	10-Jun
North Island NAS	10-May	unknown	unknown	unknown	unknown	unknown	unknown	unknown	102	80	17-Jul
Delta Beach North	11-May	unknown	unknown	unknown	unknown	unknown	unknown	unknown	344	250	25-Jul
Delta Beach South	11-May	unknown	unknown	unknown	unknown	unknown	unknown	unknown	80	65	21-Jul
NAB Ocean	12-May	unknown	unknown	unknown	unknown	unknown	unknown	unknown	278	295	19-Jul
Chula Vista WR	18-May	unknown	unknown	unknown	unknown	unknown	unknown	unknown	2	2	25-May
D Street Fill	11-May	unknown	unknown	unknown	unknown	unknown	unknown	unknown	36	30	10-Jul
Saltworks	19-May	unknown	unknown	unknown	unknown	unknown	unknown	unknown	25	17	unknown
Tijuana Estuary	13-May	24-Jun	74	5-Jan	69 - 73	54	24 - 36	18-30	128	95	22-Jul
TOTALS[c]									**4348**	**see Table 2A**	

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

b When a range was provided (as presented in Table 2A), the mean for that range is used in this column.

c Totals are not provided for nests and pairs first and second wave as data were not provided for most sites.

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

Table 4. California Least Tern Productivity Data, 1999

Site Name	Total Nests	Total Eggs	Mean Clutch Size[a]	# Eggs Hatched[b]	% Hatching[c]	Fledgling estimate method[d]	Total Fledglings
PGE, Pittsburgh	12	23	1.92	19	82.6%	3W DAY	14
NAS Alameda	276	403	1.46			early a.m.	77
Oceano (Pismo) Dunes	34	61	1.79	43	70.5%	single count	7
Mussel Rock/Guad. Dn	19	35	1.84	24	68.6%	N/A	12
Vandenberg AFB: Purisima	44	91	2.07	50	54.9%	3W DUSK	15
Santa Clara River North	22	44	2.00	36	81.8%	unknown	24
McGrath Lake	28	46	1.64	14	30.4%	unknown	
Ormond Beach	85	unknown - Type 2 site				day counts	63
NAWS Point Mugu	176	307	1.74	257	83.7%	3W DUSK	28
NAWS Pt Mugu Nesting Isl	36	69	1.92	61	88.4%	3W DUSK	12
Venice Beach	50	80	1.60	0	0.0%	3W DAY	0
L.A. Harbor Pier 400	297	502	1.69	372	74.1%	3W DUSK	165
L.A. Harbor TC2	70	116	1.66	91	78.4%	3W DUSK	
Seal Beach	74					3W DUSK	0
Bolsa Chica	65	unknown	unknown	unknown	unknown	3W DUSK	0
Huntington Beach	303	597	1.97	489	81.9%	3W DUSK	25
Upper Newport Bay	60	107	1.78	61	57.0%	3W DAY	5
White Beach	56	110	1.96	60	54.5%	unknown	50
SM River North Beach	661	1153	1.74	402	34.9%	unknown	
SM River Salt Flats	39	58	1.49	10	17.2%	unknown	
SM River Salt Flats Is.	40	69	1.73	4	5.8%	unknown	
Batiquitos Lagoon W-1	no nesting in 1999					3W DAY	11
Batiquitos Lagoon W-2	140	261	1.86	120	46.0%	3W DAY	
Batiquitos Lagoon E-1	11	21	1.91	0	0.0%	3W DAY	
Batiquitos Lagoon E-2	no nesting in 1999					3W DAY	
Batiquitos Lagoon E-3	25	48	1.92	25	52.1%	3W DAY	
San Elijo Lagoon	11	16	1.45	6	37.5%	C	2
Mission Bay FAA Island	79	136	1.72	24	17.6%	3W DAY	2
Mis. Bay Mariner's Pt	620	1096	1.77	895	81.7%	banding	60
Mis. Bay N. Fiesta Isl.	no nesting in 1999					3W DAY	0
Mis. Bay South Shore	no nesting in 1999					3W DAY	0
Lindbergh Field	20	34	1.70	27	79.4%	C	0
North Island NAS	102	177	1.74	144	81.4%	unknown	35
Delta Beach North	344	577	1.68	402	69.7%	unknown	25
Delta Beach South	80	122	1.53	86	70.5%	unknown	4
NAB Ocean	278	457	1.64	335	73.3%	unknown	24
Chula Vista WR	2	4	2.00	2	50.0%	C	0
D Street Fill	36	63	1.75	8	12.7%	C	2
Saltworks	25	38	1.52	25	65.8%	3W DUSK	6
Tijuana Estuary	128	208	1.63	83	39.9%	C	23
TOTALS	**4348**	**7129**	**1.56[e]**	**4175**	**62.1%**		**691**

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 DUSK = fledgling numbers estimated by adding total counts from dusk censuses every three weeks; 3W DAY = same but counts conducted during the day, not dusk; banding = estimates from recapture of banded chicks near fledging (see text); 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, 1999

page 1 of 2

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	% Chick Mortality[b]	Number of Dead Fledglings	Number of Dead Adults
PGE, Pittsburgh	23	0	0	4	17.4%	0	0	0.0%	0	0
NAS Alameda	403	0					90	unknown	2	1
Oceano (Pismo) Dunes	61	0	0	6	9.8%	2	1	2.3%	0	0
Mussel Rock/Guad. Dn	35	2	0	0	0.0%	7	0	0.0%	0	0
Vandenberg AFB: Purisima	91	0	0	0	0.0%	0	2	4.0%	0	0
Santa Clara River North	44	0	0	0	0.0%	11	0	0.0%	0	0
McGrath Lake	46	0	0	7	15.2%	17	0	0.0%	0	0
Ormond Beach	unknown	0	2	0	unknown	31 - 62	0	unknown	0	0
NAWS Point Mugu	307	0	11	18	5.9%	0	9	3.5%	1	0
NAWS Pt Mugu Nesting Isl	69	0	0	8	11.6%	0	0	0.0%	0	0
Venice Beach	0	0	0	0	0.0%	0	0	0.0%	0	0
L.A. Harbor Pier 400	502	0	0	51	10.2%	11	80	21.5%	1	1
L.A. Harbor TC2	116	0	0	19	16.4%	2	12	13.2%	1	1
Seal Beach				40						
Bolsa Chica	unknown - first site visit not until May 26; all 65 nests abandoned or lost to predators by June 10									
Huntington Beach	597	0	0	28	4.7%	0	78	16.0%	0	0
Upper Newport Bay	107	1	2	0	unknown	34	5	8.2%	0	1
White Beach	110	2	4	20	18.2%	0	33	55.0%	0	0
SM River North Beach	1153	2	7	269	23.3%	0	186	46.3%	4	5
SM River Salt Flats	58	0	1	9	15.5%	0	1	10.0%	0	0
SM River Salt Flats Is.	69	0	0	11	15.9%	0	2	50.0%	0	0
Batiquitos Lagoon W-1	no nesting in 1999									
Batiquitos Lagoon W-2	261	0	0	131	50.2%	0	43	35.8%	0	0
Batiquitos Lagoon E-1	21	0	0	0	0.0%	0	0	0.0%	0	0
Batiquitos Lagoon E-2	no nesting in 1999									
Batiquitos Lagoon E-3	48	0	0	7	14.6%	0	2	8.0%	0	0
San Elijo Lagoon	16	0	0	4	25.0%	2	0	0.0%	0	0
Mission Bay FAA Island	136	0	0	7	5.1%	0	0	0.0%	0	0
Mis. Bay Mariner's Pt	1096	0	0	178	16.2%	594	368	41.1%	1	1
Mis. Bay N. Fiesta Isl.	no nesting in 1999									
Mis. Bay South Shores	no nesting in 1999									
Lindbergh Field	34	0	0	5	14.7%	0	1	3.7%	2	0

Table 5. California Least Tern Non-Predator Mortality, 1999

page 2 of 2

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	% Chick Mortality[b]	Number of Dead Fledglings	Number of Dead Adults
North Island NAS	177	0	36	30	16.9%	0	2	1.4%	0	1
Delta Beach North	577	0	114	135	23.4%	0	108	26.9%	0	0
Delta Beach South	122	0	17	30	24.6%	0	3	3.5%	0	0
NAB Ocean	457	6	78	104	22.8%	0	78	23.3%	1	0
Chula Vista WR	4	0	0	0	0.0%	0	0	0.0%	0	0
D Street Fill	63	0	0	8	12.7%	0	1	12.5%	0	0
Saltworks	38	0	0	6	15.8%	6	2	8.0%	0	0
Tijuana Estuary	208	6	6	18	8.7%	26	1	1.2%	1	0
TOTALS	**7049**	**19**	**278**	**1153**	**16.4%**	**712**	**1108**	**26.5%**	**14**	**11**

a Total eggs abandoned or infertile divided by the total number of eggs

b Total dead chicks divided by the number of eggs hatched for that site (see Table 4)

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

Table 6. Reported California Least Tern Losses to Predators[a], 1999

Predator	Site Name	Suspected or Documented?[b]	Number of Eggs Lost	Number of Chicks Lost	Number of Fledglings Lost	Number of Adults Lost	Predator Mngt for this Species?	Was it Effective?	If not, why?
AMERICAN CROW	Venice Beach	D	80				yes	no	site abandoned
	L.A. Harbor Pier 400	D	73				yes	yes	
	Seal Beach	D	60				yes	unknown	site abandoned
	Bolsa Chica	S	unknown	unknown			yes	unknown	site abandoned
	Batiquitos Lagoon - all	S	unknown				yes	yes	
	San Elijo Lagoon	S	unknown	unknown			no		
AMERICAN KESTREL	L.A. Harbor Pier 400	D		1			yes	yes	
	L.A. Harbor Pier 400	S		unknown			yes	yes	
	Bolsa Chica	S		unknown	unknown		yes	unknown	site abandoned
	Huntington Beach	S		unknown	3		yes	yes	
	Batiquitos Lagoon - all	S		unknown			yes	yes	
	Mis. Bay Mariner's Pt	S			2 - 10		yes	yes	
	Lindbergh Field	S		17 - 20			yes	unknown	
ANTS	Mis. Bay Mariner's Pt	D	2 - 10	2 - 10			yes	no	not used in time
	Delta Beach North	S	2				unknown		
	Delta Beach South	S		1			unknown		
BARN OWL	Bolsa Chica	S		unknown	unknown	unknown	no		
BURROWING OWL	Delta Beach North	S		9		6	unknown		
	Delta Beach South	D		3	2		unknown		
	NAB Ocean	D	1	3	2	2	unknown		
	Tijuana Estuary	D			5 - 7	2	yes	yes	
COMMON RAVEN	Seal Beach	D	63				yes	unknown	site abandoned
	Mission Bay FAA Is.	D	29				yes	unknown	
	Mission Bay FAA Is.	S	75				yes	unknown	
	Mis. Bay Mariner's Pt	S	unknown	unknown			yes	yes	
	Tijuana Estuary	D	12				yes	yes	
COYOTE	Vandenberg AFB	D	28 - 32	33			unknown		
	Oceano (Pismo) Dunes		4				unknown		
	SM River North Beach SM River Salt Flats SM River Salt Flats Is.	D	495	unknown	unknown		yes	yes, eventually	
	San Elijo Lagoon	D	1				no		
	San Elijo Lagoon	S	unknown	unknown			no		
	D Street Fill	D	44	unknown			yes	yes	
	Tijuana Estuary	D	6				unknown		
FERAL OR DOMESTIC CAT	Bolsa Chica	S		unknown	unknown	unknown	no		
	Upper Newport Bay	S	4				no		
	Tijuana Estuary	D	4				yes	yes	
FERAL DOG	Tijuana Estuary	D	3				yes	yes	
GREAT BLUE HERON	Bolsa Chica	S		unknown			no		
	L.A. Harbor TC2	S		unknown			yes; hazing	yes	
GULL SPECIES	Bolsa Chica	S	unknown	unknown			no		
	Mis. Bay Mariner's Pt	S	21				yes	yes	
	Saltworks	S	7				unknown		
	Tijuana Estuary	D	4				yes	yes	
	NAB Ocean	D	9	3			unknown		
NORTHERN HARRIER	NAS Alameda	D		10			unknown		
	Tijuana Estuary	D	4	1			no		
PEREGRINE FALCON	Bolsa Chica	S		unknown	unknown	unknown	no		
	Seal Beach	D				2	yes, hazing	unknown	site abandoned
	Seal Beach	S				2	yes, hazing	unknown	site abandoned
	Upper Newport Bay	D		2			no		
	Upper Newport Bay	S		30			no		
	Mission Bay FAA Is.	D		22			no		
	Mis. Bay Mariner's Pt	S		unknown	unknown		no		
	Saltworks	D			2		no		
RED-TAILED HAWK	Bolsa Chica	S		unknown	unknown		no		
	Upper Newport Bay	D		2			no		
	Upper Newport Bay	S		30 - 45			no		
	Batiquitos Lagoon - all	S		unknown	unknown				
OTHER SPECIES:									
Black-widow spider	NAS Alameda	D		2 - 3					
Black-widow spider	Bolsa Chica	S		unknown					
Black-crowned Night Heron	Bolsa Chica	S	unknown	unknown			no		
Cooper's Hawk	Bolsa Chica	S		unknown	unknown		no		
Gull-billed Tern	Delta Beach North	D	1	6			yes	unknown	
Gull-billed Tern	Delta Beach South	D		2					
Gull-billed Tern	NAB Ocean	D		10					

Table 6. Reported California Least Tern Losses to Predators[a], 1999

Predator	Site Name	Suspected or Documented?[b]	Number of Eggs Lost	Number of Chicks Lost	Number of Fledglings Lost	Number of Adults Lost	Predator Mngt for this Species?	Was it Effective?	If not, why?
OTHER SPECIES (continued):									
Opossum	Bolsa Chica	S	unknown				no		
Opossum	Tijuana Estuary	D	1	1			yes	yes	
Raccoon	Bolsa Chica	S	unknown						
Raccoon	Batiquitos Lagoon - all	S	unknown				yes	yes	
Raccoon	San Elijo Lagoon	D		2			no		
Raccoon	San Elijo Lagoon	S	unknown	unknown					
White-tailed Kite	Ormond Beach	S		unknown			no		
White-tailed Kite	Bolsa Chica	S		unknown	unknown		no		
White-tailed Kite	Upper Newport Bay	S		7			no		
unidentified owl	NAS Alameda	D		21	1		unknown		
unidentified owl	NAS Alameda	S		9	1		unknown		
unknown	NAS Alameda	D		5			unknown		
unknown	Vandenberg AFB	D	5 - 9				unknown		
unknown	Huntington Beach	D	4			4	no		
unknown	White Beach	D	23	3	0	0	unknown	unknown	
unknown	SM River - all	D	81	13	1	3	unknown	unknown	
unknown	Batiquitos Lagoon W-2	D	10				yes	unknown	
unknown	Batiquitos Lagoon E-1	D	21				yes	unknown	
unknown	Batiquitos Lagoon E-3	D	15				yes	unknown	
unknown	San Elijo Lagoon	D	3 - 5				no		
unknown	NAB Ocean	D	3				unknown		
unknown	Delta Beach North	D	22	3			unknown		
unknown	D Street Fill	S	3	5			no		
unknown	Chula Vista WR	S	2	2			no		
unknown	Saltworks	S	6	15 - 17	2		no		
unknown	Tijuana Estuary	S	26	22 - 74			yes	yes	
data not provided	Guadalupe (MR) Dunes	?	unknown	unknown	unknown	unknown			
data not provided	Santa Clara R/Mcgrath	?	unknown	unknown	unknown	unknown			
data not provided	NAWS Pt. Mugu & Isl.	?	unknown	unknown	unknown	unknown			
data not provided	SM River - all	?	unknown	unknown	unknown	unknown			
data not provided	North Island NAS	?	5	2	4		unknown		
			MINIMUM losses:						
			eggs	**chicks**	**fledglings**	**adults**			
TOTAL MINIMUM LOSSES[c]			**1267**	**340**	**30**	**21**			

a Many monitors did not report predator losses.

b See text for a description of "suspected" and "documented" predators. Observations of potential predators are not included in this table.

c reported losses are minimal due to the high number of undocumented and reported "unknown" losses

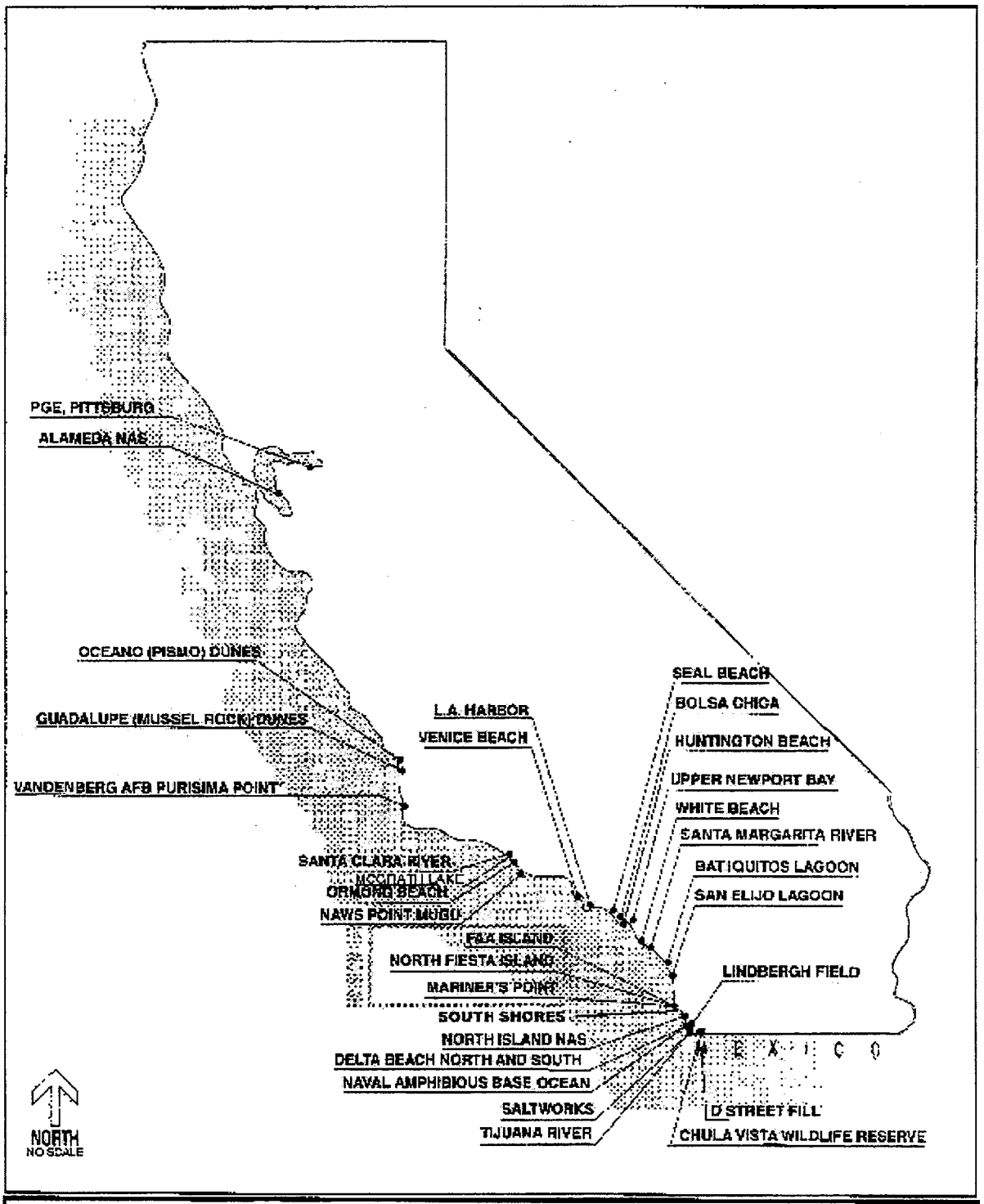


Figure 1. Location of California Least Tern Nesting Sites, 1999

Figure 2. Distribution of Pairs and Fledglings by Nesting Site, 1999

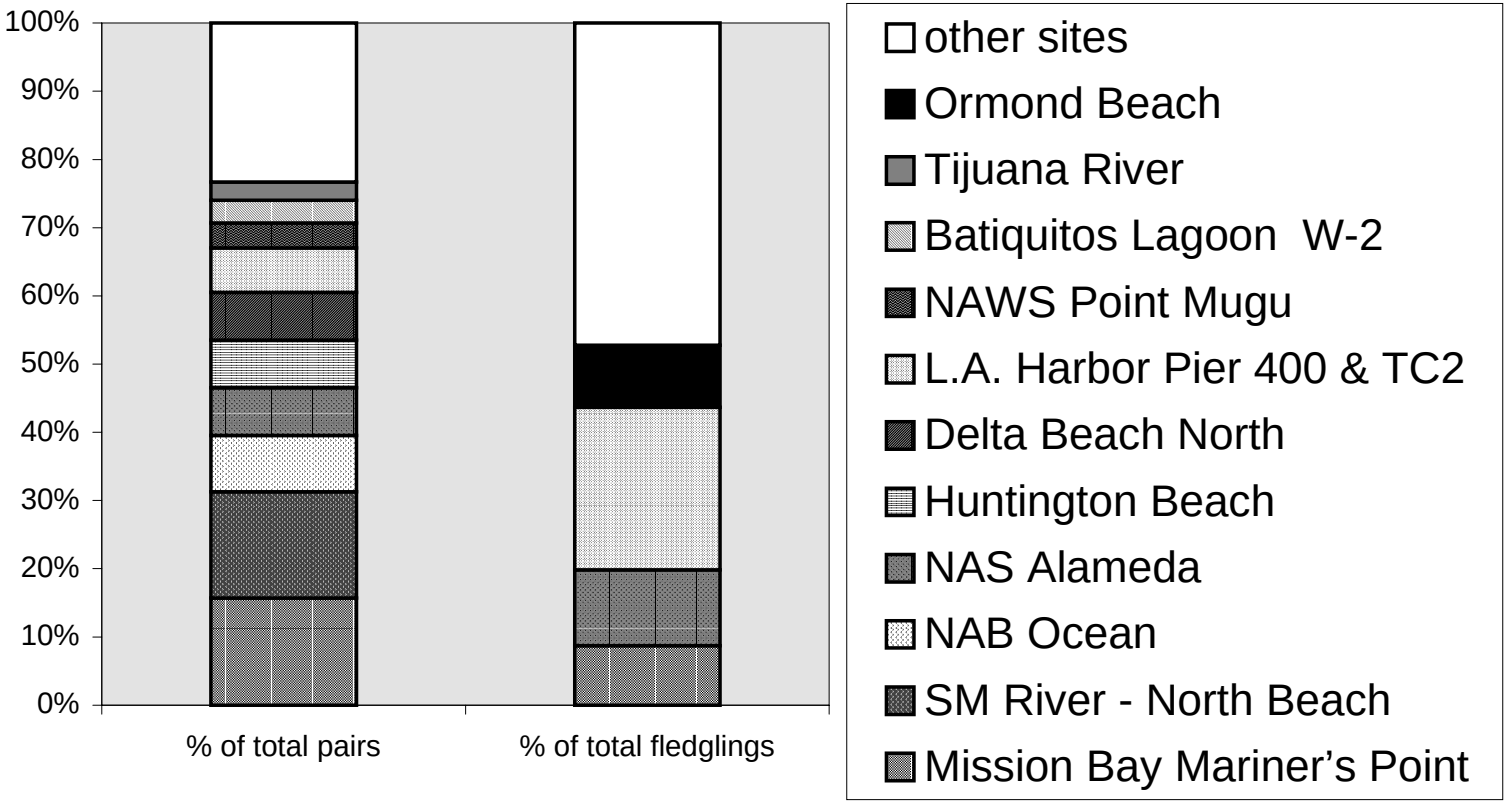


Figure 3. Percent of Statewide Pairs and Fledglings by Region, 1999

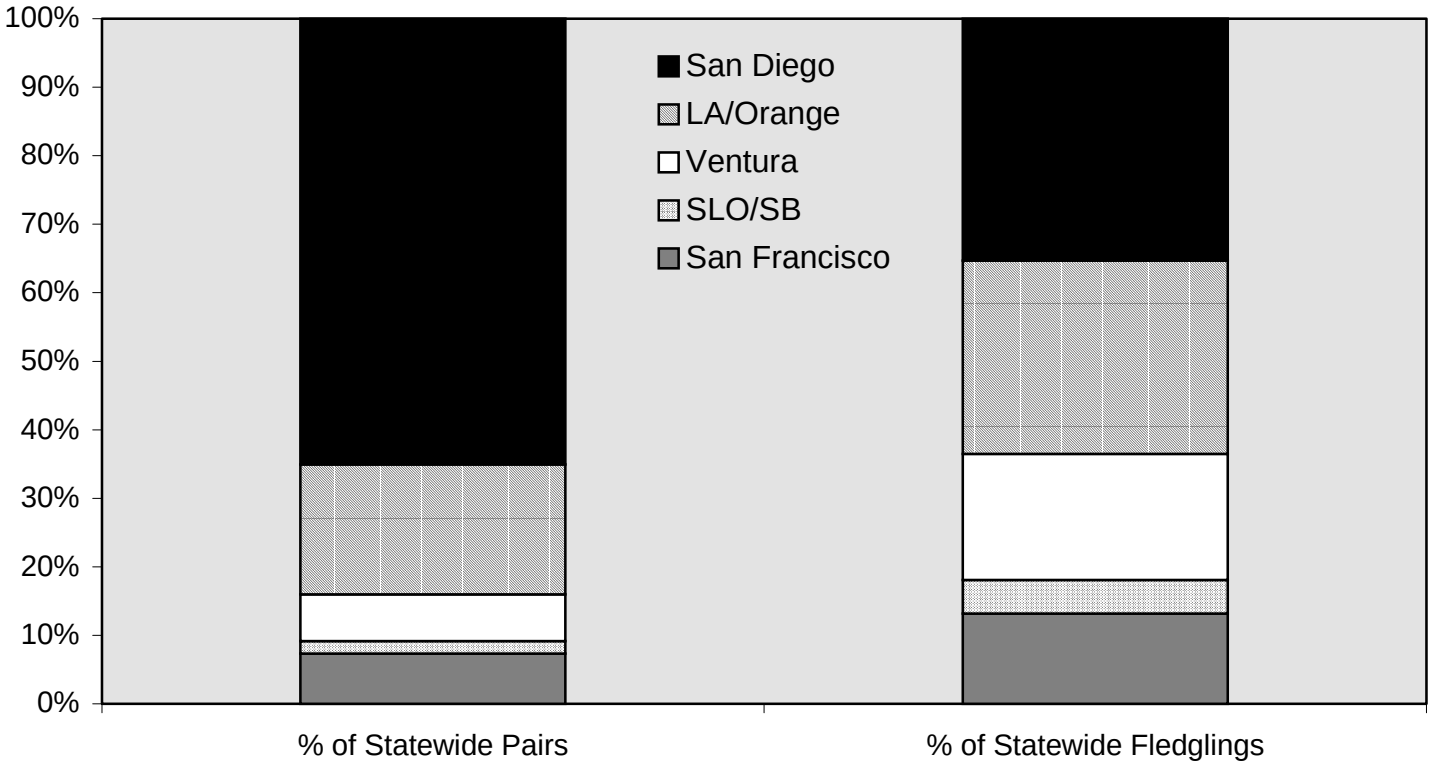
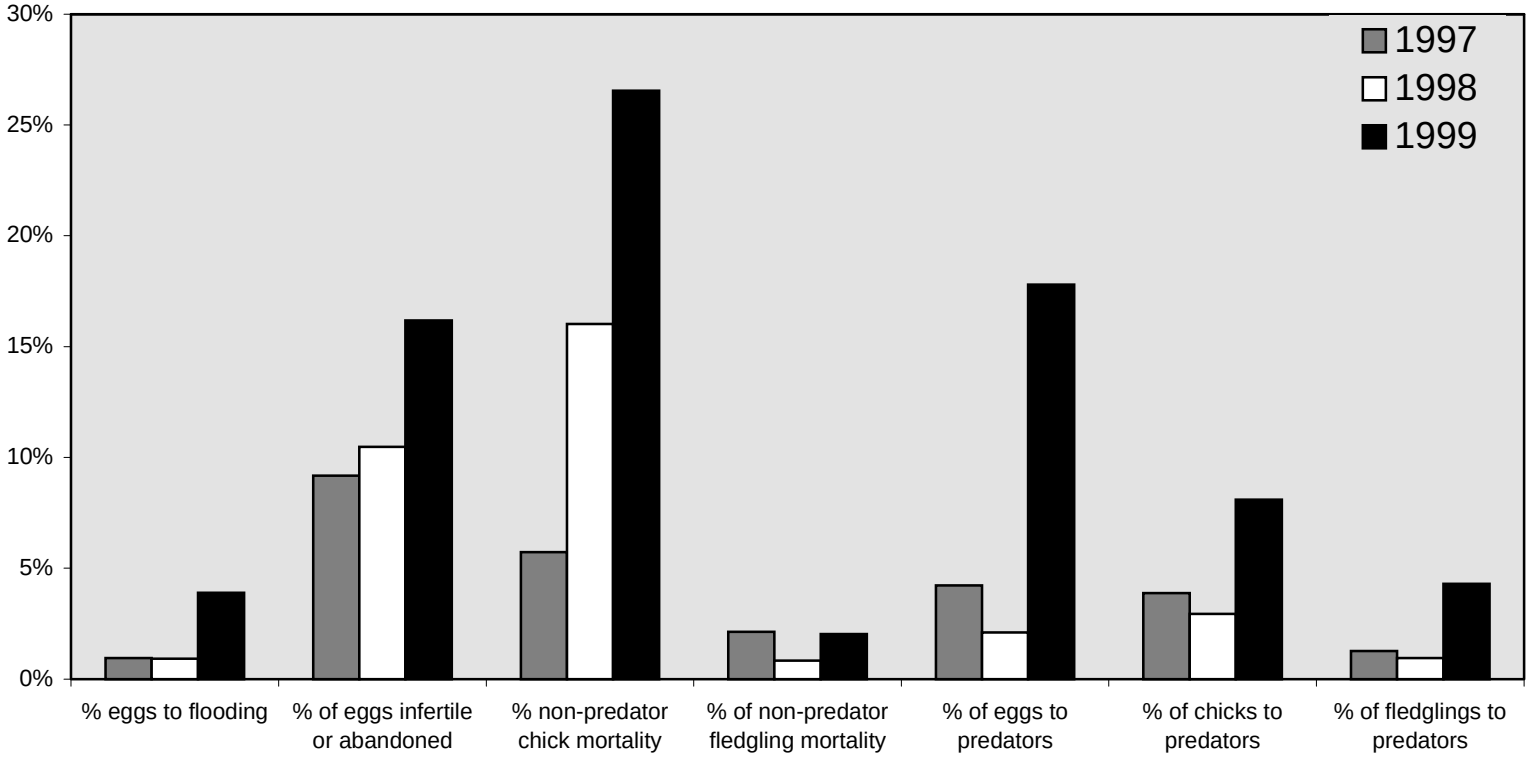
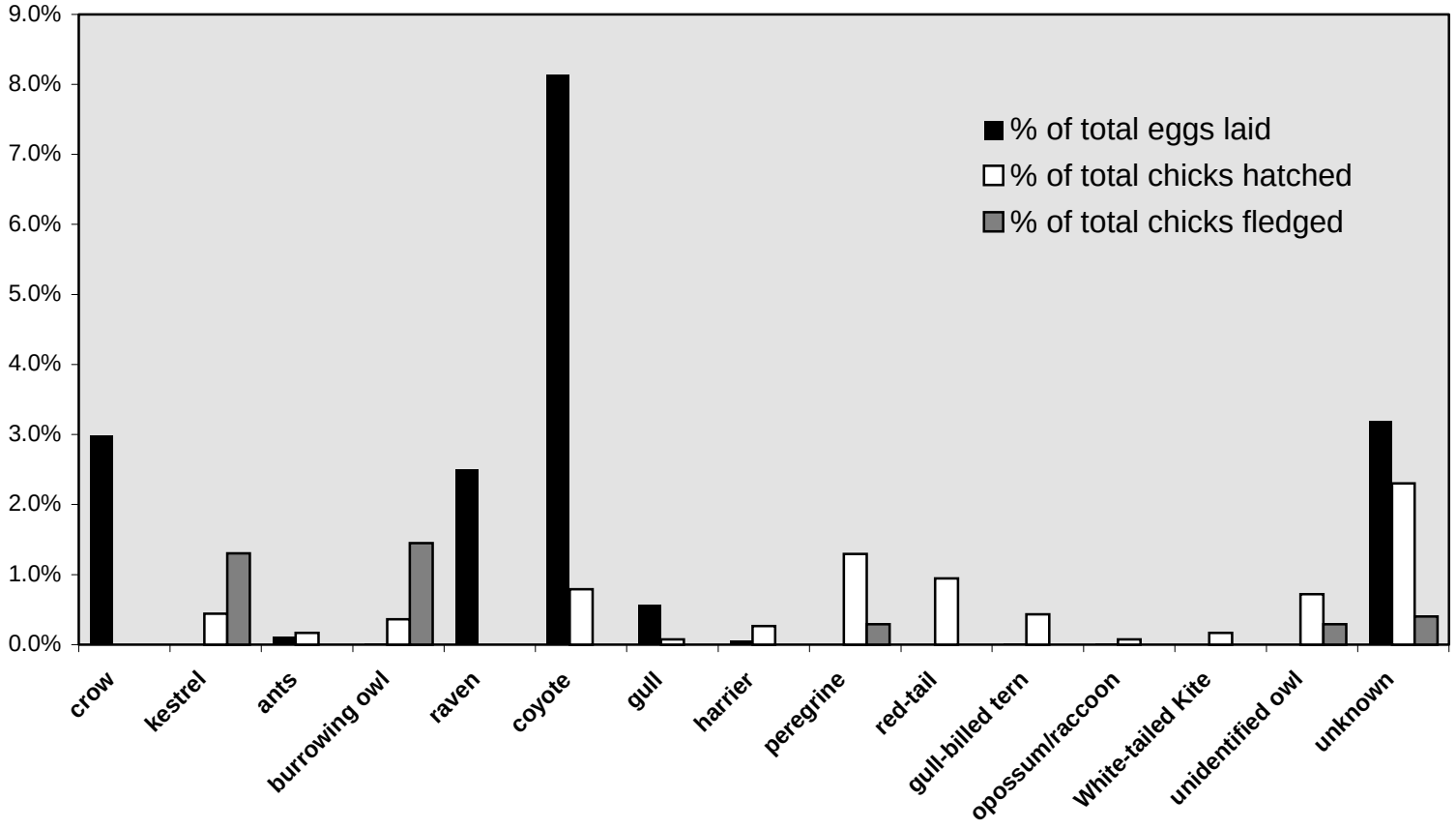


Figure 4. Comparison of Reported Types of Reproductive Failure, 1997, 1998 and 1999



source for 1997 data: Keane 1998; source for 1998 data: Keane 1999

Figure 5. Percentage of Reproductive Effort Lost to Predators, 1999



(this graph includes only reported losses; several monitors did not report predator losses, and most other sites had additional undocumented losses)

Figure 6. California Least Tern Pairs and Fledglings, 1976 to 1999

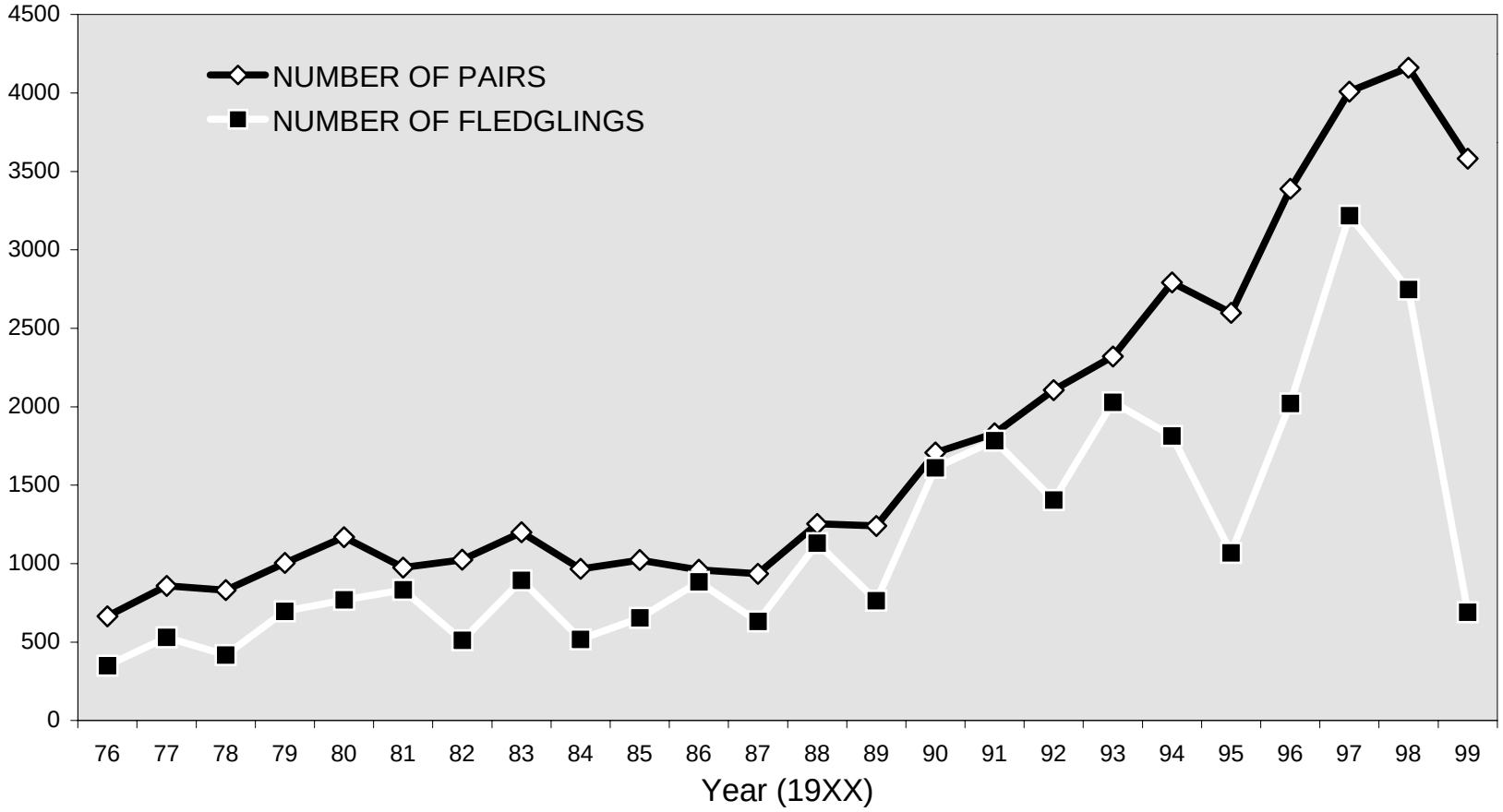


Figure 7. Fledglings per Pair Values, 1976 through 1999