

**State of California
The Resources Agency
Department of Fish and Game
Habitat Conservation Planning Branch**

**CALIFORNIA LEAST TERN
BREEDING SURVEY**

2000 SEASON

**by
Robert T. Patton**

FINAL REPORT

To

State of California
Department of Fish & Game
4949 Viewridge Avenue
San Diego, CA 92123

CONTRACT P99R506 (FY 99/2000)

CALIFORNIA LEAST TERN BREEDING SURVEY

2000 SEASON

**CONTRACTOR,
PRINCIPAL INVESTIGATOR
AND AUTHOR**

Robert T. Patton
Consulting Biologist
Zoological Society of San Diego
Center for Reproduction of Endangered Species (CRES)
Division of Applied Conservation
P.O. Box 120551
San Diego, CA 92112-0551

Prepared 15 February 2001
Revised 21 October 2002

State of California
The Resources Agency
Department of Fish and Game

CALIFORNIA LEAST TERN BREEDING SURVEY, 2000 SEASON¹

by

Robert Patton
Consulting Biologist
Zoological Society of San Diego
Center for Reproduction of Endangered Species (CRES)
Division of Applied Conservation
San Diego, CA 92112

ABSTRACT

Monitoring of nesting sites in 2000 resulted in an estimate of 4521 to 4790 breeding pairs of California least terns establishing 5301 nests at 37 locations. This represents a 31 percent increase in the minimum estimated number of breeding pairs from 1999. An estimated 3710 to 4013 fledglings were produced, or 0.77 to 0.89 fledglings per pair. This represents a 453 percent increase over productivity of the 1999 season, and 38 percent over that of 1998.

Depredation was the primary limiting factor to reproductive success. Other reported causes of mortality included a heat wave in the San Francisco Bay area, nest abandonment, and human activity, including loss of chicks to vehicles.

The nesting colony at Camp Pendleton continues to be the largest in the state, accounting for 22.8 percent of breeding pairs and producing 27.6 percent of this season's fledglings. Other colonies numbering over 200 nests included Alameda Point, Point Mugu, Venice Beach, L.A. Harbor, Huntington State Beach, Mariner's Point, Naval Amphibious Base Coronado North Delta Beach and ocean beach, and Tijuana Estuary. The nesting site first documented in 1998 at Tulare Lake bed evaporation ponds outside of Kettleman City in Kings County was used again in 2000, and newly created Caltrans mitigation islands in Albany in Alameda County were colonized and produced at least one fledgling.

¹ Patton, R. 2002. California least tern breeding survey, 2000 season. Calif. Dep. Fish and Game, Habitat Conservation and Planning Branch, Species Conservation and Recovery Program Report, 2002-03. Sacramento, CA. 24 pp. + app.

INTRODUCTION

The California least tern (*Sterna antillarum browni*) once nested in large, loose colonies on beaches throughout Southern California, south through Baja California, Mexico, and north to the San Francisco Bay area. Increasing urbanization and habitat loss has led to the decline of its population and shifted much of the nesting to less traditional colony sites, including airports and landfills (Chambers 1908, Grinnell and Miller 1944, Craig 1971, Atwood et al. 1977, Massey 1977, Palacios and Mellink 1996). The subspecies has been listed as federally endangered since 1970 (Federal Register 35:8495 & 16047, US Bureau of Sport Fisheries and Wildlife 1973), and state endangered since 1971 (California Department of Fish and Game 1972). The population in California in 1973 was thought to be as low as 624 nesting pairs (Bender 1974a), but by 1998 the population had grown to an estimated 4141 to 4182 nesting pairs (Keane 2000).

The species is uncommon to common but very localized migrant and summer visitor along the California coast, with approximately 30 nesting colonies focused in San Diego and Orange Counties, and scattered as far north as the San Francisco Bay area (Figure 1). Very rare observation records extend from Del Norte County as far north as southwestern Washington. Typically birds are present from mid-April through August, with extreme dates in early April and late October (US Fish and Wildlife Service 1980, Unitt 1984, Small 1994).

Nest numbers and colony locations vary year to year with sites occasionally abandoned following sustained disturbance and low reproductive success rates (Burger 1984, Atwood and Massey 1988). Generally, nest and pair numbers increased beginning in the 1970s with protection of colony sites and regular monitoring. Refinements in monitoring and management accelerated the increasing population trend in the 1980s, with the largest increases following implementation of predator control efforts in the late 1980s (Massey 1988, Fancher 1992, Caffrey 1995).

METHODS

Monitors and Data Compilation

Population recovery of this endangered species relies on adaptive management of nesting sites. Such management relies on regular monitoring, with assessment of management efforts and population status based on estimates of breeding pairs and reproductive success. Sites of historic and potential nesting by California least terns are monitored annually by resource agency personnel, staff of other governmental entities that may have jurisdiction over the site, contract biologists, and trained volunteers. Monitors follow survey protocol and are authorized by Federal Fish and Wildlife Endangered and Threatened Species 10(a)(1)(A) Permits issued by U.S. Fish and Wildlife Service (USFWS), and by Memoranda of Understanding issued by California Department of Fish and Game (CDFG). Levels of monitoring effort and protocol are determined by local and regional offices of the resource agencies and by site owners.

Monitoring data from each site are requested annually and compiled by a monitoring coordinator under contract with CDFG. Mid-season and end-of-season forms are distributed, but response and completeness of submitted data may vary between sites, agencies, and individual monitors. Monitoring, data collection, and reporting have been refined by the working group over the years, with a comprehensive statewide monitoring packet distributed by Caffrey in 1995

and standardization to Microsoft Excel format by Keane in 1997. No statistical analysis of data is conducted.

Site Preparation

Data requested include general categorizations of site preparation efforts. Level of site protection from human disturbance and deterrence to potential mammalian predators is indicated by ranking fence type at each site. Categorization is based on whether the fence excludes most people and mammals (e.g., chain link or solid fence that fully encloses the site), if it further deters climbing by being cantilevered or barbed along the top, if the site is only partially fenced, or if the site is not fenced at all. Included also are whether the site has signs to explain the purpose of its restricted access, whether objects such as ceramic roofing tiles are provided as shelters for chicks from weather and predators, whether decoys are placed to attract terns, and whether the site has a mapped grid system to assist in location of nests (for example, numbered posts set every 30 m in transects across the site).

The urban and/or disturbed nature of many sites requires vegetation management to ensure limited vegetation height and density, and adequate open areas to accommodate nesting. Data requested include categorization of vegetation and substrate management at each site, summary of any additional site preparation measures, and identification of those responsible. Such measures include mechanical deposition of substrate material, dragging, scraping, or disking, herbicide application, and manual weeding or brush clearing. Included also are whether such measures were sufficient or not, whether more are needed, or if no vegetation management is needed.

Monitoring Effort

Summaries are requested of the monitoring effort at each site, including the dates of the first and last monitoring visits, the number of visits during the season, whether individual nests are marked (such as with numbered stakes or tongue depressors), whether individual eggs are marked (such as numbered on the shell with permanent ink), whether chicks are banded, and if applicable, what color combinations of bands are used. The general level of monitoring is also indicated by categorizing whether the site is primarily monitored by entering the nesting area to mark nests and check contents (type 1), monitored primarily from outside of the nesting area (type 2), or monitored primarily as type 2, but the nesting area entered at least monthly (type 3).

While type 1 monitoring does cause temporary disturbances to nesting due to the monitors' presence and increases the risks of impacts, it provides much more detailed data and facilitates timely adaptive management (e.g., protection of individual nests from flooding, predator management, fence repair, prosecution of trespassers, etc.). Potential adverse impacts from monitor induced disturbances are reduced by techniques such as the use of blinds, limiting duration of in-colony activity, limiting in-colony activity to periods of reduced sources of other disturbance (e.g., moderate weather conditions, reduced adjacent human activity, no potential predators present, etc.), and adapting methods of site coverage according to stage of breeding cycle and age of chicks. Nisbet (2000) reviewed human disturbance impacts to waterbird

colonies, and recognized the benefits of regular monitoring and habituation when steps were taken to minimize potential adverse impacts.

While type 2 monitoring generally avoids potential adverse impacts from monitors' presence in the colony, it provides only the minimal data needed to assess colony status, reproductive effort and success, factors affecting colony status and success, and population recovery. Without access to nests, data from type 2 sites are restricted to a minimum number of nests (since nests not being incubated at the time of the monitoring will not be counted), chicks, and fledglings, with little data on clutch size, hatching success, predation, abandonment, or other factors limiting reproductive success.

Estimation of Numbers of Breeding Pairs

The number of nests at each site provides the basis for estimating the number of breeding pairs, and thus, the overall population. Since least terns may renest following loss of a clutch or brood (Massey and Atwood 1981), determination of the breeding population requires separating the number of renests from the total number of nests. Traditionally, a relative index of the number of breeding pairs has been calculated by simply dividing the number of nests initiated after 15 June in the later part of the season by two, then adding the result to the number of nests initiated prior to 15 June in the early part of the season. Although a somewhat artificial index, it attempts to account for an assumed level of renesting late in the season and provides a value representing the number of breeding pairs relative to the same criteria for each site in the state. This pair estimation method I provides a method consistent at all sites and is not subject to differing interpretations of renesting by different monitors.

Two other methods of estimating numbers of breeding pairs were proposed by Keane in 1997 and 1998. These pair estimation methods II and III attempt to reach more realistic numbers of breeding pairs by subtracting the estimated number of renesters from the total number of nests. Discernment of renesting is extremely difficult and subject to interpretation by each monitor. Method II attempts to diminish the subjectivity by identifying the number of nests and broods lost, which should approximate the number of renesting pairs. It assumes that all pairs losing a clutch will renest, and that they will renest within the same site. Pair estimation method III divides the season into early and late, or first and second "waves" (Massey and Atwood 1981), and subtracts the number of estimated renesters in each from the total number of nests in each, then combines the results. To compare the methods, monitors are asked to submit calculations using at least both I and II, and to indicate which, if any, method they perceive as most accurate.

Productivity

Reproductive effort and success are measured by the total number of nests, the number of eggs, the number of chicks hatched, the number of chicks reaching fledgling age, and the number of fledglings surviving to disperse. Each of these variables is monitored at each site or colony (with limitations mentioned previously) and combined for the overall population within California. Limitations to reproductive effort and success also may be indicated by each of these variables, and degree of success or limiting factors and causes may be indicated by dates of

arrival and departure, dates of nest initiations, duration and distribution of nest initiations, clutch size, dates of hatching, dates of fledging, and numbers of each age class subject to abandonment, mortality, or predation. Monitors are requested to provide data on each of these.

Additional indicators of limiting factors include the presence or absence of terns, numbers and behavior of adults, frequency and duration of foraging and feeding, size of courtship and feeder fish, nest attendance, duration of incubation, egg size and weight, chick size and weight, chick growth rate, contaminants testing, necropsies, and post-mortem testing. More direct indicators of factors limiting reproductive success include incidence of human disturbance, presence and activity of potential predators. Monitors are encouraged to summarize data on each of these if collected and if pertinent.

Mean clutch size was calculated by dividing the total number of eggs by the total number of nests at each site. Mean clutch size for the population was calculated using only a sample consisting of values reported from those sites that included both total nest and egg numbers. Data from type 2 monitored sites or sites that failed to include egg numbers were not included. Hatching success rates were calculated as percentages of the total number of chicks hatched divided by the total number of eggs. Again, only data sets including both values were used as a sample to represent the hatching rate of the population. Fledging success rate was calculated by dividing the total estimated number of fledglings by the total number of chicks hatched. Fledgling per pair ratio was calculated by dividing the estimated number of fledglings produced by the estimated number of breeding pairs at each site.

Estimation of Fledgling Production

Fledgling production and survival estimates are complicated by the tendency of fledglings to shift between the nesting area, roosting sites, and foraging areas, as well as by the arrival of fledglings from other colonies. Monitors are asked to summarize or categorize the methods used for estimation of fledgling production for each site.

Banding provides means of identifying individual chicks by recapture up to the age that they fly, thus providing data on chick survival to fledging, dependent on frequency of monitoring and site conditions that limit recapture success. Color banding of individuals, cohorts, or by site also allows for identification of birds viewed from a distance, and provides data on post-dispersal survival, movements, etc. Although heavily emphasized earlier in the monitoring program, a limited number of sites now utilize banding, and a limited number of monitors hold appropriate permits.

Monitors are encouraged to count the number of each age class of tern each visit to the site, regardless of whether employing type 1 or type 2 monitoring. Adult and fledgling numbers generally increase at dusk and decrease around dawn as birds forage by day and return to roost for the night, although roost locations are located away from the nesting area at some sites and/or during some parts of the season (Massey and Atwood 1981, Atwood 1986). For this reason, monitors are asked to specify if counts were conducted by day or at dawn/dusk.

Fledglings generally disperse from their natal colony two to three weeks after first flying, although timing may be influenced by social and foraging demands, and human and predator disturbance (Massey and Atwood 1981, Thompson and Slack 1984, Massey 1989). Assuming that each cohort of fledglings produced at a site departs within two to three weeks, count data can then be examined and counts every three weeks tallied to arrive at an estimate of fledgling

production. Alternatively, specific fledgling counts may be conducted every three weeks. Counts are complicated by the likelihood of migrant fledglings from other sites arriving or roosting, particularly at dusk, and increasing in probability as the season progresses. Detection of arrival of migrants is facilitated by observations of band combinations on roosting birds, noting sudden increases in numbers of adults and fledglings, and by tracking numbers and ages of chicks to compare expected numbers of fledglings with observed numbers.

Each of these methods addresses estimation of fledgling production at each site. Estimation of seasonal production for the entire population may be achieved by simply adding variables from each site for a total, or estimation of total productivity may be reached through a series of “window surveys”. Ideally, certain dates and times for statewide simultaneous dusk counts could be coordinated so that the entire population and numbers of fledglings produced as of that date could be counted. Attempts in the past and communication among monitors this season indicated that anything beyond local coordination would be logistically impractical. As an alternative, monitors were requested to submit numbers of active nests, observed numbers of adults, and observed numbers of fledglings at each site for the monitoring visit closest to and preceding a target date every two weeks throughout the season. Data were then compiled to compare nest, pair, and fledgling numbers statewide in these “windows” of time.

Mortality and Predation

Data are requested on direct measures of limits to reproductive success, including depredation and non-predation mortality. Monitors list numbers of cases of documented mortality by age class: eggs, nests, chicks, fledglings, and adults. Non-predation mortality is specified by cause: human damage, flooding, pre-term abandonment (abandoned prior to 21-days of incubation), post-term abandonment or non-viability (abandoned after 21 days of incubation or longer), or cause unknown.

Potentially predatory species observed at the sites are categorized as potential, possible, suspected, or documented predators of least terns. A species is considered a potential predator if it has been documented preying on least terns or similar species in the past and was observed at or adjacent to the site during the season. If tern predation has occurred but the predator species responsible cannot be determined, or if there are unexplained disappearances of eggs and chicks, and a potential predator species or evidence of that species (tracks, pellets, feces, feather, fur, etc.) was observed at or adjacent to the site during the season, that species is considered a possible predator. If the observation or evidence of that species clearly coincides with the losses, it is a suspected predator. Such evidence would include observations of that species foraging within the colony or immediate area of the loss, prey remains characteristic of that predator species, tracks or sign within the colony or immediate vicinity of the loss consistent with the timing of the loss, etc. A documented predator is a species that has been observed preying on or taking a recognizable least tern egg, chick, fledgling, or adult; or for which substantial evidence is recorded meeting the following criteria: tracks at or leading to or from tern remains (including eggshell fragments) or an empty nest that had not been expected to hatch for at least three more days; or scat, pellets, or feathers at a similar scenario. The remains must be consistent with that expected from the indicated predator species.

Incidents of predator-related mortality are similarly categorized as possible, suspected, or documented predation events. Unexplained disappearances of eggs and chicks coinciding with

the presence of a potential predator at or adjacent to the site constitute cases of possible predation. Suspected predation consists of unexplained disappearances of eggs and chicks coinciding with the presence of a potential predator foraging within the colony or immediate area of the suspected loss, or tracks or sign within the colony or immediate vicinity of the suspected loss consistent with the timing of the loss. Documented predation occurs when a potential predator is observed preying on or taking a recognizable least tern egg, chick, fledgling, or adult; when tern remains (including eggshell fragments) show signs of trauma consistent with that expected from predator species but inconsistent with non-predation mortality; or when tracks are at or leading to or from an empty nest that had not been expected to hatch for at least three more days; or scat, pellets, or feathers at a similar scenario.

RESULTS AND DISCUSSION

Monitors and Data Submission

Some monitoring data were received from all sites known to have nesting least terns in California in 2000. All data received this season were entered into Excel spreadsheets and the majority is presented in tabular form as appendices to this report. Blank cells indicate lack of submission by monitors and/or inappropriateness of the variable at that site. Nesting site locations and monitors are listed in appendix Table A-1.

Site Preparation and Monitoring Effort

General categorizations of site preparation efforts are listed for each site in appendix Table A-1. A key to categorization codes is located at the end of the appendix. A new potential nesting site consisting of shell mound islands was created by Caltrans at their Central Avenue mitigation site in Albany on the eastern shore of San Francisco Bay (Figure 1). Appendix Table A-2 summarizes the monitoring effort at each site.

Breeding Pairs and Productivity

Chronology

Dates of first and last observations of California least terns at each site in 2000 are listed in appendix Table A-3a. The earliest observed dates reported were in L.A./Orange Counties on April 14th at Huntington Beach and 17th at Venice Beach. The earliest date in San Diego County was April 19th, May 2nd along the Central Coast, and April 29th in the San Francisco Bay Area. The first nest was reported on May 3rd, at Huntington Beach; most sites had nesting commence through May, and initial nesting was delayed until early June at most Ventura County sites. The latest nest initiation dates were reported as August 2nd and 18th at Tijuana Estuary and NAB Coronado, however these nests may have been undetected by monitors and initiated earlier.

The majority of nests were initiated prior to June 15th (Appendix Table A-3a), followed by a lower number of late season nests at most sites, as is typical (Massey and Atwood 1981).

Exceptions to this included Bolsa Chica where renesting occurred following trampling of nests by flocks of larger tern and skimmer species and predation. Point Mugu and McGrath Lake in Ventura County also had significantly higher numbers of nests post-June 15th. It appears that nesting simply began late at these sites, but it is possible that it included renesters from elsewhere.

Pair and Nest Numbers

Table 1 lists estimated numbers of breeding pairs, nests, and fledglings produced at each site in California in 2000. Appendix tables 3a and 3b include calculations used to estimate numbers of breeding pairs by three methods, estimated numbers of renesters, and breakdown of nest numbers by early and late season (pre and post-June 15th, first and second “waves”). Monitoring of nesting sites in 2000 resulted in an estimate of 4521 to 4790 breeding pairs of California least terns establishing 5301 to 5306 nests at 37 locations (Figure 1). This represents a 31.0 percent increase in the minimum estimated number of breeding pairs from 1999 and a 9.18 percent increase over that of 1998 (Table 2). The record high productivity in 1997 (Keane 1998) likely resulted in high numbers of three-year-olds arriving to breed for the first time in 2000. Numbers of nests in 2000 surpassed those of 1999 by 21.9 percent and 1998 by 16.7 percent (Keane 2000, 2001), although some of this increase may relate to increased renesting rather than new breeders. Insufficient data were submitted for meaningful window survey compilation.

Clutch Size and Hatching Success

Clutch size and hatching success are listed in appendix Table A-4. A total of 8596 eggs were reported for sites with 4778 nests, yielding an average clutch size of 1.80 eggs per nest for this sample of the population (not including type 2 monitored sites or sites that failed to include egg numbers). This figure is higher than those of 1.66 in 1998 and 1.56 in 1999, but lower than that of 1.86 in 1997 (Keane 1998, 2000, 2001).

Of sites reporting total nest, egg, and hatching numbers, a total of 7164 eggs hatched. This season’s hatching success rate of 83.3 percent surpassed that of 62.1 in 1999, 80.0 in 1998, and 79.8 in 1997 (Keane 1998, 2000, 2001).

Fledgling Production

Methods of fledgling-production estimation utilized at each site, and estimates of fledgling production, are listed in appendix Table A-4. The majority of monitors relied on a combination of methods this season to arrive at their estimated number of fledglings produced. Table 1 presents minimum and maximum estimated numbers of fledglings, breeding pairs, fledglings produced per pair, and total numbers of nests. An estimated 3710 to 4013 fledglings were produced, or 0.77 to 0.89 fledglings per pair. This represents a 453 percent increase over productivity of the 1999 season, 38.1 percent over that of 1998, and 18.2 over 1997. Fledging

success was 48.6 to 52.1 percent among those sites reporting total numbers of hatched chicks and estimates of total number of fledglings produced.

Mortality and Predation

Factors limiting reproductive success that were reported this season are listed in appendix tables A-5, A-6, and A-7. 1081 to 1086 eggs, chicks, and fledglings were reported as dead or damaged from non-predator-related causes, and 722 to 959 were reported as depredated. In addition to direct take of least tern eggs, chicks, and fledglings, indirect causes of reproductive failure included reported mortality of 35 adults and depredation of 123 to 132 adults.

Non-predation Mortality

Four percent of all eggs were lost to pre-term abandonment, 3.12 percent were non-viable or abandoned post-term, 0.35 percent were lost to flooding, and 0.03 to human activities (appendix Table A-5). Six percent of chicks and fledglings succumbed to unexplained mortality, mortality related to a heat wave in the San Francisco Bay area, and human activity, including loss of chicks to vehicles. The combination of all of these non-predation causes accounted for 12.6 to 12.6 percent of reproductive effort, although the highest single cause was abandonment, which claimed 7.1 percent. At least one dead chick at Vandenberg tested positive for domoic acid poisoning.

The numbers and percentages of each of these reported causes of reproductive failure were lower this season than in the previous three years, with the exception of chick mortality which was slightly lower in 1997 (Keane 1998, 2000, 2001). However, reported adult mortality was higher than that of previous years. Numbers of eggs with unknown outcomes were also lower this year than in 1999 or 1997, although higher than that of 1998.

Predation

Depredation was the primary limiting factor to reproductive success, with 8.4 to 11.2 percent of reproductive effort (total number of eggs, chicks, and fledglings documented depredated divided by the total number of eggs reported) being taken. Nineteen species were documented preying on least terns this season, four more were suspected of predation, and an additional ten were reported as possibly responsible for losses (appendix table A-6).

The highest numbers of documented predation came from Venice Beach, where crows were responsible for depredation of 30 eggs, and cats took 40 chicks and fledglings and one adult (appendix Table A-7). Peregrine falcons were documented preying on 11 fledglings and 23 adults at Camp Pendleton, 16 fledglings and six adults at NAB Coronado, and at least 5 fledglings at LA Harbor.

Reported overall losses to depredation were 49 percent lower in 2000 than in 1999, although numbers of depredated fledglings and adults were higher this year (Keane 2001). However, significant numbers of eggs, chicks, and fledglings were reported as suspected of being depredated. By subtracting the reported numbers of fledglings and numbers of chick and

fledgling predation and mortality from the number of hatched chicks, 30 to 37 percent of chicks were unaccounted for this season. Mortality and depredation were likely under-reported, particularly at type 2 monitored sites. Despite monitoring efforts, a large time window existed each day at each site during which predation may not have been observed simply because of the absence of a monitor. Likewise, little sign of predators' presence may be left by those that carry prey from the site or devour prey intact, particularly if the prey is a small down-covered chick. Adult or fledgling terns may be preyed on while away from the site and their losses may go undetected or possibly manifested as nest abandonments. However, generally larger or older prey items leave more sign of predation than chicks do, since the predator may struggle with them more, be required to dismember or devour prey in sections, or since flight feathers may be more easily shed than down, persist longer on the site, and be detected more readily by monitors due to their size and color.

Trends, Distribution, and Productivity by Region

Comparisons of productivity variables between this season and previous seasons were previously mentioned and Table 2 lists percentages of change of numbers of breeding pairs and fledglings produced at each site for 1998 to 2000. Figures 2 and 3 were compiled from annual reports to CDFG and assessments of population status (Craig 1971, Bender 1974a, 1974b, Massey 1975, Jurek 1977, Atwood et al. 1977, 1979, Gustafson 1986, Copper 1979, 1980, 1981, 1982, Collins 1983, 1984, 1986, 1987, Copper and Patton 1985, 1986, 1987, White 1986, Massey 1988, 1989a, Obst and Johnston 1992, Johnston and Obst 1992, Fancher 1992, Caffrey 1993, 1994, 1995, 1997, 1998, Keane 1998, 2000, 2001). Figure 2 graphs estimated numbers of breeding pairs and fledglings produced over time. Generally, the number of breeding pairs continues to increase. Throughout this season, monitors commented on the high number of nests and relatively high level of hatching and fledging success. The estimated number of breeding pairs appears to have surpassed that of 1998 to the highest level since monitoring began. The estimated number of fledglings produced this year exceeds that of the exceptional production of 1997. Figure 3 charts the seasonal fledgling per pair ratio over time. While this rate has increased over that of 1998 and significantly over that of 1999, it remains below those of 1997 and the late 1980s to early 1990s. The annual variability of these measures of productivity indicates the need for continued monitoring and management.

The nesting colony at Camp Pendleton continues to be the largest in the state, accounting for 22.8 percent of breeding pairs and producing 27.6 percent of this season's fledglings. Other colonies numbering over 200 nests included Alameda Point, Point Mugu, Venice Beach, L.A. Harbor, Huntington State Beach, Mariner's Point, Naval Amphibious Base Coronado North Delta Beach and ocean beach, and Tijuana Estuary. L.A. Harbor accounted for 15.4 percent of this season's fledgling production, Huntington Beach up to 11.7 percent, and Alameda and FAA Island 5.4 percent each.

The nesting site first documented in 1998 at Tulare Lake bed evaporation ponds outside of Kettleman City in Kings County was used again in 2000, and newly created Caltrans mitigation islands in Albany in Alameda County were colonized and produced at least one fledgling. Invasive vegetative cover and predator disturbance appear to have precluded nesting this season at Chula Vista Wildlife Reserve and three of the five sites at Batiquitos Lagoon.

Table 4 provides comparison of estimated numbers of breeding pairs and fledglings produced in each region or colony cluster in California. The three sites in the San Francisco Bay Area accounted for 6.8 percent of this season's pairs and 5.9 percent of fledglings, showing a 19.6 percent increase in pairs since 1998 and 140 percent increase in fledgling production over that of 1999.

The three colonies in San Luis Obispo and Santa Barbara counties decreased by up to 34.9 percent. This area supports one percent of the breeding pairs and produced 0.9 percent of the fledglings but has tremendous potential for growth due to the acreage of potential beach nesting habitat. The decrease this season was reported by monitors to be related to continuing disturbances from recreational beach activities and depredation, with the most notable reduction in nesting attempts occurring at Oceano Dunes. Limited colony sizes in this area have likely been related to depredation, particularly at Vandenberg both this season and last, and possibly to domoic acid and red tide influences on both the terns and their prey.

The three to five sites in Ventura County (two sites each comprising the colonies of Santa Clara River/McGrath State Beach and Point Mugu, although it may be argued that Point Mugu and Ormond Beach are simply sub-areas of a single colony) increased in numbers of both breeding pairs and fledgling production over that of last year, but are below that of 1998. These sites contributed 5.8 percent of the breeding pairs and 3.6 percent of fledglings produced this season in the state. These sites experienced significant reductions from 1998 to 1999, and neither Point Mugu nor Santa Clara have returned to their 1998 numbers.

The six to eight sites in Los Angeles and Orange counties (two sites each within L.A. Harbor and Bolsa Chica) accounted for 29.4 percent of breeding pairs, increasing by 103.4 percent over that of last year, and 10.4 percent over 1998. All colonies in this area increased in size this season, with the most significant growth in the state occurring at Venice Beach and Seal Beach. Fledgling production was 36.3 percent of that statewide, a 591 percent increase over 1999 and 71.6 percent over 1998.

San Diego County colonies accommodated 57.2 percent of the breeding pairs in 2000, increasing by 14.7 and 16.1 percent over those of 1999 and 1998. FAA Island in Mission Bay experienced the most significant colony growth in this area this season. These sites produced 53.4 percent of the fledglings in 2000, a 784 percent increase over that of 1999 and 29.8 percent increase over 1998.

ACKNOWLEDGEMENTS

The compilation of this report and the recovery of this endangered species would not be possible without the contribution of untold hours and the dedication of the field monitors. I apologize to any whose names may have been inadvertently left out, not submitted, or misspelled by those filing the reports. Field work this season (generally north to south) was conducted by Laura Collins, Meredith Elliott, Bill Sydeman, Tim Burr, Katie Stewart, Michael Estabrook, Dan Cordova, Danielle Beauharnois, Paloma Nieto, Darlene Woodbury, Sandra Schultz, Tom Applegate, Don Davis, Linda and Terry O'Neill, Jan Lewison, Art Marshall, Amanda Miner, Tom Keeney, Lyn Perry, Steve Kirkland, Nathan Lang, Jennifer Brogan, Nathan Mudry, Kathy Keane, Wally Ross, Matt Amalong, Nick Liberato, Santiago Lopez, John Bradley, Charles Collins, Peter Knapp, Doreen Stadlander, Brian Foster, Kim Taylor, Ingri Quon, Shannon Lounsbury, Dennis Parker, Jeff Allen, Maryanne Bache, Shauna Wolf, Jennifer Jackson, H. Ribarich, Jamie Benjamin, Tim Dillingham, Donise Dibley, Kelly Fisher, Erin Wilson, Danny Careen, Elizabeth Copper, Susan Welker, Jennifer Price Jackson, Virginia Johnson, Monica Alfaro, and Brian Collins.

Likewise, the resource agency staff and managers of each site have ensured continuation of the survival of this species, although their roles have often been under-appreciated and overlooked. At the least they have provided the funding for the monitoring, although most have done much, much more. These include, but are not limited to, personnel at local and regional offices of USFWS and CDFG (including but not limited to Ormond Beach, Venice Beach, Bolsa Chica, Upper Newport Bay, Batiquitos Lagoon, FAA Island), NAS Alameda, USFWS National Wildlife Refuges (Alameda Point, Seal Beach, Sweetwater Marsh, South San Diego Bay Unit, Tijuana Slough), Point Reyes Bird Observatory (Alameda), Southern Energy Delta Pittsburg Power Plant, Johnson's Oyster Company (Pittsburg), Caltrans (Albany), California Department of Parks and Recreation (Oceano Dunes, McGrath, Huntington Beach, Border Field), Vandenberg AFB, Ventura Audubon (Sta Clara River), City of Oxnard (Ormond Beach), NBVC Point Mugu, Port of Los Angeles, MCB Camp Pendleton, Batiquitos Lagoon Foundation, County of San Diego Parks Department (San Elijo Lagoon), San Elijo Lagoon Conservancy, City of San Diego Parks Department (Fiesta Island, Mariner's Point), San Diego Audubon (Mariner's Point), San Diego Unified Port District and Zoological Society of San Diego (Lindbergh Field, D Street Fill, Chula Vista Wildlife Reserve), NAS North Island, NAB Coronado, and US Navy Southwest Div. (Alameda, Camp Pendleton, North Island, NAB).

The population could not have rebounded to its current level without predator management. Appreciation goes out to John Turman and personnel at USDA APHIS Wildlife Services, Wally Ross and assistants in LA/Orange County, Brian Walton and Santa Cruz Predatory Bird Group, and other predator control technicians. Don Reiersen, Mike Rust, and Eileen Paine of the UC Riverside Entomology Department provided ant management and recommendations. Meryl Faulkner and volunteers of Project Wildlife cared for sick and injured birds and conducted and coordinated necropsies and testing with County of San Diego Veterinarian.

Lyann Comrack of CDFG administered this contract, coordinated monitoring efforts, and demonstrated grace and superhuman patience in mastering this difficult group and enduring countless delays and missed deadlines. Shauna Wolf completed much of the computer data entry.

LITERATURE CITED

- Atwood, J.L. 1986. Delayed nocturnal occupation of breeding colonies by least terns (*Sterna antillarum*). *Auk* 103:242-244.
- Atwood, J.L., P.D. Jorgensen, R.M. Jurek, and T.D. Manolis. 1977. California least tern census and nesting survey, 1977. Calif. Dep. Fish and Game, Nongame Wildl. Investigations, E-1-1, Final Rep., Job V-2.11. 6 pp. + app.
- Atwood, J.L., R.A. Erickson, P.R. Kelly, and P. Unitt. 1979. California least tern census and nesting survey, 1978. Calif. Dep. Fish and Game, Nongame Wildl. Investigations, E-W-2, Final Rep., Job V-2.13. 6 pp. + app.
- Atwood, J.L., and B.W. Massey. 1988. Site fidelity of least terns in California. *Condor* 90:389-394.
- Bender, K. 1974a. California least tern census and nesting survey, 1973. Calif. Dep. Fish and Game, Spec. Wildl. Investigations, Proj. W-54-R-6, Prog. Rep., Job II-11. 7 pp. + app.
- Bender, K. 1974b. California least tern census and nesting survey, 1974. Calif. Dep. Fish and Game, Nongame Wildl. Investigations, Proj. W-54-R-6, Final Rep., Job I-1. 5 pp. + app.
- Burger, J. 1984. Colony stability in least terns. *Condor* 86:61-67.
- Caffrey, C. 1993. California least tern breeding survey, 1992 season. Calif. Dep. Fish and Game, Wildl. Manage. Div., Nongame Bird and Mammal Section Rep. 93-11, Sacramento, CA. 35 pp.
- Caffrey, C. 1994. California least tern breeding survey, 1993 season. Calif. Dep. Fish and Game, Wildl. Manage. Div., Nongame Bird and Mammal Section Rep. 94-07, Sacramento, CA. 39 pp.
- Caffrey, C. 1995. California least tern breeding survey, 1994 season. Calif. Dep. Fish and Game, Wildl. Manage. Div., Bird and Mammal Conservation Program Rep. 95-3, Sacramento, CA. 49 pp.
- Caffrey, C. 1997. California least tern breeding survey, 1995 season. Calif. Dep. Fish and Game, Wildl. Manage. Div., Bird and Mammal Conservation Program Rep. 97-6, Sacramento, CA. 57 pp.
- Caffrey, C. 1998. California least tern breeding survey, 1996 season. Calif. Dep. Fish and Game, Wildl. Manage. Div., Bird and Mammal Conservation Program Rep. 98-2, Sacramento, CA. 57 pp.

- California Department of Fish and Game. 1972. At the crossroads: a report on California's endangered and rare fish and wildlife. Calif. Dep. Fish and Game, Sacramento, CA. 99 pp.
- Chambers, W.L. 1908. The present status of the least tern in California. *Condor* 10:237.
- Collins, C.T. 1983. End of year report California least tern field study, 1983 field season. Calif. Dep. Fish and Game. Unpubl. rep. 14 pp.
- Collins, C.T. 1984. End of year report California least tern field study, 1984 field season. Calif. Dep. Fish and Game. Unpubl. rep. 15 pp.
- Collins, C.T. 1986. California least tern breeding colony size and fledgling success, 1985 and 1986. Calif. Dep. Fish and Game. Unpubl. table. 1 p.
- Collins, C.T. 1987. California least tern breeding colony size and fledgling success, 1986 and 1987. Calif. Dep. Fish and Game. Unpubl. table. 1 p.
- Copper, E. 1979. Least tern breeding season in San Diego County, 1979. Calif. Dep. Fish and Game. Unpubl. rep. 23 pp. + app.
- Copper, E. 1980. Least tern breeding season in San Diego County, 1980. Calif. Dep. Fish and Game. Unpubl. rep. 71 pp.
- Copper, E. 1981. Least tern breeding season in San Diego County, 1981. Calif. Dep. Fish and Game. Unpubl. rep. 46 pp.
- Copper, E. 1982. Least tern breeding season in San Diego County, 1982. Calif. Dep. Fish and Game. Unpubl. rep. 33 pp.
- Copper, E. 1987. Final report on least tern nesting in San Diego County, 1987. Calif. Dep. Fish and Game. Unpubl. rep. 25 pp.
- Copper, E., and R. Patton. 1985. California least tern nesting San Diego County, 1985. Calif. Dep. Fish and Game. Unpubl. rep. 28 pp.
- Copper, E., and R. Patton. 1986. A report on least tern nesting in southern San Diego County, 1986. Calif. Dep. Fish and Game. Unpubl. rep. 24 pp. + app.
- Craig, A.M. 1971. Survey of California least tern nesting sites. Calif. Dep. Fish and Game, Spec. Wildl. Investigations, Proj. W-54-R-4, Job Final Rep., II-5.1. 7 pp. + app.
- Fancher, J.M. 1992. Population status and trends of the California least tern. *Trans. West. Sect. Wildl. Soc.* 28:59-66.
- Grinnell, J., and A.H. Miller. 1944. The distribution of the birds of California. *Pacific Coast Avifauna* 27:1-608.

- Gustafson, J. 1986. Summary of the California least tern seasons for 1979-83 (5 years). Calif. Dep. Fish and Game. Unpubl. rep. 7 pp.
- Jurek, R.M. (ed.). 1977. California least tern census and nesting survey, 1976. Calif. Least Tern Recovery Team and Calif. Dep. Fish and Game, Nongame Wildl. Investigations, E-1-1. 5 pp. + app.
- Keane, K. 1998. California least tern breeding survey, 1997 season. Calif. Dep. Fish and Game, Wildl. Manage. Div., Bird and Mammal Conservation Program Rep. 98-12, Sacramento, CA. 46 pp.
- Keane, K. 2000. California least tern breeding survey, 1998 season. Calif. Dep. Fish and Game, Habitat Conservation and Planning Branch Rep., 2000-01, Sacramento, CA. 43 pp.
- Keane, K. 2001. California least tern breeding survey, 1999 season. Calif. Dep. Fish and Game, Habitat Conservation and Planning Branch, Species Conservation and Recovery Program Rep. 2001-01, Sacramento, CA. 16 pp. + app.
- Massey, B.W. 1975. California least tern census and nesting survey, 1975. Calif. Dep. Fish and Game (Nongame Wildl. Investigations) and U.S. Fish and Wildl. Serv. (Kern-Pixley N.W.R.-Endangered Species Prog.). 5 pp. + app.
- Massey, B.W. 1977. Occurrence and nesting of the least tern and other endangered species in Baja California, Mexico. *W. Birds* 8:67-70.
- Massey, B.W. 1988. California least tern field study, 1988 breeding season. Calif. Dep. Fish and Game, EW87 X-1, Contract FG 7660 final rep. 22 pp.
- Massey, B.W. 1989a. California least tern field study, 1989 breeding season. Calif. Dep. Fish and Game, Nongame Bird and Mammal Section Rep., EW88 X-1, Contract FG 8553 final rep. 20 pp. + app.
- Massey, B.W. 1989b. California least tern fledgling study, Venice, California, 1989. Calif. Dep. Fish and Game, Nongame Bird and Mammal Section Rep., EW8 X-1, Contract FG 8553 final rep. 8 pp.
- Massey, B.W., and J.L. Atwood. 1981. Second-wave nesting of the California least tern: age composition and reproductive success. *Auk* 98:596-605.
- Nisbet, I.C.T. 2000. Disturbance, habituation, and management of waterbird colonies. *Waterbirds* 23:312-332.
- Obst, B.S., and S.M. Johnston. 1992. California least tern breeding survey, 1990 season. Calif. Dep. Fish and Game, Nongame Bird and Mammal Section Rep., 92-05. 13 pp.

Johnston, S.M., and B.S. Obst. 1992. California least tern breeding survey, 1991 season. Calif. Dep. Fish and Game, Nongame Bird and Mammal Section Rep., 92-06. 19 pp.

Palacios, E., and E. Mellink. 1996. Status of the least tern in the Gulf of California. *J. Field Ornithol.* 67:48-58.

Small, A. 1994. California birds: their status and distribution. Ibis Publ. Co., Vista, CA. 342 pp.

Thompson, B.C., and R.D. Slack. 1984. Post-fledging departure from colonies by juvenile least terns in Texas. *Wilson Bull.* 96:309-313.

U.S. Bureau of Sport Fisheries and Wildlife. 1973. Threatened wildlife of the United States. Resource Publ. 114. 289 pp.

U.S. Fish and Wildlife Service. 1980. California least tern recovery plan. U.S. Fish and Wildl. Serv. Portland, OR. 100 pp.

Unitt, P. 1984. The birds of San Diego County. *San Diego Soc. Nat. Hist.* 276 pp.

White, A.N. 1986. California least tern nesting report, north San Diego County, 1986. Calif. Dep. Fish and Game. Unpubl. rep. 8 pp.

FIGURES AND TABLES

&

APPENDICES

FIGURES AND TABLES

Figures

1. Location of California least tern nesting sites, 2000.
2. California least tern breeding pairs and fledglings, 1969-2000.
3. California least tern fledgling rate, 1969-2000.

Tables

1. California least tern breeding pairs and fledgling production, 2000.
2. California least tern breeding pairs and fledgling production comparison, 1998-2000.
3. California least tern breeding pairs and fledgling production regional comparison, 1998-2000

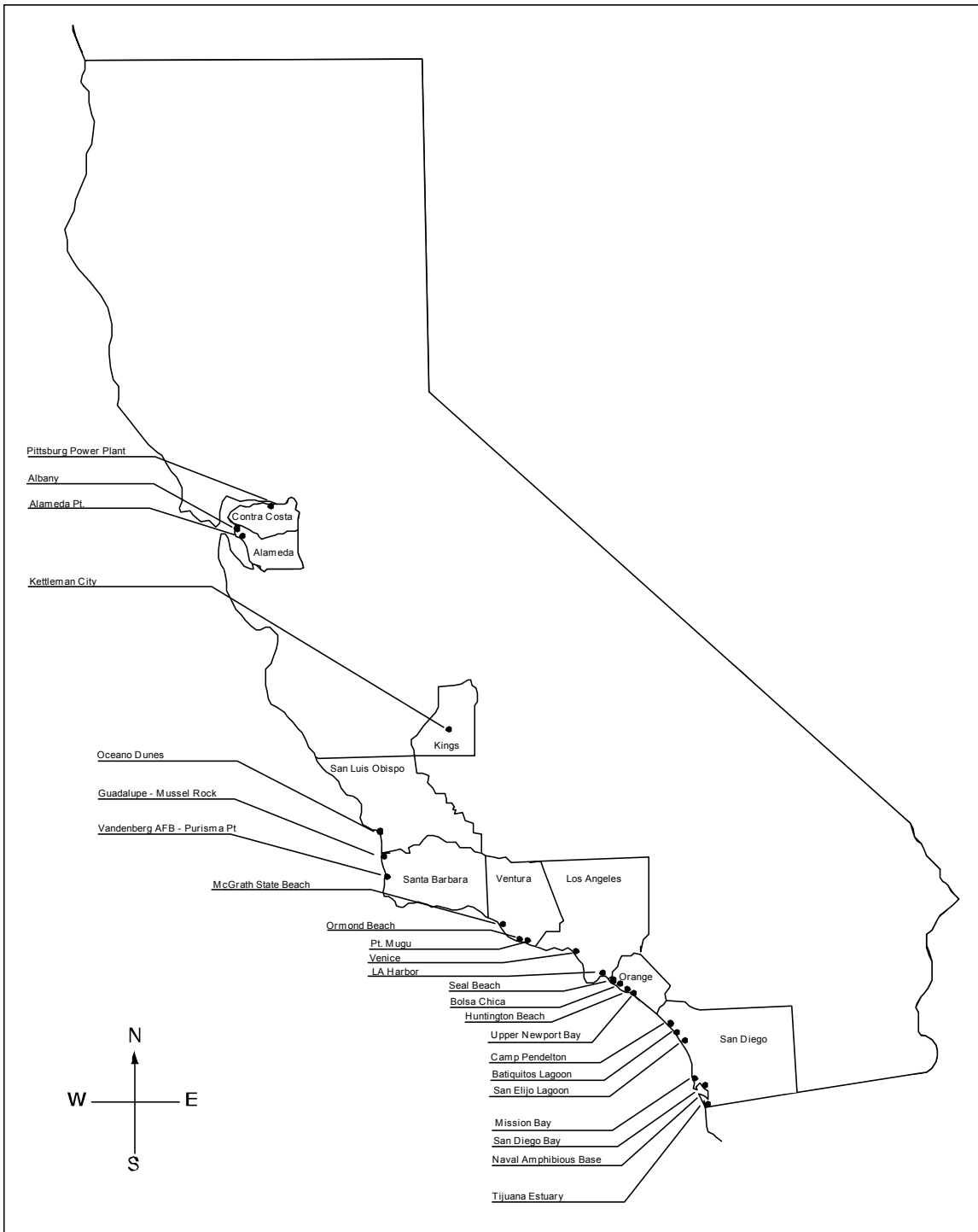


Figure 1. Location of California Least Tern Nesting Sites, 2000.

Figure 2. Calif. Least Tern Breeding Pairs and Fledglings, 1969-2000.

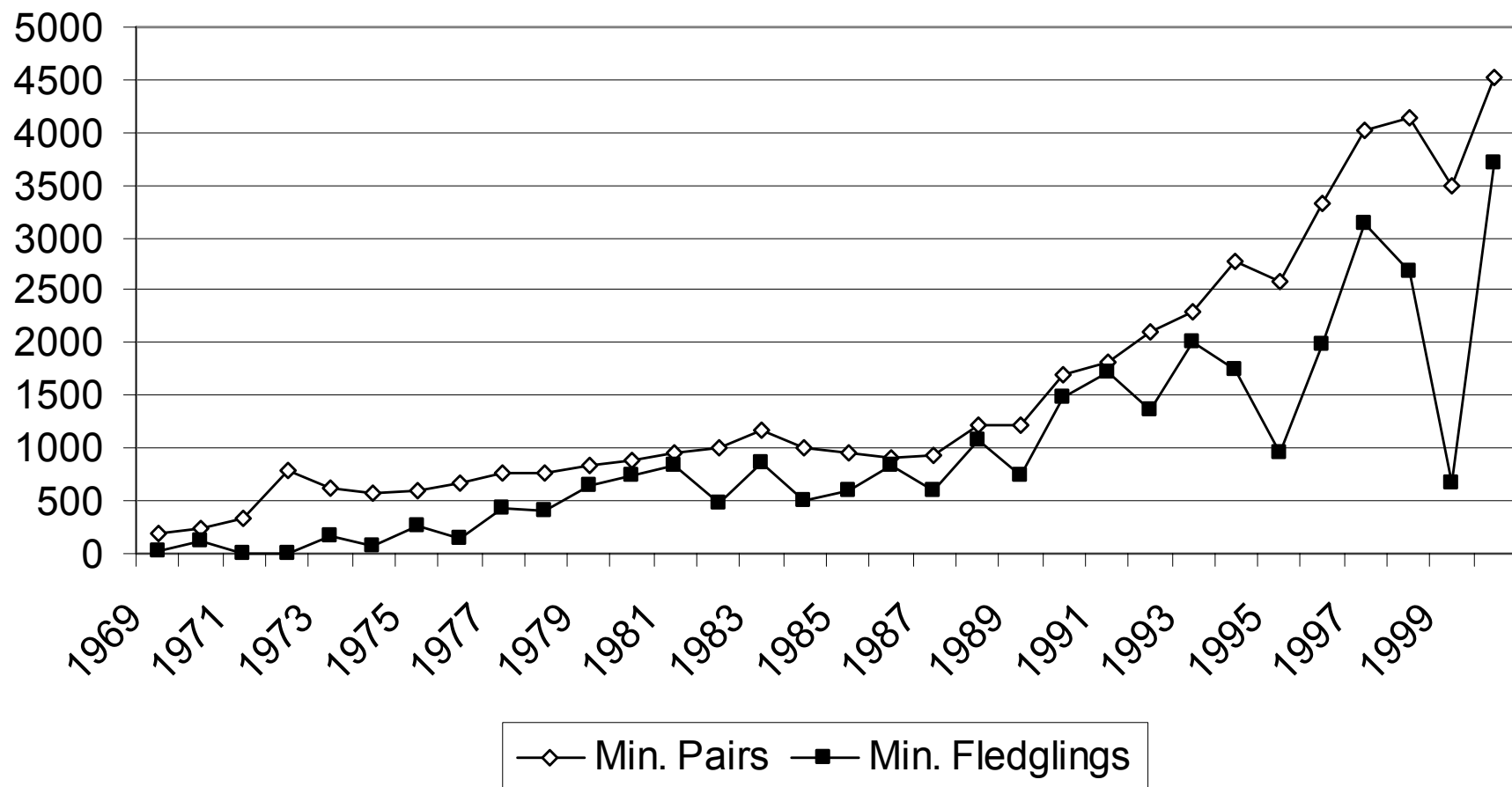


Figure 3. Calif. Least Tern Fledgling Rate (fledglings per pair), 1969-2000.

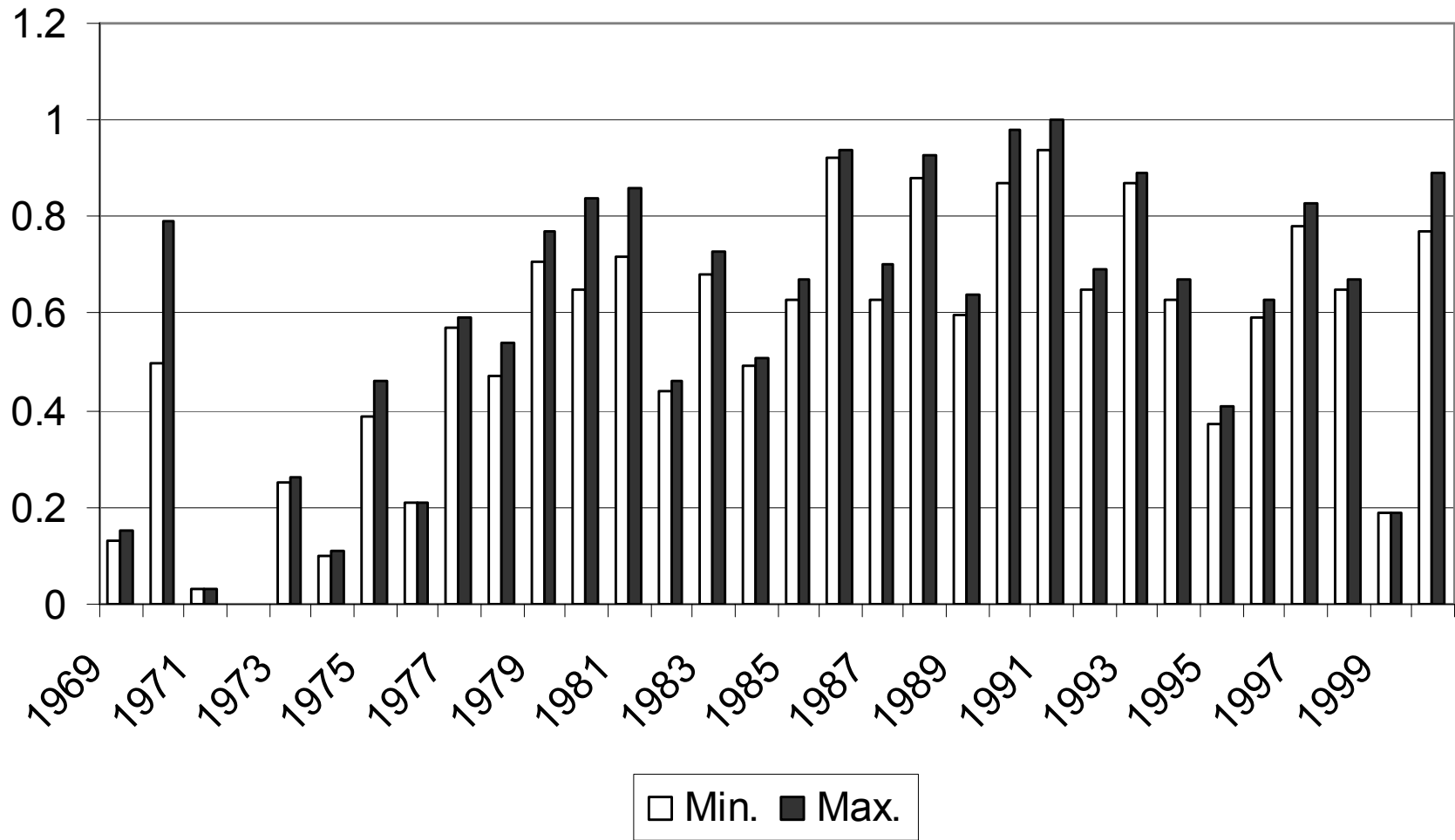


Table 1. California Least Tern breeding pairs and fledgling production, 2000.

Colony Site	Estimated Number of Breeding Pairs		Number of Nests	Estimated Number of Fledglings		Fledgling per Pair Ratio	
	Minimum	Maximum		Minimum	Maximum	Minimum	Maximum
San Francisco Bay Area							
Pittsburg Power Plant	15	15	15	16	18	1.07	1.20
Albany - Central Ave. mitigation island	6	12	15-20	1	1	0.08	0.17
Alameda Point	282	301	312	200	230	0.71	0.76
Kings County							
Kettleman City Evaporation Ponds	2	3	3	1	2	0.50	0.67
San Luis Obispo/Santa Barbara Counties							
Oceano Dunes SVRA	4	5	5	4	4	1.00	0.80
Guadalupe-Mussel Rock	9	9	9	17	17	1.89	1.89
Vandenberg AFB - Purisma Point	30	32	32	11	11	0.37	0.34
Ventura County							
Santa Clara River/McGrath State Beach - Totals	21	21	22	9	9	0.43	0.43
Santa Clara River North	5	5	6	6	6	1.20	1.20
McGrath Lake	16	16	16	3	3	0.19	0.19
Ormond Beach	73	73	73	60	65	0.82	0.89
NBVC Point Mugu							
Ormond Beach East	141	141	221	64	64	0.45	0.45
Nesting Islands	25	26	31	0	0	0.00	0.00
Los Angeles/Orange Counties							
Venice Beach	274	294	308	150	200	0.51	0.73
LA Harbor - Pier 400	428	428	548	552	552	1.29	1.29
LA Harbor - Pier 400 Corridor	9	9	17	18	18	2.00	2.00
Seal Beach NWR - NASA Island	107	107	107	180	180	1.68	1.68
Bolsa Chica Ecological Reserve	50	50	56	0	0	0.00	0.00
Huntington State Beach	400	400	481	435	435	1.09	1.09
Upper Newport Bay Ecological Reserve	60	60	68	12	12	0.20	0.20
San Diego County							
Camp Pendelton - Totals	1029	1029	1079	1025	1145	1.00	1.11
White Beach	36	36	40	1025	1145	1.00	1.11
Santa Margarita River - North Beach	910	910	950				
Santa Margarita River - Saltflats	49	49	53				
Santa Margarita River - Saltflats Island	34	34	36				
Batiquitos Lagoon Ecological Reserve							
W-1	0	0	0	0	0	0.00	0.00
W-2	110	126	135	32	32	0.25	0.29
E-1	26	29	37	6	22	0.21	0.84
E-2	0	0	0	0	0	0.00	0.00
E-3	0	0	0	0	0	0.00	0.00
San Elijo Lagoon Ecological Reserve - Saltpanne	15	15	16	7	11	0.47	0.73
Mission Bay							
FAA Island	173	173	187	200	200	1.16	1.16
North Fiesta Island	15	26	26	8	10	0.53	0.38
Mariner's Point	282	407	420	150	200	0.53	0.49
San Diego Bay							
Lindbergh Field	25	26	27	24	24	0.96	0.92
NAS North Island	128	128	134	85	85	0.66	0.66
NAB Coronado							
Delta Beach North	225	225	229	140	140	0.62	0.62
Delta Beach South	63	63	70	30	30	0.48	0.48
NAB Ocean	253	253	330	150	150	0.59	0.59
D Street Fill/Sweetwater Marsh NWR	28	31	34	27	30	0.96	0.97
Chula Vista Wildlife Reserve	0	0	0	0	0	0.00	0.00
South San Diego Bay NWR - Saltworks	35	39	44	17	17	0.49	0.44
Tijuana Estuary NERR - Totals	178	178	210	79	99	0.44	0.56
North of River	74	74	89	37	49	0.50	0.66
South of River	104	104	121	42	50	0.40	0.48
Total	4521	4790	5301	3710	4013	0.77	0.89

Table 2. California Least Tern breeding pairs and fledgling production comparison, 1998-2000.

Colony Site	2000 Min Pairs	2000 Min Fledglings	1999 Min Pairs	% + or - 1999 to 2000	1999 Min Fledglings	% + or - 1999 to 2000	1998 Min Pairs	% + or - 1998 to 2000	1998 Min Fledglings	% + or - 1998 to 2000
San Francisco Bay Area										
Pittsburg Power Plant	15	16	11	36.36	14	14.29	11	36.36	8	100.00
Albany Central Ave. mitigation islands	6	1	0	100.00	0	100.00	0	100.00	0	100.00
Alameda Point	282	200	250	12.80	77	159.74	243	16.05	90	122.22
Kings County										
Kettleman City Evaporation Ponds	2	1	n/a	n/a	n/a	n/a	1	100.00	1	0.00
San Luis Obispo/Santa Barbara Counties										
Oceano Dunes SVRA	4	4	24	-83.33	7	-42.86	37	-89.19	25	-84.00
Guadalupe-Mussel Rock	9	17	15	-40.00	12	41.67	2	350.00	0	100.00
Vandenberg AFB - Purisma Point	30	11	27	11.11	15	-26.67	19	57.89	14	-21.43
Ventura County										
Santa Clara River/McGrath State Beach - Totals	21	9	30	-30.00	24	-62.50	38	-44.74	22	-59.09
Ormond Beach	73	60	70	4.29	63	-4.76	86	-15.12	50	20.00
NBVC Point Mugu	166	64	118	40.68	40	60	274	-39.42	165	-61.21
Los Angeles/Orange Counties										
Venice Beach	274	150	43	537.21	0	100.00	383	-28.46	200	-25.00
LA Harbor	437	570	235	85.96	165	245.45	172	154.07	148	285.14
Seal Beach NWR - NASA Island	107	180	30	256.67	0	100.00	167	-35.93	94	91.49
Bolsa Chica Ecological Reserve	50	0	42	19.05	0	0.00	136	-63.24	74	-100.00
Huntington State Beach	400	435	250	60.00	25	1640.00	319	25.39	249	74.70
Upper Newport Bay Ecological Reserve	60	12	53	13.21	5	140.00	26	130.77	20	-40.00
San Diego County										
Camp Pendleton	1029	1025	672	53.13	48	2035.42	760	35.39	300	241.67
Batiquitos Lagoon Ecological Reserve	136	38	146	-6.85	10	280	179	-24.02	16	137.5
San Elijo Lagoon Ecological Reserve - Saltpanne	15	7	8	87.50	2	250.00	1	1400.00	1	600.00
Mission Bay										
FAA Island	173	200	66	160.61	2	9900.00	31	454.84	25	700.00
North Fiesta Island	15	8	0	100.00	0	100.00	21	-28.57	13	-38.46
South Shores	0	0	0	0.00	0	0.00	9	-100.00	1	-100.00
Mariner's Point	282	150	562	-49.82	60	150.00	528	-46.59	596	-74.83

Table 2. California Least Tern breeding pairs and fledgling production comparison, 1998-2000.

Colony Site	2000 Min Pairs	2000 Min Fledglings	1999 Min Pairs	% + or - 1999 to 2000	1999 Min Fledglings	% + or - 1999 to 2000	1998 Min Pairs	% + or - 1998 to 2000	1998 Min Fledglings	% + or - 1998 to 2000
San Diego Bay										
Lindbergh Field	25	24	20	25.00	0	100.00	17	47.06	18	33.33
NAS North Island	128	85	75	70.67	30	183.33	59	116.95	62	37.10
NAB Coronado										
Delta Beach North	225	140	240	-6.25	25	460.00	284	-20.77	200	-30.00
Delta Beach South	63	30	60	5.00	3	900.00	60	5.00	60	-50.00
NAB Ocean	253	150	270	-6.30	17	782.35	151	67.55	175	-14.29
D Street Fill/Sweetwater Marsh NWR	28	27	30	-6.67	2	1250.00	5	460.00	8	237.50
Chula Vista Wildlife Reserve	0	0	2	-100.00	0	0.00	2	-100.00	3	-100.00
South San Diego Bay NWR - Saltworks	35	17	15	133.33	6	183.33	39	-10.26	3	466.67
Tijuana Estuary NERR - Totals	178	79	87	104.60	19	315.79	81	119.75	45	75.56
Total	4521	3710	3451	31.01	671	452.91	4141	9.18	2686	38.12

Table 3. California Least Tern breeding pairs and fledgling production regional comparison, 1998-2000.

Region	Breeding Pairs						Fledglings					
	2000 Min Pairs	% 2000 Total Pairs	1999 Min Pairs	% + or - 1999 to 2000	1998 Min Pairs	% + or - 1998 to 2000	2000 Min Fledglings	% 2000 Total Fledglings	1999 Min Fledglings	% + or - 1999 to 2000	1998 Min Fledglings	% + or - 1998 to 2000
San Francisco Bay & Inland	305	6.75	261	16.86	255	19.61	218	5.88	91	139.56	99	120.20
San Luis Obispo/Sta Barbara Counties	43	0.95	66	-34.85	58	-25.86	32	0.86	34	-5.88	39	-17.95
Ventura County	260	5.75	218	19.27	398	-34.67	133	3.58	127	4.72	237	-43.88
Los Angeles/Orange Counties	1328	29.37	653	103.37	1203	10.39	1347	36.31	195	590.77	785	71.59
San Diego County	2585	57.18	2253	14.74	2227	16.07	1980	53.37	224	783.93	1526	29.75
Total	4521		3451	31.00	4141	9.18	3710		671	452.91	2686	38.12

APPENDICES

- A-1. California least tern site preparation and monitor information, 2000.
- A-2. Monitoring effort at California least tern sites, 2000.
- A-3a. California least tern pair and nest data, 2000 – pair estimation method I.
- A-3b. California least tern pair and nest data, 2000 – pair estimation methods I & II.
- A-4. California least tern productivity data, 2000.
- A-5. California least tern non-predator mortality, 2000.
- A-6. Predators observed at California least tern sites, 2000.
- A-7. California least tern predation, 2000.

Table A-1. California Least Tern site preparation and monitor information, 2000.

Site name	Name of primary monitor	Names of other monitors	Fence type ¹	Interpretive signs at site	Chick shelters	Decoys	Grid system	Vegetation management ²	Other site preparation	By whom
San Francisco Bay Area										
Southern Energy Delta Pittsburg Power Plant (SE)	Laura Collins		2	yes	yes	no	no	4	oyster shell deposited	Southern Energy Delta & Johnson's Oyster Co.
Albany - Central Ave. mitigation island	Chuck Morton, Karen Taylor								shell mound created	CalTrans
NAS Alameda (formerly NAS Alameda; now called Alameda Point)	Meredith Elliott	Bill Sydeman, Tim Burr, Katie Stewart	1	yes	yes	no	yes	2	repair fence, clean shelters	Alameda Point representatives, Navy, PRBO
Kings County										
Kettleman City Evaporation Ponds	Jeff Seay		4	no	no	no	no			
San Luis Obispo/Santa Barbara Counties										
Oceano Dunes SVRA	Dan Cordova	Michael Estabrook, Danielle Beauharnois	1	yes	No	no	yes	none	erect fencing	CDPR
Guadalupe-Mussel Rock	Paloma Nieto	Darlene Woodbury	4	Yes	no	no	No	7	none	
Vandenberg Air Force Base	Sandra Schultz	Tom Applegate	1	no	no	no	no	no	no	USAF
Ventura County										
Santa Clara River/McGrath State Beach										
Santa Clara River North	Don Davis	Linda O'Neill, Terry O'Neill, Jan Lewison, Art Marshall	1	yes	no	no	yes	1	none	Ventura Audubon
McGrath Lake	Don Davis	Linda O'Neill, Terry O'Neill, Jan Lewison, Art Marshall	1	yes	no	no	yes	1	none	CDPR

Continued on next page

Table A-1. California Least Tern site preparation and monitor information, 2000.

Site name	Name of primary monitor	Names of other monitors	Fence type ¹	Interpretive signs at site	Chick shelters	Decoys	Grid system	Vegetation management ²	Other site preparation	By whom
Ormond Beach	Amanda Miner		3	yes	no	no	no			CDFG, Oxnard City Corps
NBVC Point Mugu										
Ormond Beach East	Tom Keeney	Lyn Perry, Steve Kirkland, Nathan Lang, Jennifer Brogan	3	yes			no		no	USN
Nesting Islands	Tom Keeney	Lyn Perry, Steve Kirkland, Nathan Lang, Jennifer Brogan	3	yes		yes	no	4	no	USN
Los Angeles/Orange Counties										
Venice Beach, CA	Nathan Mudry		1	no	yes	no	yes	yes	none	CDFG
LA Harbor Pier 400	Kathy Keane	Wally Ross, Nathan Mudry, Matt Amalong, Nick Liberato, Santiago Lopez	1	no	yes	yes	yes	yes	site graded	Port of Los Angeles
LA Harbor TC2	Kathy Keane	Wally Ross, Nathan Mudry, Matt Amalong, Nick Liberato, Santiago Lopez	3	no	no	no	no	no	no	Port of Los Angeles
Seal Beach	John Bradley	Charles Collins	1	no	yes	no	yes	4		USFWS
Bolsa Chica Ecological Reserve	Peter Knapp		4	no	yes	no	yes	1		CDFG
Huntington State Beach	Doreen Stadtlander	Wally Ross	2	yes	yes	no	yes	6	fence repair	CDPR

Continued on next page

Table A-1. California Least Tern site preparation and monitor information, 2000.

Site name	Name of primary monitor	Names of other monitors	Fence type ¹	Interpretive signs at site	Chick shelters	Decoys	Grid system	Vegetation management ²	Other site preparation	By whom
Upper Newport Bay Ecological Reserve	Peter Knapp		4	yes	yes	yes	no	4		CDFG
San Diego County										
Camp Pendelton	Brian Foster	K.Taylor, I.Quon, S.Lounsbury, D.Parker, R.Patton, J.Allen, M.Bache, S.Wolf, J.Jackson, H.Ribarich, J.Benjamin	3	yes	no	no	yes			USMC
Batiquitos Lagoon Ecological Reserve	Donise Dibley	Tim Dillingham, Kelly Fisher, Errin Wilson, Danny Careen, Elizabeth Copper, Brian Foster	3	yes	yes	no	yes	3		CDFG
San Elijo Lagoon	Robert Patton	Susan Welker	3	yes	No	no	No	7	water level management	San Diego County Parks, San Elijo Lagoon Conservancy
Mission Bay										
FAA Island	Jennifer Jackson		1	yes	yes	no	yes	yes		CDFG
North Fiesta Island	Ginger Johnson		1	yes	yes	yes	no	4	sand added	San Diego City Parks Dept.
Mariner's Point	Ginger Johnson		1	yes	yes	no	yes	2	signs added	San Diego Audubon Society/City Parks Dept.
Lindbergh Field	Robert Patton	Shauna Wolf, E.Copper, B.Foster	3	no	no	no	yes	3		Port of San Diego

Continued on next page

Table A-1. California Least Tern site preparation and monitor information, 2000.

Site name	Name of primary monitor	Names of other monitors	Fence type ¹	Interpretive signs at site	Chick shelters	Decoys	Grid system	Vegetation management ²	Other site preparation	By whom
NAS North Island	Elizabeth Copper		1	yes	yes	yes	yes	yes		USN
NAB Coronado	E.Copper	Marit Evans-Layng, B.Foster, K.Taylor, S.Lounsbury, D.Parker, R.Patton, J.Allen, M.Bache, S.Wolf, J.Jackson, H.Ribarich, J.Benjamin								
Delta Beach North	E.Copper		3	yes	yes	yes	yes	yes		USN
Delta Beach South	E.Copper		3	yes	yes	yes	yes	yes		USN
NAB Ocean	E.Copper		3	yes	no	no	yes	no		USN
D Street Fill/Sweetwater Marsh NWR	Robert Patton	Shauna Wolf, Monica Alfaro, E.Copper, B.Foster, Brian Collins	3	yes	yes	yes	yes	4		Port of San Diego, Zoological Society of San Diego, USFWS
Chula Vista Wildlife Reserve	Robert Patton	S.Wolf, M.Alfaro, E.Copper, B.Foster	3	yes	yes	yes	yes	4		Port of San Diego, Zoological Society of San Diego
South San Diego Bay NWR - Saltworks	Robert Patton	M.Alfaro, E.Copper, B.Foster, Brian Collins	3	yes	no	no	no	7		
Tijuana Estuary NERR	Robert Patton	S.Wolf, M.Alfaro, B.Collins	3	yes	no	no	no	7		USFWS, CDPR

¹ Fence type:

1. Fully enclosed site; deters most mammals.
2. Full enclosed & cantilevered to deter climbing mammals.
3. Incomplete; does not deter most mammals.
4. No fencing/exclosure.

² Vegetation management:

1. Mechanical removal.
2. Manual removal.
3. Herbicide.
4. Combination of above means.
5. Other means.
6. Needed but none done in 2000.
7. None needed.

Table A-2. Monitoring effort at California Least Tern sites, 2000.

Site name	Site type ¹	Date of first monitoring visit	Date of last monitoring visit	Total number of monitoring visits	Nest marking	Egg marking	Banding	If color-banding, what color(s) were used
San Francisco Bay Area								
Southern Energy Delta Pittsburg Power Plant (SE)	2	25-Apr	11-Aug	23	no	no	no	
Albany - Central Ave. mitigation island	2				no	no	no	
NAS Alameda	3	30-Apr	19-Aug	105	yes	no	no	
Kings County								
Kettleman City Evaporation Ponds	2				no	no	no	
San Luis Obispo/Santa Barbara Counties								
Oceano Dunes SVRA	3	1-Mar	30-Sep					
Guadalupe-Mussel Rock	1	15-Mar	31-Aug	43	yes	no	No	
Vandenberg Air Force Base	2	21-Apr	21-Aug	61	no	no	no	NA
Ventura County								
Santa Clara River/McGrath State Beach								
Santa Clara River North	1	4-Jun	18-Aug	42	yes	none	none	
McGrath Lake	1	4-Jun	18-Aug	42	yes	no	no	
Ormond Beach	2	1-May	25-Aug	44	no	no	no	
NBVC Point Mugu								
Ormond Beach East	1	31-May	7-Aug	19	yes	yes	no	NA
Nesting Islands	1	1-Jun	11-Aug	8	yes	yes	no	NA
Los Angeles/Orange Counties								
Venice Beach, CA	1	17-Apr	18-Aug	42	yes	no	no	none
LA Harbor Pier 400	1	26-Apr	18-Aug	44	yes	no	no	none
LA Harbor TC2	1	31-May	18-Aug	32	yes	no	no	
Seal Beach	1						yes	
Bolsa Chica Ecological Reserve	2				no	no	no	
Huntington State Beach	1	14-Apr	16-Aug	36	yes	no	no	
Upper Newport Bay Ecological Reserve	2				no	no	no	
San Diego County								
Camp Pendelton	1				yes	yes	yes	mauve/black
Batiquitos Lagoon Ecological Reserve	1	3-Apr	18-Aug	54	yes	no	no	
San Elijo Lagoon	3	22-Apr	26-Sep	18	no	yes	yes	NA
Mission Bay								
FAA Island	1				yes	yes	yes	
North Fiesta Island	1	4-May	29-Jul	27	yes	yes	yes	
Mariner's Point	1	25-Apr	14-Aug	51	yes	yes	yes	green/blue
Lindbergh Field	1	19-Apr	24-Aug	47	yes	yes	yes	
NAS North Island	1				yes	yes	yes	blue/orange
NAB Coronado								
Delta Beach North	1				yes	yes	yes	red/yellow or yellow/red
Delta Beach South	1				yes	yes	yes	
NAB Ocean	1				yes	yes	yes	blue/pink
D Street Fill/Sweetwater Marsh NWR	1	3-Mar	24-Aug	45	yes	yes	yes	NA
Chula Vista Wildlife Reserve	1	16-Mar	24-Aug	39	NA	NA	NA	NA
South San Diego Bay NWR - Saltworks	1	28-Mar	27-Sep	27	yes	yes	yes	NA
Tijuana Estuary NERR	1	6-Mar	24-Aug	29	yes	yes	yes	NA

¹Site Type:

1. Monitors regularly enter colony to check individual nests.
2. Monitored primarily from outside colony.
3. Monitored primarily from outside, but entered more frequently than once per month.

Table A-3a. California Least Tern pair and nest data, 2000 - pair estimation method I.

Pair Estimation I							
Site name	Date terns first observed	Date terns last observed	Date of first nest	Date of last nest initiation	Total nests prior to 15 June	Total nests 15 June & later	# early nests + (# late nests/2) = Total pairs
San Francisco Bay Area							
Southern Energy Delta Pittsburg Power Plant (SE)	9-May	3-Aug	24-May	between 6-Jul & 12-Jul	10	5	13
Albany - Central Ave. mitigation island							6-12
NAS Alameda	29-Apr	17-Aug	14-May	2-Jul	252	60	282
Kings County							
Kettleman City Evaporation Ponds	prior to 8-Jun	22-Sep	prior to 15-Jun	prior to 20-Jul	1	2	2
San Luis Obispo/Santa Barbara Counties							
Oceano Dunes SVRA	2-May	28-Aug	26-May	26-Jun	2	3	4
Guadalupe-Mussel Rock	5-May	11-Aug	29-May	13-Jun	9	0	9
Vandenberg Air Force Base	5-May	15-Aug	26-May	11-Jul	27	5	30
Ventura County							
Santa Clara River/McGrath State Beach	prior to 4-Jun	-					
Santa Clara River North		3-Sep	4-Jun	12-Jul	1	5	4
McGrath Lake			12-Jun	6-Jul	2	14	9
Ormond Beach			6-Jun	11-Jul	72	1	73
NBVC Point Mugu							
Ormond Beach East	19-May	10-Aug	30-May	26-Jul	61	160	141
Nesting Islands			1-Jun	13-Jul	20	11	26
Los Angeles/Orange Counties							
Venice Beach, CA	17-Apr	18-Aug	27-May	13-Jul	281	27	294
LA Harbor Pier 400	26-Apr	18-Aug	8-May	24-Jul	461	87	505
LA Harbor TC2	20-May	11-Aug	31-May	14-Jul	16	1	17
Seal Beach					107	0	107
Bolsa Chica Ecological Reserve					25	31	41
Huntington State Beach	14-Apr	16-Aug	3-May		343	138	412
Upper Newport Bay Ecological Reserve					36	32	52
San Diego County							
Camp Pendelton - Totals					978	101	1029
White Beach	20-Apr	10-Aug	9-May	5-Jul			36
Santa Margarita River - North Beach	25-Apr	5-Sep	7-May	30-Jul			910
Santa Margarita River - Saltflats	6-May	15-Aug	11-May	16-Jul			49
Santa Margarita River - Saltflats Island	6-May	15-Aug	16-May	11-Jul			34
Batiquitos Lagoon Ecological Reserve							
W-1					0	0	0
W-2	21-Apr	14-Aug	prior to 16-May		116	19	126
E-1	27-Apr	18-Aug	28-May		20	17	29
E-2					0	0	0
E-3					0	0	0

Continued on next page

Table A-3a. California Least Tern pair and nest data, 2000 - pair estimation method I.

Pair Estimation I							
Site name	Date terns first observed	Date terns last observed	Date of first nest	Date of last nest initiation	Total nests prior to 15 June	Total nests 15 June & later	# early nests + (# late nests/2) = Total pairs
San Elijo Lagoon	7-May	24-Aug	16-May	1-Jul	15	1	16
Mission Bay							
FAA Island					172	15	180
North Fiesta Island	4-May	19-Jul	11-May	8-Jun	26	0	26
Mariner's Point	2-May	11-Aug	8-May	28-Jun	394	26	407
Lindbergh Field	2-May	22-Aug	11-May	18-Jul	24	3	26
NAS North Island	26-Apr	12-Aug	7-May	30-Jun	124	10	129
NAB Coronado							
Delta Beach North	24-Apr	23-Aug	8-May	21-Jun	226	3	228
Delta Beach South	24-Apr		8-May		61	9	66
NAB Ocean	24-Apr	4-Sep	10-May	19-Aug	239	91	285
NAB Ocean - North					124	30	139
NAB Ocean - South					115	61	146
D Street Fill/Sweetwater Marsh NWR	19-Apr	29-Aug	9-May	1-Jul	27	7	31
Chula Vista Wildlife Reserve	26-Apr	3-Aug			0	0	0
South San Diego Bay NWR - Saltworks	26-Apr	30-Aug	17-May	19-Jul	35	9	40
Tijuana Estuary NERR - Totals							
North of River	26-Apr	13-Sep	18-May	20-Jul	56	33	73
South of River	26-Apr	13-Sep	11-May	2-Aug	79	42	100

Table A-3b. California Least Tern pair and nest data, 2000 - pair estimation methods II & III.

Pair Estimation II						Pair Estimation III (optional)							
Site name	Total pairs (Estimation I)	Total nests	Number of unsuccessful nests before 20 June	Estimated broods lost before 20 June	Total pairs not reesting	Date of second wave start (if any)	Total first wave nests (or prior to 15 June)	Estimated reesters first wave	Total pairs first wave	Total nests 2nd wave (or 15 June & later)	Estimated reesters 2nd wave	Total pairs 2nd wave	Total pairs
San Francisco Bay Area													
Southern Energy Delta Pittsburg Power Plant (SE)	13	15	0	0	15	23-Jun	10	0	10	5	0	5	15
Albany - Central Ave. mitigation island	6-12	15-20			6-12								
NAS Alameda	282	312	6	5	301	8-Jun	199	0	199	113	21	92	291
Kings County													
Kettleman City Evaporation Ponds	2	3	0	0	3		1	0	1	2	0	2	3
San Luis Obispo/Santa Barbara Counties													
Oceano Dunes SVRA	4	5	0	0	5	19-Jun	1	0	1	4	0	4	5
Guadalupe-Mussel Rock	9	9	0	0	9	n/a	9	0	9	0	0	0	9
Vandenberg Air Force Base	30	32	0	0	32	na	27	0	27	5	1	4	31
Ventura County													
Santa Clara River/McGrath State Beach													
Santa Clara River North	4	6	1	0	5		1						
McGrath Lake	9	16	0	0	16		2		2	14			
Ormond Beach	73	73	1	1	71	11-Jul	72	0	72	1	0	1	73
NBVC Point Mugu													
Ormond Beach East	141	221			141	NA							
Nesting Islands	26	31			26	NA							
Los Angeles/Orange Counties													
Venice Beach, CA	294	308	17	17	274		281	10	271	27	5	22	293
LA Harbor Pier 400	505	548	17	20	511	11-Jun	407	105	302	141	15	126	428
LA Harbor TC2	17	17	1	1	15	31-May	0	0	0	17	8	9	9
Seal Beach	107	107			107								
Bolsa Chica Ecological Reserve	41	56			50								
Huntington State Beach	412	481	25	?	456								400
Upper Newport Bay Ecological Reserve	52	68			60								

Continued on next page

Table A-3b. California Least Tern pair and nest data, 2000 - pair estimation methods II & III.

Pair Estimation II					Pair Estimation III (optional)								
Site name	Total pairs (Estimation I)	Total nests	Number of unsuccessful nests before 20 June	Estimated broods lost before 20 June	Total pairs not renesting	Date of second wave start (if any)	Total first wave nests (or prior to 15 June)	Estimated renesters first wave	Total pairs first wave	Total nests 2nd wave (or 15 June & later)	Estimated renesters 2nd wave	Total pairs 2nd wave	Total pairs
San Diego County													
Camp Pendelton - Totals	1029	1079			1029								
White Beach	36	40			36								
Santa Margarita River - North Beach	910	950			910								
Santa Margarita River - Saltflats	49	53			49								
Santa Margarita River - Saltflats Island	34	36			34								
Batiquitos Lagoon Ecological Reserve													
W-1	0	0											
W-2	126	135		0			116	0-15	101-116	19	0-10	9-19	110-135
E-1	29	37					20	0-5	15-20	17	0-6	11-17	26-37
E-2	0	0											
E-3	0	0											
San Elijo Lagoon	16	16	1	2-4	11-13	1-Jul	15	0	15	1	1	0	15
Mission Bay													
FAA Island	180	187			173								
North Fiesta Island	26	26	1	10	15	none	26	1	25	0	0	0	25
Mariner's Point	407	420	137	1	282	18-Jun	394	138	256	26	0	26	282
Lindbergh Field	26	27	2	0	25								
NAS North Island	129	134			128								
NAB Coronado													
Delta Beach North	228	229			225								
Delta Beach South	66	70			63								
NAB Ocean	285	330			253								
NAB Ocean - North	139	154	7		147								
NAB Ocean - South	146	176			106								

Continued on next page

Table A-3b. California Least Tern pair and nest data, 2000 - pair estimation methods II & III.

Pair Estimation II						Pair Estimation III (optional)							
Site name	Total pairs (Estimation I)	Total nests	Number of unsuccessful nests before 20 June	Estimated broods lost before 20 June	Total pairs not renesting	Date of second wave start (if any)	Total first wave nests (or prior to 15 June)	Estimated renesters first wave	Total pairs first wave	Total nests 2nd wave (or 15 June & later)	Estimated renesters 2nd wave	Total pairs 2nd wave	Total pairs
D Street Fill/Sweetwater Marsh NWR	31	34	1	up to 5	28								
Chula Vista Wildlife Reserve	0	0			0				0			0	0
South San Diego Bay NWR - Saltworks	40	44	10	0	34								35-39
Tijuana Estuary NERR	173	210			178								

boldface indicates pair estimate perceived by monitor to be most accurate

Table A-4. California Least Tern productivity data, 2000.

Site name	Total nests	Total eggs	Mean clutch size	Total eggs hatched	Percent hatching success	Date of first chick	Date of first fledgling	Fledgling estimate method ¹	Total fledglings
San Francisco Bay Area									
Southern Energy Delta Pittsburg Power Plant (SE)	15	29	1.93	26	90	16-Jun	6-Jul	C	16-18
Albany - Central Ave. mitigation island	15-20			2+				C	1+
NAS Alameda	312	575	1.84	361	63	5-Jun	28-Jun	C	200-230
Kings County									
Kettleman City Evaporation Ponds	3			3+		prior to 20-Jul	prior to 4-Aug	C	1-2
San Luis Obispo/Santa Barbara Counties									
Oceano Dunes SVRA	5	10	2	8	80	18-Jun	11-Jul	C	4
Guadalupe-Mussel Rock	9	18	2	18	100	20-Jun	18-Jul	3WD	17
Vandenberg Air Force Base	32	64	2	50	78	18-Jun	13-Jul	C	11
Ventura County									
Santa Clara River/McGrath State Beach	22	42	1.9	35	83	3-Jul	22-Jul	S	9
Santa Clara River North	6	11	1.83	10	90	26-Jun	30-Jul	S	6
McGrath Lake	16	31	1.94	25	81	29-Jun	22-Jul	S	3
Ormond Beach	73	60+				24-Jun	15-Jul	C	60-65
NBVC Point Mugu									
Ormond Beach East	221	420	1.9	392	93	22-Jun	14-Jul	3WN	64
Nesting Islands	31	60	1.94	58	97	29-Jun	-		
Los Angeles/Orange Counties									
Venice Beach	308							C	150-200
LA Harbor Pier 400	548	921	1.68	828	90	31-May	20-Jun	3WN (dawn)	552
LA Harbor TC2	17	33	1.94	27	82	21-Jun	12-Jul	3WN (dawn)	18
Seal Beach	107	202	1.89					C	180
Bolsa Chica Ecological Reserve	56								0
Huntington State Beach	481	848	1.76	735	87	26-May	20-Jun	3 WD	435
Upper Newport Bay Ecological Reserve	68							3WD	12
San Diego County									
Camp Pendelton - Totals	1079	1937	1.8	1790	92	30-May	18-Jun	C	1025-1145
White Beach	40	71	1.78	58	82	1-Jun	20-Jun	C	25-30
Santa Margarita River - North Beach	950	1705	1.79	1582	93	30-May	18-Jun	C	980-1075
Santa Margarita River - Saltflats	53	95	1.79	91	96	3-Jun	20-Jun	C	10-25
Santa Margarita River - Saltflats Island	36	66	1.83	59	89	3-Jun	20-Jun	C	5-15
Batiquitos Lagoon Ecological Reserve									
W-1	0								
W-2	135	248	1.84	245	99	4-Jun	24-Jun	3WD	32
E-1	37	67	1.81	59	88	12-Jun	24-Jun	3WD	6-22
E-2	0								
E-3	0								

Continued on next page

Table A-4. California Least Tern productivity data, 2000.

Site name	Total nests	Total eggs	Mean clutch size	Total eggs hatched	Percent hatching success	Date of first chick	Date of first fledgling	Fledgling estimate method ¹	Total fledglings
San Elijo Lagoon	16	26	1.63	14	54	6-Jun	2-Jul	C	7-11
Mission Bay									
FAA Island	187	341	1.82	303	89			C	200
North Fiesta Island	26	48	1.85	40	83	1-Jun	22-Jun	3WD	8-10
Mariner's Point	420	794	1.89	518	65	29-May	23-Jun	R, 3WD	150-200
Lindbergh Field	27	52	1.93	46	88	2-Jun	22-Jun	C	24
NAS North Island	134	237	1.77	216	91	31-May	19-Jun	C	85
NAB Coronado									
Delta Beach North	229	410	1.79	385	94	2-Jun	23-Jun	C	140
Delta Beach South	70	130	1.86	120	92	31-May	28-Jun	C	30
NAB Ocean	330	582	1.76	533	92	31-May	24-Jun	C	150+
NAB Ocean - North	154								
NAB Ocean - South	176								
D Street Fill/Sweetwater Marsh NWR	34	62	1.82	48	77	1-Jun	24-Jun	C	27-30
Chula Vista Wildlife Reserve	0								
South San Diego Bay NWR - Saltworks	44	75	1.7	47	63	7-Jun	28-Jun	C	17
Tijuana Estuary NERR - Totals	210	365	1.74	262	72	1-Jun	22-Jun	C	79-99
North of River	89	156	1.75	121	78	8-Jun	29-Jun	C	37-49
South of River	121	209	1.73	141	67	1-Jun	22-Jun	C	42-50
Total	5301-5306	8596+	1.8	7167+	83	26-May	18-Jun		3710-4013

¹Fledgling estimate methods:

R - band recapture data

3WD - daytime counts every 3 weeks

3WN - dusk counts every 3 weeks

C - combination of methods

S - single date count

Table A-5. California Least Tern non-predator mortality, 2000.

Site name	No. of eggs					No. of nests					No. of dead			Comments
	Human damaged	Lost to flooding	Abandoned pre-term	Abandoned post-term/nonviable	Outcome unknown	Human damaged	Lost to flooding	Abandoned pre-term	Abandoned post-term/nonviable	Outcome unknown	Chicks	Fledglings	Adults	
San Francisco Bay Area														
Southern Energy Delta Pittsburg Power Plant	0	0-2	2-3	1-2	at least 1	0	0-2	1-2	1-2	1	0	0	0	flooding
Albany - Central Ave. mitigation island														
NAS Alameda	0	0	19	105	79	0	0	15	81	66	81	2	1	dead chicks caused by heat wave (June 12-16).
Kings County														
Kettleman City Evaporation Ponds											3+	1-2	6	
San Luis Obispo/Santa Barbara Counties														
Oceano Dunes SVRA	0	0	2	0	0	0	0	1	0	0	0	0	0	NA
Guadalupe-Mussel Rock	0	0	0	0	0	0	0	0	0	0	1	0	0	Undetermined
Vandenberg Air Force Base	0	0	5	unk	8 estimated	0	0	3	0	4	27	0	0	most chicks had injuries
Ventura County														
Santa Clara River/McGrath State Beach				4	1				2	1	3			
Ormond Beach	0	0	0	2	10-20 (10 nests)						none observed			
NBVC Point Mugu														
Los Angeles/Orange Counties														
Venice Beach, CA	0	0	26	0	0	0	0	26	0	0	35	22	3	peregrine falcon & a cat for fledglings
LA Harbor Pier 400	0	0	48	25	0	0	0	40	18	0	20	5	1	peregrine falcon for fledglings
LA Harbor TC2	0	0	4	0	0	0	0	2	0	0	0	0	0	
Seal Beach			10					10			3			
Bolsa Chica Ecological Reserve														eggs crushed by flocks of larger terns
Huntington State Beach	0	0	36	38	34	0	0	36	38	34	4	0	0	4 chicks no signs of trauma
Upper Newport Bay Ecological Reserve														

Continued on next page

Table A-5. California Least Tern non-predator mortality, 2000.

Site name	No. of eggs					No. of nests					No. of dead			Comments
	Human damaged	Lost to flooding	Abandoned pre-term	Abandoned post-term/nonviable	Outcome unknown	Human damaged	Lost to flooding	Abandoned pre-term	Abandoned post-term/nonviable:	Outcome unknown	Chicks	Fledglings	Adults	
San Diego County														
Camp Pendelton - Totals		5	67				3	30			118	24	16	
White Beach		0	6				0	3			2	1	2	
Santa Margarita River - North Beach		5	57				3	25			103	21	14	
Santa Margarita River - Saltflats		0	0				0	0			8	1	0	
Santa Margarita River - Saltflats Island		0	4				0	2			5	1	0	
Batiquitos Lagoon Ecological Reserve														
W-1														
W-2	0	0	2	1	0			1	1		33	1	2	
E-1	0	0	4	3	1			2	2	1	2	2	4	
E-2														
E-3														
San Elijo Lagoon	0	0	1	0	5	0	0	1	0	4	0	0	0	Abandonment after predation
Mission Bay														
FAA Island			28					28						
North Fiesta Island	0	0	8	0	23 (probable hatch)	0	0	7	0	15 (probable hatch)	0	0	1	Abandonment after predation, adult cause unknown.
Mariner's Point	0	0	32	0	335 (probable hatch)	0	0	27	0	200 (probable hatch)	11	1	0	Abandonment after predation
Lindbergh Field	0	0	4	3	0	0	0	3	3	0	1	0	0	1 chick no visible trauma
NAS North Island	0	0	12	8	0			12	8		3	1	0	fledgling killed by aircraft

Continued on next page

Table A-5. California Least Tern non-predator mortality, 2000.

Site name	No. of eggs					No. of nests					No. of dead			Comments
	Human damaged	Lost to flooding	Abandoned pre-term	Abandoned post-term/nonviable	Outcome unknown	Human damaged	Lost to flooding	Abandoned pre-term	Abandoned post-term/nonviable:	Outcome unknown	Chicks	Fledglings	Adults	
NAB Coronado														
Delta Beach North	0	0	1	22			1	12			12	1	0	
Delta Beach South	0	0	2	5			1	2			0	0	0	
NAB Ocean	2	0	6	29			6	19			7	1	0	
D Street Fill/Sweetwater Marsh NWR	0	0	3	5	3	0	3	5	3		2	0	1	
Chula Vista Wildlife Reserve	0	0	0		0	0	0		0		0	0	0	
South San Diego Bay NWR - Saltworks	0	0	3	6	7	0	2	6	5		3	0	0	
Tijuana Estuary NERR - Totals	1	25	19	11	42	1	16	15	9	27	7	1	0	1 nest ATV, 1 chick pedestrian, 1 fledgling vehicle
North of River	0	25	2	3	5	0	16	2	3	4	3	0	0	
South of River	1	0	17	8	37	1	0	13	6	23	4	1	0	
Total	3	30-32	344-345	268-269	549-559	2	19-21	304-305	207-208	371	376	62-63	35	

Table A-6 - Predators observed at California Least Tern sites, 2000.

Predator species	Predation		
	Possible	Suspected	Documented
crabs (spp.)	x		
black widow spider			
ants (spp.)	x		x
snakes (spp.)	x		x
great blue heron	x		
black-crowned night heron	x		x
black-bellied plover			
gulls (spp.)	x	x	x
Caspian tern			
gull-billed tern	x	x	x
osprey			
white-tailed (black-shouldered) kite	x	x	
northern harrier	x	x	x
Cooper's hawk	x		
red-tailed hawk	x	x	x
American kestrel	x	x	x
peregrine falcon	x	x	x
greater roadrunner	x		
barn owl	x	x	x
great-horned owl	x		
burrowing owl	x		
owls (spp.)	x	x	x
rock dove			
American crow	x		x
common raven	x	x	x
loggerhead shrike	x	x	
horned lark		x	
western meadowlark			
red-winged blackbird	x		
unknown avian spp.			
unknown mammal spp.			
opossum	x		x
black-tailed jackrabbit			
California ground squirrel	x		
rats (spp.)	x		
rodents (spp.)	x		
canids (spp.)			
domestic dog	x	x	
coyote	x	x	x
gray fox	x	x	x
red fox			
raccoon	x	x	x
long-tailed weasel	x		x
striped skunk	x		
mountain lion	x		
bobcat	x		x
domestic cat	x	x	x
unknown spp.	x	x	x

Table A-7. California Least Tern predation, 2000.

Site name	Predation					Number of			Documented predation				
	Possible	Suspected	Documented	Eggs	Nest	Chicks	Fledglings	Adults	Total number of preyed on				
									Eggs	Nests	Chicks	Fledglings	Adults
San Francisco Bay Area													
Southern Energy Delta Pittsburg Power Plant (SE)		NoHa, AmCr	AmCr	AmCr (1D 3S)	AmCr (2?)	AmCr 0-2+?P, NoHa 2-6S			(1)	-1	0	0	0
Albany - Central Ave. mitigation island													
NAS Alameda	PeFa, BaOw	HoLa	NoHa	NoHa 6D, HoLa 11S			BaOw 7P	PeFa 1P	17	12	0	7	1
Kings County													
Kettleman City Evaporation Ponds									0	0	0	0	0
San Luis Obispo/Santa Barbara Counties													
Oceano Dunes SVRA	LoSh	LoSh		LoSh 2P	LoSh 1P	LoSh 4S			0	0	0	0	0
Guadalupe-Mussel Rock									0	0	0	0	0
Vandenberg Air Force Base	GBHe, gulls, LoSh	NoHa, AmKe	AmKe	0	0	GBHe 0-3P, gulls 0-3P, NoHa 0-3S, AmKe 1D 2-8S, LoSh 0-8P			0	0	1	0	0
Ventura County													
Santa Clara River/McGrath State Beach									0	0	0	0	0
Ormond Beach	dogs, WTKi	dogs, WTKi	None						0	0	0	0	0
NBVC Point Mugu													
Los Angeles/Orange Counties													
Venice Beach		PeFa, CoRa	AmCr, cat	AmCr 30D, CoRaS, catD	AmCr 15D, catD	cat 20D	cat 20D	PeFa2S, cat 1D	30	15	20+	1-20	3
LA Harbor Pier 400		PeFa	gulls, PeFa	gulls 24D	gulls 20D	PeFaS	PeFa 5D, PeFa 10-20S	PeFaS	24	20	unk.	5-20	unk.
LA Harbor TC2		AmKe				AmKe 4-9S			0	0	4-9	0	0
Seal Beach													
Bolsa Chica Ecological Reserve													
Huntington State Beach	owls, AmCr	AmKe	AmKe	AmCr 5P		AmKe S	AmKe 2D	owls 7P	5?		unk	2	7
Upper Newport Bay Ecological Reserve	Ra, GBHe, Co	AmCr											

Continued on next page

Table A-7. California Least Tern predation, 2000.

Site name	Predation					Number of			Documented predation				
	Possible	Suspected	Documented	Eggs	Nest	Chicks	Fledglings	Adults	Total number of preyed on				
									Eggs	Nests	Chicks	Fledglings	Adults
San Diego County													
Camp Pendelton - Totals	mtn. lion, cat, dog, Bo, Ra, We, BuOw, AmCr, AmKe, WTKi, NoHa, CoRa, GBTe, GBHe, BCNH, GrRo, snake, crab								21	16	23	23	40
White Beach			BaOw or GHOw, Bo, unk.	unk.4D	unk.2D	owl sp. 1D, Bo 1D, unk. 1D	unk spp. 1D	BaOw or GHOw 2D, Bo 1D, unk. 1D	4	2	3	1	3
Santa Margarita River - North Beach			BCNH, PeFa, gull, BaOw or GHOw, CoRa, Bo, We, Op, snake, unk., ant	BCNH1D, CoRa8D, gull6D, We1D, unk.1D	BCNH1D, CoRa7D, gull4D, We1D, unk.1D	BaOw or GHOw 1D, Bo 10D, Op 2D, snake 1D, ant 7D	PeFa 9D, BaOw or GHOw 2D, unk 3D	PeFa 14D, BaOw or GHOw 8D, Bo 4D	17	14	14	14	26
Santa Margarita River - Saltflats			PeFa, RTHa, Co, unk.			Co 4D, unk.2D	PeFa 2D, RTHa 1D, unk 5D	PeFa 9D, unk. 2D	0	0	6	8	11
Santa Margarita River - Saltflats Island				0	0								
Batiquitos Lagoon													
W-1													
W-2	AmCr, AmKe, CoRa, GBHe, gulls, RTHa, RWBI, GS, cat, Ra, We, CoHa								0	0	?	?	2
E-1	AmCr, gulls, RTHa, We, CoHa, Co												
E-2													
E-3													
San Elijo Lagoon	snakes, GBHe, gulls, RTHa, AmCr, dog, Sk, Bo	AmKe, PeFa, CoRa, Co, Ra	Co, Ra	CoRa (1D), Co 2D, Ra 4D	CoRa (1D), Co 1D, Ra 2D	AmKe S, PeFa S, CoRa S, Co S, Ra S		PeFa 1D	6	3	0-7	0	1

Continued on next page

Table A-7. California Least Tern predation, 2000.

Site name	Predation								Documented predation					
	Possible	Suspected	Documented	Eggs	Nest	Number of			Total number of preyed on					
						Chicks	Fledglings	Adults	Eggs	Nests	Chicks	Fledglings	Adults	
Mission Bay														
FAA Island			gull, CoRa		10D					10				
North Fiesta Island	CoRa, Op, Sk	RTHa, AmKe, BaOw, cat	AmKe	(CoRa 0-1P, Op 0-1P, Sk 0-1P)		RTHa 0-20S, AmKe 1D 0-19S, BaOw 0-20S	RTHa 0-10S, AmKe 0-10S, BaOw 0-10S, cat 0-1S	RTHa 0-3S, AmKe 0-3S, BaOw 0-3S	(1)	(1)	1-25	5-19	3-10?	
Mariner's Point	GBHe, rats	gulls, AmKe, PeFa, Op	Op	GBHe P, gulls (1S), Op 1D 243S, rats 0-10P	GBHe P, AmKe 0-150S, PeFa 0-150S, Op 1D 131S, rats 0-10P	GBHe P, AmKe 0-150S, PeFa 0-150S			245	133	150-250?	50-100?	0	
Lindbergh Field	ant, gull, AmKe, CoRa, Op, GS, rat, cat	AmKe, gull							0	0	?	?	1-2	
NAS North Island	GBHe, BCNH, AmKe, PeFa, WeGu, CoRa								1	1	0	1	1	
NAB Coronado														
Delta Beach North	cat, gopher, GBHe, BCNH, NoHa, AmKe, PeFa, gull, GBTe, CoRa, ant	cat, GBTe, PeFa	cat, GBTe, PeFa, unk			cat 1D, GBTe 2D, unk. 1D	PeFa 16D	PeFa 6D, unk. 1D	0	0	4	16	7	
Delta Beach South	GBHe, BCNH, AmKe, gull, GBTe, GHOW, LoSh, CoRa, ant	GBTe, PeFa, ant	ant, unk	unk. 2D	unk1D	ants 2D	unk. 3D	unk. 2D	2	1	2	3	2	
NAB Ocean	Op, GS, Sk, cat, dog, GBHe, NoHa, AmKe, PeFa, gull, GBTe, AmCr, CoRa	NoHa, PeFa, AmKe	NoHa, AmKe, unk	unk. 10D	unk7D	NoHa 1D, AmKe 1D	unk. 2D	PeFaS, unk. 1D	10	7	2	2	1	
D Street Fill/Sweetwater Marsh NWR	NoHa, PeFa, AmKe, owl, CoRa, dog	NoHa, AmKe, GHOW	NoHa, owl	unk2D	unk2D	NoHa1D, unk2D, 15S		unk1D	2	2	3	0	1	

Continued on next page

Table A-7. California Least Tern predation, 2000.

Site name Chula Vista Wildlife Reserve	Predation					Number of			Documented predation				
	Possible	Suspected	Documented	Eggs	Nest	Chicks	Fledglings	Adults	Total number of preyed on				
									Eggs	Nests	Chicks	Fledglings	Adults
South San Diego Bay NWR - Saltworks	NoHa, PeFa, AmKe, gull, GBTe, BaOw, CoRa, owl, Op, GF, Co, dog	NoHa, PeFa, AmKe, gull, GBTe, BaOw, GF, Co	PeFa, gull, BaOw, GF, Co	gull11D, GF5D, Co3D, unk2D, 5S	gull6D, GF4D, Co2D, unk1D, 7S	unk1D, 26S		PeFa2D , BaOw1 D, unk1D	21	13	1	0	4
Tijuana Estuary NERR - Totals	NoHa, AmKe, PeFa, gull, GBTe, BaOw, CoRa, Op, We, rodent, GS, cat, dog, Co, Sk	NoHa, AmKe, PeFa, gull, GBTe, BaOw, Op, We, rodent, cat	BaOw, gull, rodent, unk	gull3D, rodent2D, unk2D	gull2D, rodent1D, unk1D, 42S	unk2D, 147-168S	unk5-6D	unk 8- 9D, BaOw1 D	6	4	2	5-6	9-10
Total									390- 392	237- 239	213- 349	119-218	123- 132

Predation codes:

P - possible predation

S - suspected predation

D - documented predation

() - predation of previously abandoned egg or nest

Predator codes:

AmCr - American crow

GBHe - great blue heron

owl - owl species

AmKe - American kestrel

GBTe - gull-billed tern

PeFa - peregrine falcon

ant - ant species

GF - gray fox

Ra - raccoon

BaOw - barn owl

GHOW - great horned owl

RTHa - red-tailed hawk

BCNH - black-crowned night-heron

GrRo - greater roadrunner

Sk - striped skunk

Bo - bobcat

GrEg - great egret

snake - snake species

BuOw - burrowing owl

GS - Calif. ground squirrel

unk - unknown species

cat - feral & domestic cat

gull - gull species

We - long-tailed weasel

Co - coyote

HoLa - horned lark

WeGu - western gull

CoHa - Cooper's hawk

LoSh - loggerhead shrike

WeMe - western meadowlark

CoRa - common raven

mntn lion - mountain lion

WTKi - white-tailed kite

crab - crab species

NoHa - northern harrier

dog - feral & domestic dog

Op - opossum