

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

**California Least Tern Breeding Survey  
2004 Season**

**by  
Daniel A. Marschalek**

# **Final Report**

To

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

## **California Least Tern Breeding Survey**

**2004 Season**

Daniel A. Marschalek  
California Department of Fish and Game  
4949 Viewridge Avenue  
San Diego, CA 92123

Prepared 28 February 2005  
Revised 9 June 2005

State of California  
The Resources Agency  
Department of Fish and Game

## California Least Tern Breeding Survey 2004 Season<sup>1</sup>

by

Daniel A. Marschalek  
California Department of Fish and Game  
4949 Viewridge Avenue  
San Diego, CA 92123

### ABSTRACT

Monitoring to document breeding success of California least terns (*Sterna antillarum browni*) continued in 2004, with observers at 32 sites providing data. An estimated 6354-6805 California least tern breeding pairs established 7977 nests and produced 1351-1624 fledglings at 48 documented locations. The fledgling to breeding pair ratio was 0.20-0.26. Statewide, 12,774 eggs were reported, with a site average of 1.56 eggs per nest (St Dev = 0.248) and an average clutch size of 1.625 eggs (St Dev = 0.50) for Type 1 sites. Numbers of nesting least terns were not uniformly distributed across all sites. Camp Pendleton, LA Harbor, Naval Base Coronado, Pt. Mugu and Batiquitos Lagoon represented 65% of the breeding pairs while LA Harbor, Alameda Pt., Pt. Mugu and Batiquitos Lagoon produced 70% of the fledglings. Three large sites (LA Harbor, Camp Pendleton and Batiquitos Lagoon) in southern California experienced high levels of chick mortality. Starvation was believed to be the cause of 33-57% death rate of chicks. The main predators of least tern chicks were coyotes (*Canis latrans*) and American crows (*Corvus brachyrhynchos*), accounting for up to 676 and 1022 deaths, respectively. Gulls (*Larus* sp.), peregrine falcons (*Falco peregrinus*) and American crows were reported from the most sites. The monitoring effort of 2004 is scheduled to continue in 2005.

---

<sup>1</sup> Marschalek, D.A. 2005. California least tern breeding survey, 2004 season. California Department of Fish and Game, Habitat Conservation and Planning Branch, Species Conservation and Recovery Program Report, 2005-01. Sacramento, CA. 24 pp. + app.

## INTRODUCTION

The California least tern (*Sterna antillarum browni*) is a migratory species, nesting along the west coast of North America, from Baja California, Mexico, north to the San Francisco Bay area (USFWS 1980). Least terns establish nesting colonies on sandy soils with little vegetation along the ocean, lagoons, and bays. Their nests are shallow depressions lined with shells or other debris (Massey 1974, Cogswell 1977). Least terns are generally present at nesting areas between mid-April and late September (Massey 1974, Cogswell 1977, Patton 2002), often with two waves of nesting during this time period (Massey and Atwood 1981). This species was listed as endangered by U.S. Fish and Wildlife Service (USFWS) in 1970 (USFWS 1973) and California Department of Fish and Game (CDFG) in 1971 (CDFG 1976) due to a population decline resulting from loss of habitat (Craig 1971, Cogswell 1977).

The endangered status initiated monitoring efforts to determine the population status of least terns in California. Craig (1971) conducted the initial surveys of breeding colonies in 1969 and 1970, focusing on site characteristics, including historical use and threats to each colony. In 1973, the first annual breeding survey was conducted (Bender 1974a), which changed the focus of the monitoring effort from an earlier descriptive effort to quantifying breeding numbers and nesting success for each breeding colony. Factors determining breeding success, such as predation and egg and chick abandonment, were recorded starting in 1975 (Massey 1975). From 1976 to 1978, research and new management techniques were initiated to develop a better understanding of least tern biology and increase breeding success. These techniques included banding to study local movements (Jurek 1977), use of chick shelters (Jurek 1977), identifying key feeding areas (Atwood et al. 1977), and extensive use of decoys (Atwood et al. 1979). The first documented records of fledglings appeared in the 1977 annual survey report (Atwood et al. 1977). Massey (1989a) later conducted an analysis of fledgling survey techniques to determine a method that minimized sampling problems associated with the tendency of young to quickly leave the nesting area.

Monitoring of breeding colonies increased from one to three visits per year to more frequent than one visit per week for most sites since 1971. However, wide variation exists among sites and years. The observed statewide population increase of least terns in the 1970s and 1980s has been attributed to increased sampling and associated personnel rather than an actual increase in the number of California least terns (Atwood et al. 1977, USFWS 1980 Massey 1988). Additionally, USDA Wildlife Services (formerly Animal Damage Control) commenced predator management activities to benefit least terns in the 1980's. Their involvement resulted from monitors identifying predation of pre-flying young as the main factor of poor breeding success rather than reduced habitat and pair disturbance (Collins 1984).

Obst and Johnston (1992) recommended that datasheets and fledgling counts be standardized across the state. This was accomplished in 1993 when all site monitors were provided with the same datasheets and instructions (Caffrey 1994, 1995a). Over the last decade, monitors continued to provide comparable data of California least tern breeding success and these data are compiled into an annual summary report. These latest monitoring efforts were continued for the 2004 breeding season in California.

## **METHODS**

Monitors for each site that had least tern nesting in 2003 or planned monitoring activities for 2004 were provided datasheets prior to the arrival of adults (Appendix A). These forms were identical to those used in 2003 to continue standardized data collection for the entire state. Forms and instructions to report final breeding data were provided at the same time so monitors could collect and prepare data requested for the annual report. General updates from each site were compiled about every two weeks and distributed to CDFG and USFWS representatives so that any potential problems could be dealt with quickly.

### **Site Preparation**

Information about each nesting site was requested to determine the level of protection provided to the birds. If a site had more than one discrete cluster of nests, the monitor had the option of reporting information for each sub-colony or the site as a whole. Use of shelters to protect chicks from predators and weather, decoys to attract adults, presence of interpretive signs to explain restricted access, and a grid system to assist in locating nests required a yes/no response. However, fence type and vegetation management were more variable. In an attempt to standardize and simplify these two variables, categories were created which were easily reported as a number.

Fence type was reported as one of four categories: (1) the fence deterred or excluded most people and mammalian predators (i.e. chain link or solid fence that fully encloses the site), (2) cantilevered and/or barbed wire at the top deterred cats and other climbing mammals, (3) the fence would not deter most mammalian predators (i.e. not fully fenced on all sides, or fenced only with posted signs and wire or twine), (4) no enclosure.

Vegetation management was reported as one of seven categories: (1) mechanically graded or dragged to remove vegetation, (2) manually removed, (3) herbicide (Roundup or Rodeo) use, (4) combination of 1, 2 or 3, (5) vegetation removed by other means, (6) no vegetation management occurred prior to the nesting season, but was needed in the opinion of the monitor, (7) vegetation management was not necessary.

### **Monitoring**

#### **Sampling Type and Intensity**

Each site was categorized as Type 1, 2 or 3 based on the level of sampling intensity employed. At a Type 1 site, monitors entered the colony to mark nests and record the number of eggs; a Type 2 nesting site was monitored from outside the colony. A Type 3 site was monitored primarily from outside the colony, but sampling within the colony occurred more frequently than once per month or more than 5 times during the season when nests are active or chicks are present. Type 1 sites yield more data, such as clutch size, hatching success, and evidence of predation. This type of monitoring allows more quantitative comparisons to be made among sites and years. Type 2 monitoring, however, minimizes disturbance to the nesting colony, possibly offering better conditions for behavior studies (Keane 1998, 2000, 2001).

Information regarding other monitoring techniques was requested as well. This included whether nests were marked (generally with a tongue depressor or wooden stake), eggs marked (numbering the shell) or birds banded. When color-banding studies were conducted, the band color was requested (Table 1).

**Table 1.** Color combinations of current and past California least tern banding studies conducted at breeding areas in California.

Site Name	Color Combination	Abbreviation
Oceano Dunes SVRA	Green/Yellow	G/Y
MCB Camp Pendleton	Mauve (Violet)/Black	M/K
Batiquitos Lagoon Ecological Reserve	Red/White	R/W
Mariner's Point	Blue/Green	B/G
NIMAT	Aqua (light blue)/Orange	A/O
NI 1-1	Black/Aqua (Light Blue)	K/A
Naval Amphibious Base Ocean	Blue/Pink, Red/Blue	B/P, R/B
Delta Beach North	Yellow/Red	Y/R
Delta Beach South	White/Black	W/K
2004 Captive	Anodized Red	-
2003 Captive	Anodized Green	-
2002 Captive	Anodized Blue	-

Sampling intensity was reported as the total number of visits to a site and dates of first and last visits. Optional data included monthly averages of visits per week, number of hours per visit (total, within colony and within colony in blind) and number of monitors per visit.

### Pair Estimation

Three different calculations (Methods I, II, III) were used to determine the total number of breeding pairs at any one site. Adjustments to the total number of nests was required to estimate breeding pair totals due to pairs renesting after a failed attempt and young adults nesting later in the year (Massey and Atwood 1981).

Method I assumes the total number of breeding pairs renesting is equal to half of the number of nests in the second wave, with the second wave defined as all nests initiated after 14 June. If there is a time period with an obvious lull in nest initiation, dates of nest initiation dictate the start of the second wave. Total breeding pairs of a site is calculated by adding the number of nests of the first wave (prior to 15 June) to half of the nests in the second wave.

$$\text{Total Pairs} = \# \text{ nests prior to 15 June} + [(\# \text{ nests 15 June or after}) / 2]$$

Method II calculates the total number of breeding pairs by subtracting the total number of nests and broods lost prior to 20 June from the total number of nests. This method assumes that

renesting will not occur from a nest or brood lost after 20 June and the number of nests and broods lost before this date are equal to the number of pairs renesting at that same site.

$$\text{Total Pairs} = \text{total nests} - (\# \text{ unsuccessful nests prior 20 June} + \# \text{ broods lost prior 20 June})$$

Method III is much more subjective, relying on the monitor to estimate of the number of renesting pairs in the first and second wave. This calculation subtracts the estimated number of renesting pairs for each wave from the total nests during each wave. The totals for waves one and two are then added to estimate the total number of breeding pairs. Adult banding can reduce the subjectivity of Method III by allowing the monitor to observe renesting pairs.

$$\text{pairs first wave} = \# \text{ nests prior to 15 June} - \text{estimated renesters prior to 15 June}$$

$$\text{pairs second wave} = \# \text{ nests 15 June or after} - \text{estimated renesters 15 June or after}$$

$$\text{Total Pairs} = \text{pairs first wave} + \text{pairs second wave}$$

### Productivity

Productivity was measured by counting the number of nests, eggs, eggs hatched, hatching success and total fledglings at each site. Dates of first chick and fledgling were also typically recorded. These data will not be available for Type 2 or 3 sites simply because monitors cannot easily observe eggs and nests from a distance. “Window surveys” of active nests, fledglings, and adults were conducted at two-week intervals throughout the breeding season for statewide comparison.

The mean clutch size was calculated by dividing the total number of eggs by the total number of nests for each site, then averaging site values. Sites were treated as independent samples in this calculation. Clutch size was also calculated by using data from sites that reported clutch sizes of every nest detected. In those cases, each nest was treated as an independent sample. Only Type 1 sites were used for clutch size calculations because the data from Type 2 and 3 sites was not reliable.

Accurate fledgling counts are problematic as fledglings quickly move from their nesting areas (Massey 1989a). At least four specific techniques may be used and are reported as an abbreviation: (R) based on band recapture data, (3WD) based on daytime counts of fledglings added up every 3 weeks beginning 2-3 weeks after the first fledgling observation, (3WN) based on dusk counts of fledglings added up every 3 weeks beginning 2-3 weeks after the first fledgling observation, and (other) description of alternate method.

### Mortality and Predation

Identifying causes of mortality was of particular importance since it has been identified as the main cause of low reproductive success for this species (Collins 1984). Numbers of lost nests and individuals of each age class (egg, chick, fledgling and adult) were recorded. Causes

of mortality were further separated into either non-predation events or predation. Non-predation causes of death included abandonment, flooding and human damage.

Predators were characterized as either “potential,” “possible,” “suspected” and/or “documented.” *Potential* predators were classified as species known to feed on least terns and observed on or near the site without the loss of terns. If predation of terns occurred and a potential predator was known to be on or near the site through direct observation or other signs (track, scat, etc.), the animal was considered a *possible* predator. A *suspected* predator was reported when loss of least terns directly corresponded to the presence of a predator. These three predator classifications rely on the expertise of the monitors. *Documented* predators required a direct observation of a predator killing a least tern or substantial evidence to indicate responsibility. This evidence could be characteristic feeding patterns or tracks leading to a carcass or shell remains.

Both preventive and reactive predator management techniques were used to reduce the loss of least terns. Select predators were often removed from the site or adjacent areas just prior to the terns arriving in the spring. When predation was documented, the predator was removed using appropriate capture techniques. Sensitive and protected species were either trapped and released at off-site locations or were left on site and monitored.

## **RESULTS and DISCUSSION**

### **Site Preparation**

Managers at most sites (Figure 1) implemented a variety of techniques to control vegetation, generally using mechanical and chemical methods together. Fences to protect nesting sites were extremely variable, ranging from no fence to a chain link fence completely enclosing the site. While the majority of sites used chick shelters, few used decoys. Site-specific and complete site preparation data are provided in Appendix B-1.

### **Monitoring**

Twenty-seven of 32 sites monitored in 2004 were Type I site, the majority monitored at least one or two times per week. A grid system to assist in locating nests was not used at every site but almost every monitor marked nests in some fashion. Site-specific and complete monitoring data are located in Appendix B-2.

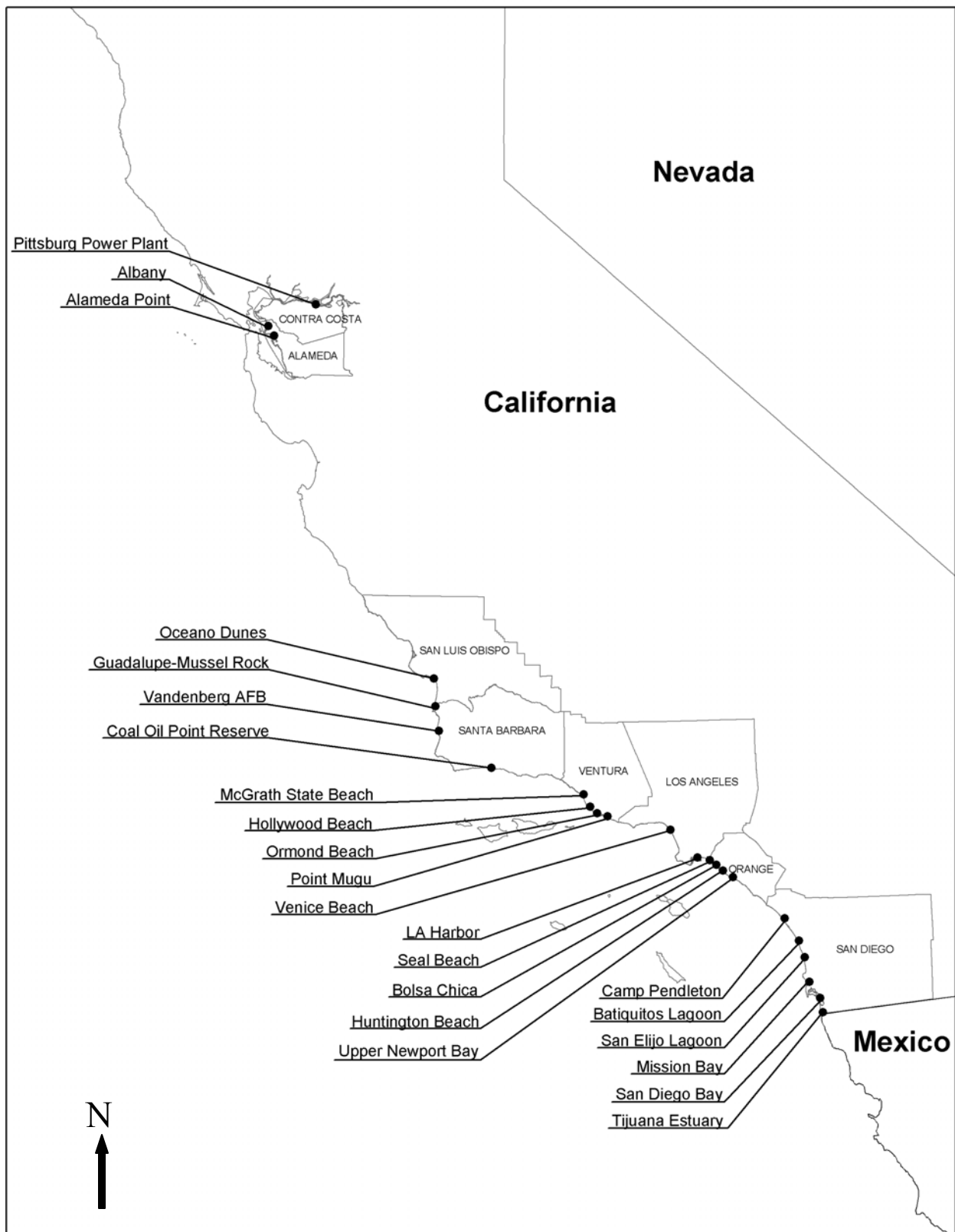
### **Productivity**

At least partial data were received and analyzed for all monitored least tern nesting areas in California for 2004. An estimated 6354-6805 California least tern breeding pairs established 7977 nests and produced 1351-1624 fledglings at 48 documented locations (Table 2). The fledgling to breeding pair ratio was 0.20 to 0.26 fledglings per pair. Statewide, 12,774<sup>2</sup> eggs

---

<sup>2</sup> Not available for Oceano Dunes and Burris Sand Pit.

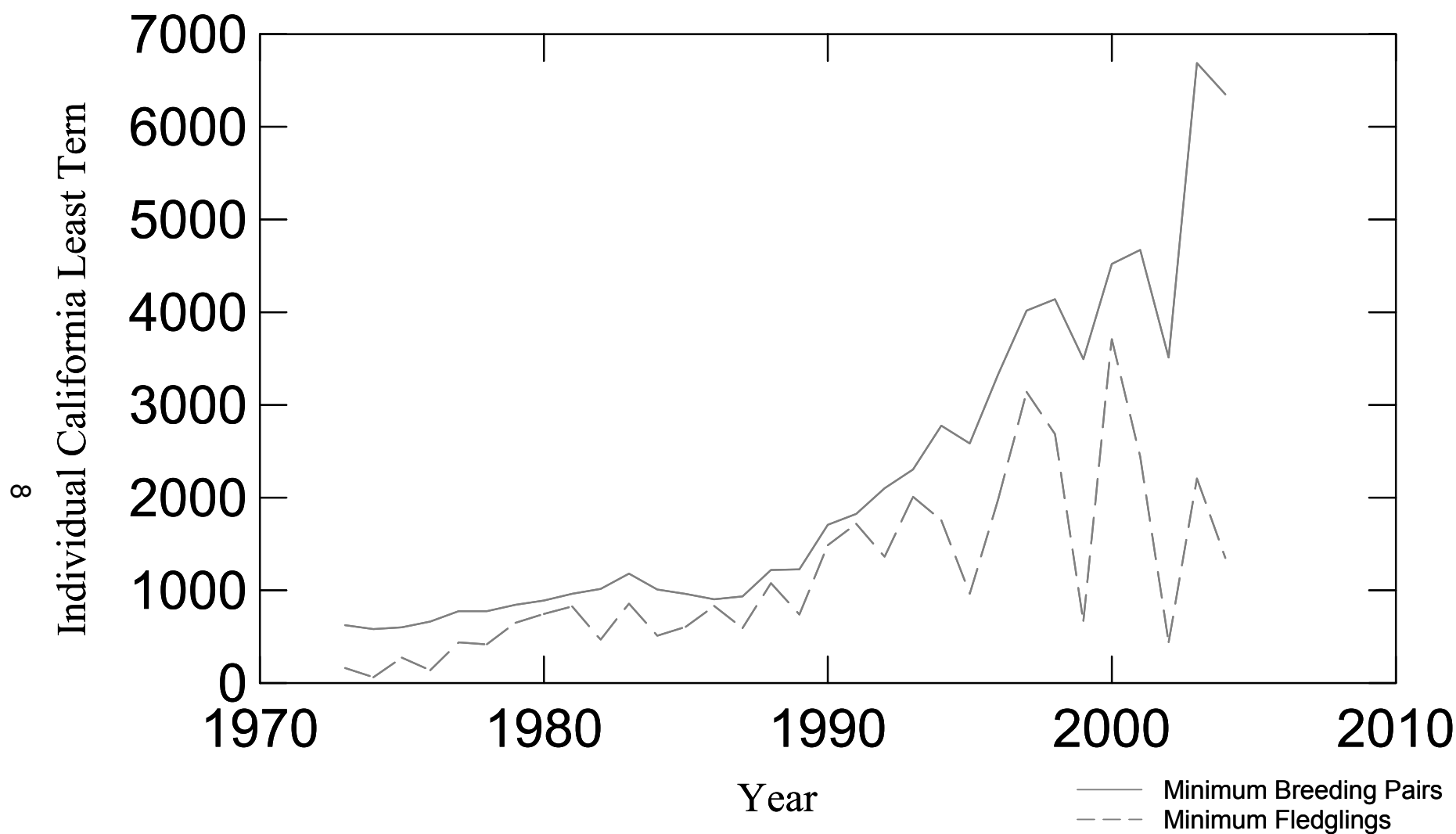




**Figure 1.** California sites monitored for California least tern nesting in 2004.

Table 2. California least tern productivity in 2004.

2004	Estimated Number of Breeding Pairs		Number of Nests	Estimated Number of Fledglings		Fledgling per Pair Ratio	
Site	Minimum	Maximum		Minimum	Maximum	Minimum	Maximum
San Francisco Bay Area							
Pittsburg Power Plant	12	12	15	1	1	0.08	0.08
Albany Central Ave. Mitigation Island	0	0	0	0	0	0	0
Alameda Point	379	379	440	155	380	0.41	1.00
San Luis Obispo/Santa Barbara Counties							
Oceano Dunes SVRA	47	47	63	25	25	0.53	0.53
Guadalupe-Mussel Rock	8	8	8	0	0	0	0
Vandenberg AFB	1	1	1	0	0	0	0
Coal Oil Point Reserve	6	6	6	0	0	0	0
Ventura County							
Santa Clara River/McGrath State Beach	64	64	83	27	27	0.42	0.42
Hollywood Beach	50	50	50	27	27	0.54	0.54
Ormond Beach	29	29	29	4	4	0.14	0.14
Pt Mugu- Totals	490	517	617	121	121	0.23	0.25
Holiday Beach	6	12	12	9	9	0.75	1.50
Ormond Beach East	386	394	453	110	110	0.28	0.28
Nesting Islands	11	21.5	25	0	0	0	0
Eastern Arm	87	89.5	127	2	2	0.02	0.02
Los Angeles/Orange Counties							
Venice Beach	17	17	17	0	0	0	0
LA Harbor	951	951	1071	556	556	0.58	0.58
Seal Beach NWR - Anaheim Bay	190.5	206	206	73	73	0.35	0.38
Bolsa Chica Ecological Reserve	137	186.5	229	60	60	0.32	0.44
Huntington State Beach	309.5	309.5	323	38	38	0.12	0.12
Burris Sand Pit	3	3	5	2	2	0.67	0.67
Upper Newport Bay Ecological Reserve	60	72	89	n/a	n/a	---	---
San Diego County							
MCB Camp Pendleton	1355	1355	1430	47	60	0.03	0.04
Red Beach	1	1	1	0	0	0	0
White Beach	86	86	102	7	9	0.08	0.10
Santa Margarita River - North Beach North	424	424	450	12	15	0.03	0.04
Santa Margarita River - North Beach South	770	770	801	25	30	0.03	0.04
Santa Margarita River - Saltflats	38	38	39	2	4	0.05	0.11
Santa Margarita River - Saltflats Island	36	36	37	1	2	0.03	0.06
Batiquitos Lagoon Ecological Reserve	431	570	592	110	110	0.19	0.26
San Elijo Lagoon Ecological Reserve	0	0	0	0	0	0	0
Mission Bay							
FAA Island	178	178	315	10	12	0.06	0.07
North Fiesta Island	11	11	17	0	0	0	0
Mariner's Point	100	125	299	0	0	0	0
San Diego River Mouth (S)	27	27	42	10	10	0.37	0.37
San Diego Bay							
Lindbergh Field & Former Naval Training Center	65	70	76	10	17	0.14	0.26
USN Totals	1041	1041	1207	40	40	0.04	0.04
NI MAT	162	162	172	6	6	0.04	0.04
DBN	237	237	263	9	9	0.04	0.04
DBS	173	173	195	4	4	0.02	0.02
NABO	469	469	577	21	21	0.04	0.04
D Street Fill/Sweetwater Marsh NWR	77	94	111	4	11	0.04	0.14
Chula Vista Wildlife Reserve	30	48	66	11	18	0.23	0.60
South San Diego Bay Unit, SDNWR - Saltworks	31	40	49	4	6	0.10	0.19
Silver Strand State Beach	1	1	1	0	0	0	0
Tijuana Estuary NERR	253	387	520	16	26	0.04	0.10
Total	6354	6805	7977	1351	1624	0.199	0.256



**Figure 2.** Number of documented California least tern breeding pairs and fledglings in California during annual surveys, 1973-2004. (Data from: Craig 1971; Bender 1974a, 1974b; Massey 1975, 1988, 1989b; Atwood et al. 1977; Jurek 1977; Atwood et al. 1979; Collins 1984, 1986 and 1987; Gustafson 1986; Johnston and Obst 1992; Obst and Johnston 1992; Caffrey 1993, 1994, 1995b, 1997, 1998; Keane 1998, 2000, 2001; Patton 2002, 2004 unpubl. table)

were reported, with mean clutch size of each site averaging 1.56 eggs per nest (St Dev = 0.248) and a statewide clutch size of 1.625 eggs (St Dev = 0.50).

The 2004 California least tern nesting season lasted approximately six months. The first recorded least tern at a nesting site was on 6 April at Batiquitos Lagoon Ecological Reserve and the last observed on 7 September at Naval Base Coronado. The first nest was detected on 3 May at Alameda Point, the first chick on 29 May at Alameda Point and Camp Pendleton, and the first fledgling on 21 June at Alameda Point. Least terns established at least one nest at all sites that had nesting in 2003 and utilized an additional five sites. A second nesting wave was not documented at nine sites, although this number is probably higher, as some sites did not report this information. Site-specific and complete productivity data are located in Appendix B-3 (breeding pair estimation) and B-4 (productivity).

The 6354 recorded minimum breeding pairs in 2004 were 5% lower than the 6688 total in 2003 (Patton 2004 unpubl. table). However, this is the second highest count recorded for California (Figure 2) (Craig 1971; Bender 1974a, 1974b; Massey 1975, 1988, 1989b; Atwood et al. 1977; Jurek 1977; Atwood et al. 1979; Collins 1984, 1986 and 1987; Gustafson 1986; Johnston and Obst 1992; Obst and Johnston 1992; Caffrey 1993, 1994, 1995b, 1997, 1998; Keane 1998, 2000, 2001; Patton 2002, 2004 unpubl. table). Fledgling numbers were not proportional to the number of breeding pairs. Although there were high numbers of breeding pairs, the number of fledglings was the third lowest total in the last nine years.

The majority of breeding pairs nested in San Diego County (3600 pairs, 56.7%) and the fewest in San Luis Obispo and Santa Barbara Counties (62 pairs, 1.0%) (Table 3). Breeding pairs were not a predictor for fledgling numbers, however. The fledgling-to-pair ratio ranged from a low of 0.073 in San Diego County to a high of 0.437 in Los Angeles and Orange Counties.

Camp Pendleton had the highest number of breeding pairs, nests, eggs and chicks in the state while Los Angeles Harbor (Port of Los Angeles) had the second highest totals in each category (Table 4). Los Angeles Harbor had the highest number of fledglings and fledgling-to-pair ratio in the state, while Camp Pendleton had 47 fledglings, eighth highest total in the state.

A few sites constituted the majority of breeding activity for the state in 2004, which is a trend observed in the past (Caffrey 1994, 1995, 1997 and 1998). Five sites (Camp Pendleton, Port of Los Angeles, Naval Base Coronado, Pt. Mugu and Batiquitos Lagoon Ecological Reserve) had over 400 minimum breeding pairs, which represented 65% of the state total. Eggs and nests tend to show a linear relationship with number of breeding pairs, resulting in an uneven distribution of eggs and nests as well. Fledgling numbers were also unevenly distributed as the four sites with over 100 fledglings each (Port of Los Angeles, Alameda Point, Pt. Mugu and Batiquitos Lagoon Ecological Reserve) contributed 70% of the state's production.

## **Mortality and Predation**

Chick mortality (Table 5) contributed to low reproductive success at a few sites, including Camp Pendleton, Batiquitos Lagoon Ecological Reserve and Port of Los Angeles, where 57, 49 and 33% of chicks were found dead, respectively. These three sites represented

84% of the total reported chick deaths. Food shortages were believed to be the main cause of chick mortality at these sites. Monitors observed adults returning to nests with fish at low rates and inappropriate sizes. At other sites, including Bolsa Chica and Pt. Mugu, food appeared to be sufficient and chick mortality was low. Least tern mortality due to non-predation factors was greater than mortality due to predation in 2004.

**Table 3.** Regional productivity comparison, 2004.

<b>Region</b>	<b>Breeding Pairs*</b>	<b>Proportion of Total</b>	<b>Fledglings*</b>	<b>Proportion of Total</b>	<b>Fledgling:Pair</b>
<b>San Francisco Bay Area</b>	391	0.062	156	0.116	0.399
<b>San Luis Obispo/Santa Barbara Counties</b>	62	0.010	25	0.019	0.403
<b>Ventura County</b>	633	0.100	179	0.133	0.283
<b>Los Angeles/Orange County</b>	1668	0.262	729	0.539	0.437
<b>San Diego County</b>	3600	0.567	262	0.194	0.073
<b>Total</b>	6354	1.000	1351	1.000	0.212

\* Breeding pair and fledgling numbers represent the minimum number recorded if a site reported a range of abundance.

**Table 4.** Nesting sites with highest observed number of breeding pairs, nests, eggs, chicks and fledglings (actual number observed in parenthesis).

<b>Breeding Pairs</b>	<b>Nests</b>	<b>Eggs</b>	<b>Chicks</b>	<b>Fledglings</b>
Camp Pendleton (1355)	Camp Pendleton (1430)	Camp Pendleton (2558)	Camp Pendleton (1876)	LA Harbor (556)
LA Harbor (951)	LA Harbor (1071)	LA Harbor (1748)	LA Harbor (1380)	Alameda Pt (155)
Naval Base Coronado (879)	Naval Base Coronado (1035)	Pt Mugu (1048)	Batiquitos (858)	Pt Mugu (121)
Pt Mugu (490)	Pt Mugu (617)	Batiquitos (592)	Alameda Pt (554)	Batiquitos (110)
Batiquitos (431)	Batiquitos (592)	Alameda Pt (755)	Seal Beach (285)	Seal Beach (73)

It was very difficult to accurately determine the predator species involved in a tern predation event. These events were not typically observed and often little or no evidence remained at the site. The uncertainty of the exact predator species responsible for a depredation event often resulted in reporting a range of least terns lost to a particular species rather than an exact number.

**Table 5.** Cause of mortality of least terns with associated counts for each life stage. Complete and site specific mortality data is located in Appendix B-5 (non-predation) and B-6 (predation).

	Eggs	Nests	Chicks	Fledglings	Adults
<b>Non-predation</b>	3269	1579 - 1934	2290	47 - 48	33
<b>Predation</b>	2342 - 2418	1353 - 1356	460 – 508*	15-16*	32 - 33
<b>Total</b>	5611 - 5687	2932 - 3290	2750 – 2798*	62 – 64*	65 - 66

\*Upper limit of range is not exact due to minimum numbers reported.

Thirty-five species were reported as possible, suspected or documented predators of least terns, including the first case of least tern depredation by black-billed magpies (*Pica hudsonia*) at Port of Los Angeles (Table 6). The most common predators were birds, with gulls, peregrine falcons and American crows each reported from twelve different sub-colonies and American kestrels (*Falco sparverius*) and common ravens (*Corvus corax*) from ten. The most common mammalian predator was the coyote.

**Table 6.** Documented or suspected predators of least terns in 2004. Number of sub-colonies each species was reported from in parenthesis.

Species	Species	Species
American crow (12)	Unknown avian (4)	Barn owl (1)
Gulls (12)	Ants (3)	Black-bellied plover (1)
Peregrine falcon (12)	Domestic cat (3)	Black-billed magpie (1)
American kestrel (10)	Great-horned owl (3)	Black-crowned night heron (1)
Common raven (10)	Black-tailed jackrabbit (2)	Black widow spider (1)
Coyote (8)	Opossum (2)	Burrowing owl (1)
Northern Harrier (7)	Owls (2)	Canids (1)
California ground squirrel (5)	Rodents (2)	Domestic dog (1)
Gull-billed tern (4)	Snakes (2)	Gray fox (1)
Loggerhead shrike (4)	Striped skunk (2)	Osprey (1)
Raccoon (4)	Unknown mammal (2)	Rats (1)
Red-tailed Hawk (4)		

Predation led to the loss of about 2400 eggs, 500 chicks, 15 fledglings and 33 adults (Table 5). To quantify mortality resulting from specific predators, the proportion of total least tern eggs, chicks, fledglings and adults depredated by a known predators was calculated (Table 7). When a range of individuals depredated by a species was reported, the average was used. Coyotes were responsible for the greatest loss of least terns (554-676 total individuals, 17%), with American crows (36-1022, 14%) and California ground squirrels (*Spermophilus beecheyi*) (463-557, 10%) also over 10%. Similar trends resulted when calculations included minimum or maximum values of the reported range. Nests were excluded from this analysis since the number of eggs better represents the loss of individuals. Site-specific and complete mortality data are located in Appendix B-5 (non-predation) and B-6 (predation).

Predation by coyotes and American crows in past years was a major problem (Keane 2001, Patton 2002). These two species continued to be a problem in 2004. Raptors, primarily American kestrels and peregrine falcons, contributed to losses as well, mainly of chicks and adults. Abandonment is not included in depredation data but can be driven by a predator, as suspected at FAA and Mariner's Point in Mission Bay. At these two locations, peregrine falcons were believed to be responsible for adults with active nests to abandon the area.

High levels of chick mortality attributed to food shortages have also been observed in past years (Caffrey 1993). Indirect evidence appears to support food shortage as a major cause of chick mortality in 2004. However, starvation with these small animals is difficult to confirm. Fish appeared to be available early in the year, however, these levels dropped later in the summer.

**Table 7.** Species responsible for greatest proportion of depredated least tern eggs, chicks, fledglings or adults. Bolded species are responsible for one of the ten greatest numbers of least terns lost to predation regardless of whether minimum, average or maximum values of the reported range were used for analysis.

Species	Proportion of Least Tern Individuals Depredated*
<b>Coyote</b>	0.1682
<b>American crow</b>	0.1364
<b>California ground squirrel</b>	0.1018
<b>Gulls</b>	0.0998
<b>Gull-billed tern</b>	0.0784
<b>American kestrel</b>	0.0678
Rats	0.0671
<b>Peregrine falcon</b>	0.0632
Northern harrier	0.0574
Unknown avian	0.0221

\*Based on average of the range reported for least terns depredated by each species.

## Summary by Site

Management and monitoring of California least terns requires a site-by-site perspective. This can be dictated by the biology or geography of the area or the specific nesting area, or by human related issues. This section includes detailed site-specific information that is of particular importance for management.

### San Francisco Bay Area *Pittsburg Power Plant*

At the Pittsburg Power Plant site, twelve breeding pairs established 15 nests and produced one fledgling. Suspected predation by great blue herons (*Ardea herodias*) and raccoons (*Procyon lotor*) caused poor fledgling success. In addition to predation, up to 18 Canada geese (*Branta canadensis*) were observed roosting, foraging and nesting within and adjacent to the area used by least terns. Geese were responsible for trampling nests in 2003.

Early attempts to reduce the number of geese appeared to be successful, however, goose numbers increased as these measures ceased with the presence of terns on site. Prior to the 2004 breeding season, a portion of the nesting area was covered with 0.75 tons of oyster shells to enhance nesting substrate.

#### *Albany Central Ave. Mitigation Island*

The Albany site did not have least tern nesting in 2004 for the third consecutive year (Patton 2004 unpubl. table).

#### *Alameda Point*

At the Alameda Point site, 379 breeding pairs established 440 nests and produced 155-380 fledglings, including a four-egg clutch nest. For the second consecutive year, chick mortality was high. Postmortem examination was not able to determine the cause of the high mortality rate (30%). Documented predation was minimal: nine eggs, twelve chicks, four fledglings and one adult were lost from northern harrier (*Circus cyaneus*), American kestrel, unidentified owl species, common raven and unknown avian species. The nesting site was expanded from 6 to 9.7 acres prior to the 2004 breeding season. The expanded area was enhanced with new sand, oyster shells and a fence. Eighteen nests were established in the expanded area.

#### San Luis Obispo/Santa Barbara Counties *Oceano Dunes SVRA*

The Oceano Dunes SVRA site had 47 breeding pairs, 63 nests and produced 25 fledglings. At midseason, availability of fish appeared to be adequate.

#### *Guadalupe-Mussel Rock*

Eight breeding pairs established eight nests and produced no fledglings at Guadalupe-Mussel Rock. This follows a one-year absence of least tern nesting at this site (Patton 2004 unpubl. table). Of the eight nests, three hatched at least one chick, three were destroyed by unknown causes, one was abandoned and one was depredated by a coyote. Increased predator management of this site has been suggested to increase breeding success of least terns.

#### *Vandenberg AFB*

One breeding pair established one nest and produced no fledglings. No nesting was recorded at the Beach 2 sub-colony for four of the last five years and an unusually large drop in breeding pairs occurred at the Purisima Point sub-colony (Patton 2004 unpubl. table). More than 60 terns were observed at the site; however, only one nest was established and it was never incubated. Food shortages were believed to be the cause of the breeding failure at Vandenberg AFB. Over 200 fecal samples from an on-site roosting area were collected and will be analyzed.



### *Coal Oil Point Reserve*

Coal Oil Point Reserve experienced the documented first least tern nesting activity. In 2004, six breeding pairs established six nests and produced no fledglings. Predation was the cause of the breeding failure. Skunks (*Mephitis*) destroyed four nests and two nests were abandoned after a great horned owl (*Bubo virginianus*) killed one of the adults from each nest. About 20 least terns have used the reserve post breeding since 2001. Monitors have expressed interest in providing nesting information for this site in the future and are investigating methods to reduce depredation.

### Ventura County

#### *Santa Clara River/McGrath State Beach*

At the Santa Clara River site, 64 breeding pairs established 83 nests and produced 27 fledglings. Twenty-nests hatched, four were abandoned, one was lost to predation and 118 had unknown outcomes.

#### *Hollywood Beach*

Hollywood Beach had 50 breeding pairs, 50 nests and 27 fledglings. Least tern nesting was unexpected at this site in 2004; however, the site monitor is prepared for least tern nesting and data collection in 2005. This is the second year in which nesting was documented at Hollywood Beach. In 1997, eight least tern nests were documented.

#### *Ormond Beach*

At Ormond Beach, 29 breeding pairs established 29 nests and produced four fledglings. A large number of eggs had unknown outcomes. Ormond Beach also had problems with ultralight aircraft and paragliders disrupting the nesting colony (Alvarez 2004): adult terns abandoned the nesting site by 18 July, suggesting a causal effect.

#### *NAS Point Mugu*

Point Mugu had a total of 490-517 breeding pairs, 617 nests and 121 fledglings. Ormond Beach East had the highest number of pairs, nests and fledglings of the four sub-colonies. The Holiday Beach sub-colony had 12 nests in 2004, the first nests at this site since its construction in 2003. The highest percentage of mortality was due to coyotes, eating 33% of the eggs. This is the first year that coyotes have been problematic at this site. Although predation caused a low hatching rate, a large number of fledglings were produced. The food source appeared to be adequate, as adults fed chicks fish of appropriate size.

### Los Angeles/Orange Counties

#### *Venice Beach*

Venice Beach had 17 breeding pairs, 17 nests and no fledglings; all nests were depredated by crows. Two hundred least terns were observed at the site early in the season and

many scrapes were found. Food shortage was believed to be the cause of the low nesting activity as perch and pompano, not anchovies (*Engraulis mordax*), were found dropped on the site by adults. Also, monitors observed adults on the sand without fish. It is also the second year out of the last three that nest numbers were below 300 [2002 had only 2 nests (Patton 2004 unpubl. table)].

#### *Los Angeles Harbor*

The Port of Los Angeles site had 951 breeding pairs, 1071 nests and 556 fledglings. Starvation was thought to be the leading cause of death. Despite 453 chicks, 31 fledglings and 12 adults found dead, this site produced the most fledglings of any site in the state. Predation appeared to be relatively low.

Black-billed magpies were a documented predator of least terns at this site in 2004. A pair nested near the least tern site and produced two fledglings. All individuals were removed after depredation was observed. Twenty-seven American crows, three common ravens, gulls and feral cats (*Felis catus*), one burrowing owl (*Athene cunicularia*) and one American kestrel were also removed from the least tern nesting site (Ross 2004).

#### *Seal Beach NWR*

At Seal Beach NWR, 190-206 breeding pairs established 206 nests and produced 73 fledglings. Mortality due to predation or other factors appeared to be minimal. Monitors used a method based on the growth rate of least terns to calculate fledgling numbers. Since the growth rate after five days is linear (wing length 40-41 mm/week), the date an individual will fledge can be predicted. Individuals present within one week of the predicted fledging time are recorded as fledglings. Predator managers removed 125 American crows, 24 common ravens, one loggerhead shrike (*Lanius ludovicianus*), one American kestrel, one red-tailed hawk (*Buteo jamaicensis*) and two deer mice (*Peromyscus maniculatus*) from the nesting area (Ross 2004).

#### *Bolsa Chica Ecological Reserve*

At Bolsa Chica Ecological Reserve, 137-187 breeding pairs established 229 nests and produced 60 fledglings. Predation had a negative influence on reproductive success, as coyotes and raccoons resulted in the loss of 250 eggs, 160 nests and 20 chicks during two separate nights. Other mammals removed from the site included four ground squirrels, two striped skunks and one rat (Ross 2004). Predator managers also removed six different bird species, including 99 American crows, 19 American kestrels, ten loggerhead shrikes, three common ravens, one peregrine falcon and one red-tailed hawk (Ross 2004). Sensitive and protected species were trapped and released off site. No evidence of chick starvation was reported at this site.

Fences were repaired on two different occasions to prevent access by mammalian predators, especially coyotes. A planned restoration project scheduled for completion in late 2005-early 2006 will alter the tern nesting area.

### *Huntington State Beach*

At Huntington State Beach, 310 breeding pairs established 323 nests and produced 38 fledglings. Predation was a major influence on reproductive success, with 66 eggs and 42 nests depredated by American crows and 263 eggs and 168 nests depredated by California ground squirrels. About ten chicks may have also been lost to a peregrine falcon. Monitors indicated that the predation rate was so high that without control, breeding would have been a complete failure at this site. Vegetation management activities were curtailed to protect two rare plant species, Coastal Woolly Heads (*Nemacaulis denudata denudate*) and San Diego Marsh-Elder (*Iva hayesiana*) growing on site.

### *Burris Sand Pit*

At Burris Sand Pit, an inland site adjacent to the Santa Ana River, a minimum of three breeding pairs established five nests and produced two fledglings. Undetected nesting is possible since this site was observed from a distance.

### *Upper Newport Bay Ecological Reserve*

At Upper Newport Bay Ecological Reserve, a Type 2 monitoring site, 60-72 breeding pairs established 89 nests. Fledgling numbers were unknown. Common ravens and canids were major predators on eggs and chicks. Dredging around the nesting island is planned for 2005-2006.

### San Diego County

#### *MCB Camp Pendleton*

At Camp Pendleton, a total of 1355 breeding pairs established 1430 nests and produced 47-60 fledglings, the highest number of nests of any site within the state for 2004. The Santa Margarita River North Beach sites (North and South), with 88% of the breeding pairs and nests, produced over 75% of the fledglings at Camp Pendleton. The lone nest at Red Beach did not produce fledglings. Most of the eggs hatched with 1877 chicks observed, however, over 1000 chicks were found dead. Monitors observed adults bringing Pacific saury (*Cololabis saira*) to the chicks, rather than anchovies. It was also noted by monitors that chicks hatch weights were low.

### *Batiquitos Lagoon Ecological Reserve*

At Batiquitos Lagoon Ecological Reserve, 431-570 breeding pairs established 592 nests and produced 110 fledglings. This site had an 83% hatching rate; however, mortality of 417 chicks led to a relatively low fledging rate. This mortality is believed to be a result of starvation. Chick and fledgling mortality rate was much higher at the western sub-colonies (42% at W1 and 68% at W2) than the eastern sub-colonies (E1 was highest at 23%). A predator manager was available throughout the breeding season. Predation appeared to be relatively low, with an unknown species of gull the only documented predator.

### *San Elijo Lagoon Ecological Reserve*

No least tern breeding activity was detected at San Elijo Lagoon Ecological Reserve. Over 30 adults were seen courting early in the season but left the site without attempting to nest.

#### *Mission Bay*

##### - FAA Island

FAA Island had 178 breeding pairs, 315 nests, and 6 fledglings. Predation by gulls, American Crows and possible peregrine falcons were the leading cause of poor fledgling production. As in past years, vegetation was cleared manually from about half the island. Vegetation management is hindered due to difficulties of transporting large equipment to the island. Care was taken to avoid nests of California horned larks (*Eremophila alpestris actia*) and Belding's Savannah sparrows (*Passerculus sandwichensis beldingi*).

##### - North Fiesta Island

At North Fiesta Island, 11 breeding pairs established 17 nests and produced no fledglings. Despite daily visits by Wildlife Services, American crows, common ravens and snakes were suspected of consuming all 17 nests before eggs hatched, however, a peregrine falcon in the area may have resulted in abandonment prior to depredation. Adults abandoned the site early (12 June) possibly due to the peregrine falcon.

##### - Mariner's Point

At Mariner's Point, 299 breeding pairs established 299 nests and produced no fledglings. American crows and rats consumed up to 309 eggs in 201 nests. A peregrine falcon in the area may have resulted in abandonment prior to depredation. Adults abandoned the site early (9 June), leaving 144 eggs in 96 nests, possibly due to the peregrine falcon.

##### - San Diego River Mouth (S)

The first documented nesting of least terns on the south shore of the San Diego River near the Pacific Ocean occurred in 2004. Twenty-seven breeding pairs established 42 nests and produced 5 fledglings. The nesting area was adjacent to Dog Beach, a City of San Diego Park. A temporary plastic fence was installed by the City of San Diego staff to prevent dog and human access to the nesting area.

#### *San Diego Bay*

##### - Lindbergh Field

At Lindbergh Field, 65-70 breeding pairs established 76 nests and produced 10-17 fledglings. No food shortages were reported. American kestrels depredated 44-51 chicks.

- NAS North Island

At North Island, 162 breeding pairs established 172 nests and produced six fledglings.

-Naval Base Coronado

Naval Base Coronado had 879 breeding pairs, 1035 nests and 34 fledglings with the majority of the production at the Naval Amphibious Base Ocean sub-colony. North Delta Beach had similar numbers to South Delta Beach.

- Silver Strand State Beach

Silver Strand State Beach had one breeding pair establish one nest and produce no fledglings. Chicks were observed for four days. This is the first least tern nesting activity recorded at Silver Strand State Beach since state-wide annual surveys began.

- D Street Fill/Sweetwater Marsh NWR

At D Street, 77-94 breeding pairs established 111 nests and produced 4-11 fledglings. Predation by gull-billed terns (*Sterna nilotica*), northern harriers, American kestrels, peregrine falcons and/or gray foxes (*Urocyon cinereoargenteus*) led to the loss of 71-79 chicks.

- Chula Vista Wildlife Reserve

Chula Vista NWR had 30-48 breeding pairs, 66 nests and 11-18 fledglings. Peregrine falcons depredated two adult least terns and gull-billed terns, northern harriers, peregrine falcons and/or gulls contributed to the loss of 54-61 chicks.

- South San Diego Bay Unit, SDNWR - Saltworks

At Saltworks NWR, 31-40 breeding pairs established 49 nests and produced 4-6 fledglings. Unknown outcomes of 39 eggs from 25 nests and 22-24 chicks lost to predation resulted poor reproductive success.

*Tijuana Estuary NERR*

At Tijuana Estuary, 253-387 breeding pairs established 520 nests and produced 16-26 fledglings. High winds were problematic this year, burying many nests with sand. Non-predation factors led to the loss of 272 eggs, including 178 abandoned and 58 flooded. Another 328 eggs had unknown outcomes. Predation led to the loss of 76 eggs and 97-104 chicks.

**Other Research**

Ants

The University of California Riverside provided assistance to monitors to identify ant species known to pose problems for least terns (e.g. red imported fire ant (*Solenopsis invicta*))

and suggested techniques to control ant populations on nesting sites. The red imported fire ant (*Solenopsis invicta*) and Argentine ant (*Linepithema humile*) are two species of management concern.

## ACKNOWLEDGEMENTS

I would like to thank Robert Patton for providing the data collection and reporting materials used in 2003 and willingness to assist in the 2004 monitoring and reporting. I would also like to thank Lyann Comrack (CDFG) for providing the opportunity and funding for this position. Field monitors, site managers and others involved in the 2004 coordinated efforts towards the recovery of the California least tern deserve a great deal of credit for their hard work before, during and after the 2004 breeding season. These include, but are not limited to (alphabetically): Greg Abbott, Matt Alexander, Matt Amalong , Tom Applegate, Maryanne Bache, Chris Bandy, Steve Barnhill, Chris Barr, Connie Beach , Brian Bonesteel, John Bradley , Slader Buck, Tim Burr, Chris Carrillo, Brian Collins, Charles Collins , Laura Collins, Lyann Comrack, Tammy Conkle, Elizabeth Copper, Emilie Craig, Don Davis, Tim Dillingham, Adam Eidson, Jack Fancher, Meryl Faulkner, Erin Feinblatt, John Fitch, Brain Foster, Laura Gardner, Doug George, Richard Gilb, Kenneth Gilliland, Loren Hays, Rachel Hurt, Jennifer Jackson, Ginger Johnson, Ron Jurek, Kathy Keane, Steve Kirkland, Peter Knapp, Julianna Krolak, Nathan Lang, Carolyn Lieberman, Jan Lewison, Santiago Lopez, Eileen Maher, Art Marshall, Nancy Mitton, Chuck Morton, Nathan Mudry, Randy Nagel, Linda O'Neill, Terry O'Neill, Jeff Opdycke, Gary Page, Robert Patton, Lyn Perry, Dave Polalski, Dave Prior, Nancy Read, Don Reiersen, Willie Richerson, Dan Robinette, Elizabeth Rogan, Wally Ross, Martin Ruane, Michael Rust, Tom Ryan, Cristina Sandoval, Bob Schallmann, Brian Shelton, Reed Smith, Jonathan Snyder, Karen Taylor , Mike Taylor, John Turman, Erik Waardenburg, Morgan Wehtje, Susan Welker, Mike Wells, Shauna Wolf, Patrick Zimmerman. I would also like to thank C. Fritz for her comments.

## LITERATURE CITED

Alvarez, F. 2004. Paragliders suspected in death of least terns. Los Angeles Times article dated 7 September 2004.

Atwood J.L., R.A. Erickson, P.R. Kelly, and P. Unitt. 1979. California least tern census and nesting survey, 1978. California Department of Fish and Game, Nongame Wildl. Investigations, E-W-2, Final Report, Job V-2.13. 6 pp + app.

Atwood, J.L., P.D. Jorgensen, R.M. Jurek, and T.D. Manolis. 1977. California least tern census and nesting survey, 1977. California Department of Fish and Game, Nongame Wildl. Investigations, E-1-1, Final Report, Job V-2.11. 6 pp + app.

Bender, K. 1974a. California least tern census and nesting survey, 1973. California Department of Fish and Game, Spec. Wildl. Investigations, Proj. W-54-R-6, Prog Report, Job II-11. 7 pp + app.

Bender, K. 1974b. California least tern census and nesting survey, 1974. California Department of Fish and Game, Nongame. Wildl. Investigations, Proj. W-54-R-6, Final Report, Job I-1. 4 pp + app.

Caffrey, C. 1993. California least tern breeding survey, 1992 season. California Department of Fish and Game, Wildlife Management Division, Nongame Bird and Mammal Section Report 93-11, Sacramento, CA. 35 pp.

Caffrey, C. 1994. California least tern breeding survey, 1993 season. California Department of Fish and Game, Wildlife Management Division, Nongame Bird and Mammal Section Report 94-07, Sacramento, CA. 39 pp.

Caffrey, C. 1995a. California Least Tern Monitoring Packet. California Department of Fish and Game, unpublished report under contract FG4121 WM.

Caffrey, C. 1995b. California least tern breeding survey, 1994 season. California Department of Fish and Game, Wildlife Management Division. Bird and Mammal Conservation Program Report 95-3, Sacramento, CA. 49 pp.

Caffrey, C. 1997. California least tern breeding survey, 1995 season. California Department of Fish and Game, Wildlife Management Division. Bird and Mammal Conservation Program Report 97-6, Sacramento, CA. 57 pp.

Caffrey, C. 1998. California least tern breeding survey, 1996 season. California Department of Fish and Game, Wildlife Management Division. Bird and Mammal Conservation Program Report 98-2, Sacramento, CA. 57 pp.

California Department of Fish and Game. 1976. At the crossroads: a report on California's endangered and rare fish and wildlife. State of California, Sacramento. 100 pp.

- Cogswell, H. L. 1977. Water birds of California. University of California Press, Berkeley and Los Angeles, CA. 399 pp.
- Collins, C.T. 1984. End of year report California least tern field study, 1984 field season. California Department of Fish and Game. Unpubl. Report. 15 pp.
- Collins, C.T. 1986. End of year report California least tern field study, 1986 field season. California Department of Fish and Game. Unpubl. Report. 19 pp.
- Collins, C.T. 1987. End of year report California least tern field study, 1987 field season. California Department of Fish and Game. Unpubl. Report. 20 pp.
- Craig, A.M. 1971. Survey of California least tern nesting sites. California Department of Fish and Game, Spec. Wildl. Investigations, Proj. W-54-R-4, Job Final Report, II-5.1. 7 pp + app.
- Gustafson, J. 1986. Summary of the California least tern seasons for 1979-83 (5 years). California Department of Fish and Game. Unpubl. Report. 7 pp.
- Johnston, S.M, and B.S. Obst. 1992. California least tern breeding survey, 1991 season. California Department of Fish and Game, Nongame Bird and Mammal Section Report, 92-06. 19 pp.
- Jurek, R.M. (ed). 1977. California least tern census and nesting survey, 1976. California Least Tern Recovery Team and California Department of Fish and Game, Nongame Wildl. Investigations, E-1-1. 5 pp. + app.
- Keane, K. 1998. California least tern breeding survey, 1997 season. California Department of 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. California Department of 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. California Department of Fish and Game, Habitat Conservation and Planning Branch, Species Conservation and Recovery Program Rep., 2001-01, Sacramento, CA. 16 pp. + app.
- Massey, B.W. 1974. Breeding biology of the California least tern. Proc. Linnean Soc. New York 72: 1-24.
- Massey, B.W. 1975. California least tern census and nesting survey, 1975. California Department of 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. 1988. California least tern study, 1988 breeding season. California Department of Fish and Game, EW87 X-1, Contract FG 8553 Final Rep. 20 pp. + app.

Massey, B.W. 1989a. California Least Tern Fledgling Study, Venice CA. California Department of Fish and Game, Wildlife Management Division. Bird and Mammal Conservation Program Report under contract FG 8553, Sacramento, CA. 8 pp.

Massey, B.W. 1989b. California least tern study, 1989 breeding season. California Department of Fish and Game, EW88 X-1, Contract FG 7660 Final Rep. 22 pp.

Massey, B.W. and J.L. Atwood. 1981. Second-wave nesting of the California least tern: age composition and reproductive success. *Auk* 98:595-605.

Obst, B.S., and S.M. Johnston. 1992. California least tern breeding survey, 1990 season. California Department of Fish and Game, Nongame Bird and Mammal Section Report, 92-05. 13 pp.

Patton, R.T. 2002. California least tern breeding survey, 2000 season. California Department of Fish and Game, Species Conservation and Recovery Program Report, 2002-03. 24 pp. + app.

Patton, R.T. 2004. unpublished table of California least tern productivity data, 2000-2003.

Ross, W.L. 2004. Bolsa Chica Wetlands California least tern western snowy plover 2004 breeding season predator management report. California Department of Fish and Game. 15 pp.

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

U.S. Fish and Wildlife Service. 1980. California least tern recovery plan. U.S. Fish and Wildlife Service, Region 1. Portland, OR. 58 pp.

## **Appendix A**

### **Data Sheets**

# General Data Sheet

Page 1

Location:				Date:		Job:		Observer(s):			
Time start:				Time stop:				On site:			
Est/Measured	Time:		Temp:	Wind Spd/Dir:		Cloud cvr (%):		Precip. (Y/N):		Tide: H L In Out	
ADULTS	Total:			NESTS	Total:			New:			
CHICKS	Observed:			Est max:		New Chicks:		Fledglings Obs:		Est max:	
Mortality (Y/N):	Adult:		Fledgling:		Chick:		Egg:		Nest:		
Predation (Y/N):	Adult:		Fledgling:		Chick:		Egg:		Nest:		
Take (Y/N):	Adult:		Fledgling:		Chick:		Egg:		Nest:		
Col Live (Y/N):	Adult:		Fledgling:		Chick:		Egg:		Other:		
Col Dead (Y/N):	Adult:		Fledgling:		Chick:		Egg:		Fish:	Other:	
Nest No.	Grid No.	New/ Incub.	Status	Nest No.	Grid No.	New/ Incub.	Status	Nest No.	Grid No.	New/ Incub.	Status
1				31				61			
2				32				62			
3				33				63			
4				34				64			
5				35				65			
6				36				66			
7				37				67			
8				38				68			
9				39				69			
10				40				70			
11				41				71			
12				42				72			
13				43				73			
14				44				74			
15				45				75			
16				46				76			
17				47				77			
18				48				78			
19				49				79			
20				50				80			
21				51				81			
22				52				82			
23				53				83			
24				54				84			
25				55				85			
26				56				86			
27				57				87			
28				58				88			
29				59				89			
30				60				90			

Egg/Nest Codes: E=egg, CH=chick, NC=New Chick, H=hatched and no longer present, PH=probable hatch, FH=failed to hatch, A=abandoned  
P=Preyed on, DAM=damaged, F=flooded, B=buried, Col=collected, M=moved, Unk=unknown. Circle Nest Number if new or if status has changed.

[illegible]

[illegible]

# Master Nest List Form

[illegible]

*Version #1*

[illegible]

*Version #2*

[illegible]



## Multi-visit Form

Species:					LOCATION						
Date 1		Date 2		Date 3		Date 4					
Observers:		Observers:		Observers:		Observers:					
Date 5		Date 6		Date 7		Date 8					
Observers:		Observers:		Observers:		Observers:					
Date 9		Date 10		Date 11							
Observers:		Observers:		Observers:							
Nest	Found	Grid	Prior	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Band Number
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											
21											
22											
23											
24											
25											
26											
27											
28											
29											
30											
31											
32											
33											
34											
35											
36											
37											
38											
39											
40											
41											
Nest	Found	Grid	Prior	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Band Number

**Appendix B**  
**Site Specific Data**

## Appendix B-1: Site Preparation.

[illegible]

Appendix B-1: Site Preparation (continued).

Site name:	Sub-colony names (if any):	Name of primary monitor:	Names of other monitors:	Fence type:	Interpretive signs at site:	Chick shelters:	Decoys:	Grid system:	Vegetation management:	Other site preparation:	By whom:
<b>Ventura County</b>											
Santa Clara River/McGrath State Beach	McGrath Campground South, McGrath Lake	Don Davis	Linda O'Neill, Terry O'Neill, Jan Lewison, Art Marshall	none, 2	yes- for WSP	no	no	no- utilize natural markers	no	none	n/a
Hollywood Beach		Reed Smith		3	yes	no	no	no	no	none	
Ormond Beach		Julianna Krolak	Reed Smith	plastic	yes	no	no	no	no	none	Al Sanders, Dan Pearson
Pt Mugu- Totals											
Holiday Beach		Martin Ruane	Emilie Craig, Nathan Lang, Kenneth Gilliland, Lyn Perry	none	yes	no	no	no	remove beachgrass	none	Base biologists
Ormond Beach East		Martin Ruane	Emilie Craig, Nathan Lang, Kenneth Gilliland, Lyn Perry	4, none	yes	no	no	no	7, some removal of giant reed and beachgrass	none	Base biologists
Nesting Islands		Martin Ruane	Emilie Craig, Nathan Lang, Kenneth Gilliland, Lyn Perry	4, none	no	no	no	no	4, removal of all vegetation possible	none	Monitors
Eastern Arm		Martin Ruane	Emilie Craig, Nathan Lang, Kenneth Gilliland, Lyn Perry	none	no	no	no	no	removal of giant reed	none	Base biologists

Appendix B-1: Site Preparation (continued).

Site name:	Sub-colony names (if any):	Name of primary monitor:	Names of other monitors:	Fence type:	Interpretive signs at site:	Chick shelters:	Decoys:	Grid system:	Vegetation management:	Other site preparation:	By whom:
<b>Los Angeles/Orange Counties</b>											
Venice Beach		Mike Taylor, Tom Ryan		2	yes	yes- 75	yes	yes		1 fence maint.	
LA Harbor - Pier 400		Kathy Keane	Nathan Mudry, Matt Amalong, Wally Ross, Santiago Lopez	2	yes	yes- 65	yes	yes		1	Port of Los Angeles
Seal Beach NWR - Anahiem Bay		John Bradley	Charles Collins, John Fitch, Bob Schallmann, Wally Ross	1- chain-link	yes	yes- 180	yes- 12	yes		3 Electric fence maintenance	USFWS, Aquarium of the Pacific volunteers, Wally Ross, other contractor
Bolsa Chica Ecological Reserve		Peter Knapp	Wally Ross	3	no	yes- 55	YES	yes		2 none	none
Huntington State Beach	There is a Main Colony and an outer nesting area (additional acreage fenced off outside main nesting colony with temporary fencing)	Jonathan Snyder	Randy Nagel	1 (3 for outer nesting area)	yes	yes- (about 50 semi-circular tiles)	no	yes	"6" Vegetation was not conducted this year for the first time in several years to protect rare plants. Conditions were okay this year but will get worse if management is not conducted.	Repair of Chick Fencing	Wally Ross, California State Parks, and monitors
Upper Newport Bay Ecological Reserve		Brian Shelton	Connie Beach, Matt Alexander	none	yes	yes- roof tiles	no	yes	yes- cut Roto-till, rake		DFG volunteers

Appendix B-1: Site Preparation (continued).

Site name:	Sub-colony names (if any):	Name of primary monitor:	Names of other monitors:	Fence type:	Interpretive signs at site:	Chick shelters:	Decoys:	Grid system:	Vegetation management:	Other site preparation:	By whom:
<b>San Diego County</b>											
MCB Camp Pendleton		Brain Foster									
Red Beach		Brain Foster									
White Beach		Brain Foster									
Santa Margarita River - North Beach North		Brain Foster									
Santa Margarita River - North Beach South		Brain Foster									
Santa Margarita River - Saltflats		Brain Foster									
Santa Margarita River - Saltflats Island		Brain Foster									
Batiquitos Lagoon Ecological Reserve		Nathan Mudry, Matt Amalong			1 yes	yes - 40	no	yes		4	CDFG
San Elijo Lagoon Ecological Reserve		Robert Patton									
<b>Mission Bay</b>											
FAA Island		Jennifer Jackson			4 yes	no	no	yes		1 herbicide treatment	CDFG, USFWS
North Fiesta Island		Ginger Johnson	Jennifer Jackson		1 yes	yes- 78	yes- 47	yes		4 grid system expansion	City Parks Dept, volunteers
Mariner's Point		Ginger Johnson	Jennifer Jackson		2 yes	yes- 78	no	yes		2 Signs installed, grid system expansion	Audubon Society vounteers, City Parks Dept.
San Diego River Mouth (S)		Jennifer Jackson		4, then 1	yes	no	no	no		7	

Appendix B-1: Site Preparation (continued).

Site name:	Sub-colony names (if any):	Name of primary monitor:	Names of other monitors:	Fence type:	Interpretive signs at site:	Chick shelters:	Decoys:	Grid system:	Vegetation management:	Other site preparation:	By whom:
<b>San Diego Bay</b>											
Lindbergh Field & Former Naval Training Center		Robert Patton									
USN Totals		Elizabeth Copper									
NI MAT		Elizabeth Copper									
DBN		Elizabeth Copper									
DBS		Elizabeth Copper									
NABO		Elizabeth Copper									
D Street Fill/Sweetwater Marsh NWR		Robert Patton									
Chula Vista Wildlife Reserve		Robert Patton									
South San Diego Bay Unit, SDNWR - Saltworks		Robert Patton									
Silver Strand State Beach		Shuana Wolf				no	no	no			
Tijuana Estuary NERR		Robert Patton									

**Legend**

Fence Type:

- 1- Fully enclosed site deterring most predators.
- 2- Fully enclosed site and cantilevered to deter climbing predators.
- 3- Incomplete, deterring few predators.
- 4- No fence/exclosure.

Vegetation Management

- 1- Mechanical Removal
- 2- Manual Removal
- 3- Herbicide
- 4- Combination of 1, 2 or 3
- 5- Other Means
- 6- Needed, but not conducted in 2004
- 7- None Needed

Appendix B-2: Monitoring.

Site name:	Site type:	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:
<b>San Francisco Bay Area</b>								
Pittsburg Power Plant	2	20-Apr-04	10-Aug-04	26	no	no	no	n/a
Albany Central Ave. Mitigation Island		no nesting						
Alameda Point	1	20-Apr-04	12-Aug-04	65	yes	no	no	n/a
<b>San Luis Obispo/Santa Barbara Counties</b>								
Oceano Dunes SVRA								
Guadalupe-Mussel Rock		6-Mar-04	31-Aug-04	3/week	no	no	no	n/a
Vandenberg AFB								
Purisima Pt	3	15-Apr-04	30-Jul-04	82	yes	no	no	n/a
Beach 2	3	28-May-04	7-Jul-04	10	yes	no	no	n/a
Coal Oil Point Reserve								
<b>Ventura County</b>								
Santa Clara River/McGrath State Beach	1	12-May-04	12-Aug-04	34	yes	no	no	n/a
Hollywood Beach	1	7-May-04	27-Aug-04	13	yes	no	no	n/a
Ormond Beach	1	29-May-04	20-Aug-04	27	yes	no	no	n/a
Pt Mugu- Totals								
Holiday Beach	1	25-Jun-04	5-Aug-04	11	yes	no	no	n/a
Ormond Beach East	1	6-May-04	23-Aug-04	29	yes	no	no	n/a
Nesting Islands	1	27-May-04	28-Jul-04	15	yes	no	no	n/a
Eastern Arm	1	24-May-04	3-Aug-04	15	yes	no	no	n/a
<b>Los Angeles/Orange Counties</b>								
Venice Beach	1	15-May-04	29-Jun-04	19	yes	no	no	n/a
LA Harbor - Pier 400	1	17-Apr-04	17-Aug-04	57	yes	no	chicks	
Seal Beach NWR - Anahiem Bay	1	19-May-04	25-Jun-04	8	yes	no	chicks	n/a
Bolsa Chica Ecological Reserve	1	7-May-04	21-Jul-04	11	yes	no	no	n/a
Huntington State Beach	1	3-May-04	2-Aug-04	15	yes	no	no	n/a
Upper Newport Bay Ecological Reserve	2	8-May-04	29-Jul-04	14	yes	yes	no	n/a
<b>San Diego County</b>								
MCB Camp Pendleton	1							mauve/black
Red Beach	1							mauve/black
White Beach	1							mauve/black
Santa Margarita River - North Beach N	1							mauve/black
Santa Margarita River - North Beach S	1							mauve/black
Santa Margarita River - Saltflats	1							mauve/black
Santa Margarita River - Saltflats Island	1							mauve/black
Batiquitos Lagoon Ecological Reserve	1	6-Apr-04	13-Sep-04	48	yes	no	no	n/a
San Elijo Lagoon Ecological Reserve	2	no nesting						



Appendix B-2: Monitoring (continued).

Site name:	Site type:	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:
<b>Mission Bay</b>								
FAA Island	1						no	n/a
North Fiesta Island	1	14-Apr-04	23-Jul-04	26	yes	yes	no	n/a
Mariner's Point	1	20-Apr-04	24-Jul-04	28	yes	yes	no	n/a
San Digo River Mouth (S)	1						no	n/a
<b>San Diego Bay</b>								
Lindbergh Field & Former Naval Training Center	1							
USN Totals	1							
NI MAT	1							
DBN	1							yellow/red
DBS	1							white/black
NABO	1							blue/pink
D Street Fill/Sweetwater Marsh NWR	1							
Chula Vista Wildlife Reserve	1							
South San Diego Bay Unit, SDNWR - Saltworks	1							
Silver Strand State Beach	1							
Tijuana Estuary NERR	1							

### Appendix B-3: Pair Estimation (Method 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:
<b>San Francisco Bay Area</b>						
Pittsburg Power Plant	28-Apr-04	16-Jul-04	25-May-04	6-Jul-04	10	5
Albany Central Ave. Mitigation Island						
Alameda Point	20-Apr-04	11-Aug-04	3-May-04	9-Jul-04	373	67
<b>San Luis Obispo/Santa Barbara Counties</b>						
Oceano Dunes SVRA						
Guadalupe-Mussel Rock	1-Jun-04	19-Jul-04	12-Jun-04	23-Jun-04	3	5
Vandenberg AFB					0	1
Purissima Pt	5-May-04	21-Jul-04	15-Jun-04	15-Jun-04	0	1
Beach 2	No Terns	No Terns	No Nests	No Nests	0	0
Coal Oil Point Reserve					6	0
<b>Ventura County</b>						
Santa Clara River/McGrath State Beach	12-May-04	21-Aug-04	24-May-04	18-Jul-04	44	39
Hollywood Beach	7-May-04	20-Aug-04	7-May-04	30-Jul-04	2	46
Ormond Beach	29-May-04	8-Aug-04	4-Jun-04	18-Jul-04	10	19
Pt Mugu- Totals	29-Apr-04	mid Aug 2004			389	228
Holiday Beach			25-Jun-04	16-Jul-04	0	12
Ormond Beach East			6-May-04	10-Aug-04	319	134
Nesting Islands			27-May-04	7-Jul-04	18	7
Eastern Arm			24-May-04	1-Jul-04	52	75
<b>Los Angeles/Orange Counties</b>						
Venice Beach	15-May-04	29-Jun-04	1-Jun-04	25-Jun-04	2	15
LA Harbor - Pier 400	1-May-04	17-Aug-04	17-May-04	16-Jul-04	821	250
Seal Beach NWR - Anaheim Bay	9-Apr-04	4-Aug-04	19-May-04	30-Jun-04	175	31
Bolsa Chica Ecological Reserve	19-Apr-04	8-Sep-04	14-May-04	17-Jul-04	144	85
Huntington State Beach	mid-April	monitoring	38124	38194	296	27
Upper Newport Bay Ecological Reserve	8-May-04	29-Jun-04	14-May-04	9-May-04	55	34
<b>San Diego County</b>						
MCB Camp Pendleton	10-Apr-04	14-Aug-04	11-May-04	10-Aug-04		
Red Beach	25-Apr-04	31-Jul-04	14-Jul-04	14-Jul-04		
White Beach	20-Apr-04	11-Aug-04	12-May-04	23-Jul-04		
Santa Margarita River - North Beach N	22-Apr-04	14-Aug-04	11-May-04	10-Aug-04		
Santa Margarita River - North Beach S	10-Apr-04	14-Aug-04	9-May-04	10-Aug-04		
Santa Margarita River - Saltflats	17-Apr-04	5-Aug-04	15-May-04	6-Jul-04		
Santa Margarita River - Saltflats Island	9-May-04	5-Aug-04	11-May-04	19-Jul-04		
Batiquitos Lagoon Ecological Reserve	6-Apr-04	7-Aug-04	11-May-04	10-Jul-04	532	60
San Elijo Lagoon Ecological Reserve						

Appendix B-3: Pair Estimation (Method I) (continued).

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:
<b>Mission Bay</b>						
FAA Island	1-May-05	22-Aug-04	18-May-04	14-Jul-04		
North Fiesta Island	20-Apr-04	12-Jun-04	20-May-04	4-Jun-04	17	0
Mariner's Point	25-Apr-04	20-Jul-04	12-May-04	14-Jun-04	299	0
San Diego River Mouth (S)	unknown	1-Sep-04	26-May-04	30-Jun-04		
<b>San Diego Bay</b>						
Lindbergh Field & Former Naval Training Center						
USN Totals	10-Apr-04	7-Sep-04	11-May-04	6-Jul-04		
NI MAT	21-Apr-04	31-Jul-04	11-May-04	25-Jun-04		
DBN	16-Apr-04	23-Aug-04	14-May-04	26-Jun-04		
DBS	10-Apr-04	20-Aug-04	17-May-04	23-Jun-04		
NABO	19-Apr-04	7-Sep-04	13-May-04	6-Jul-04		
D Street Fill/Sweetwater Marsh NWR						
Chula Vista Wildlife Reserve						
South San Diego Bay Unit, SDNWR - Saltworks						
Silver Strand State Beach						
Tijuana Estuary NERR						

### Appendix B-3: Pair Estimation (Method II and III).

Site name:	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:
<b>San Francisco Bay Area</b>												
Pittsburg Power Plant	15	3	0	12	22-Jun-04	10	0	10	5	3	2	12
Albany Central Ave. Mitigation Island								0				
Alameda Point	440	28	33	379	n/a							
<b>San Luis Obispo/Santa Barbara Counties</b>												
Oceano Dunes SVRA	63			63								
Guadalupe-Mussel Rock	8	0	0	8	none	8	0	8	0	0	0	8
Vandenberg AFB	1	1	0	0								
Purisima Pt	1	1	0	0	none	1	0	1	0	0	0	1
Beach 2	0	0	0	0	none	0	0	0	0	0	0	0
Coal Oil Point Reserve	6			6								
<b>Ventura County</b>												
Santa Clara River/McGrath State Beach	83			83								
Hollywood Beach	50	0	0	50	9-Jul-04	2	0	2	46	0	46	48
Ormond Beach	29	2	0	27	none	10	0	10	n/a	n/a		
Pt Mugu- Totals	617	113	0	504								
Holiday Beach	12	0	0	12	none	n/a	n/a		n/a	n/a		
Ormond Beach East	453	59	0	394	none	n/a	n/a		n/a	n/a		
Nesting Islands	25	14	0	11	none	n/a	n/a		n/a	n/a		
Eastern Arm	127	40	0	87	none	n/a	n/a		n/a	n/a		
<b>Los Angeles/Orange Counties</b>												
Venice Beach	17	8	8	1	none	2	0	2	15	0	15	17
LA Harbor - Pier 400	1071	81	16	974	15-Jun-04	821	0	821	250	16	234	1055
Seal Beach NWR - Anahiem Bay	206	5	3	198	16-Jun-04	175	1	174	31	0	31	205
Bolsa Chica Ecological Reserve	229	92	0	137	none	144	70	74	85	25	60	134
Huntington State Beach	323											
Upper Newport Bay Ecological Reserve	89	25	4	60	insufficient data	55	0	55	34	insufficient data	insufficient data	insufficient data
<b>San Diego County</b>												
MCB Camp Pendleton	1430			1430								
Red Beach	1			1								
White Beach	102			102								
Santa Margarita River - North Beach N	450			450								
Santa Margarita River - North Beach S	801			801								
Santa Margarita River - Saltflats	39			39								
Santa Margarita River - Saltflats Island	37			37								
Batiquitos Lagoon Ecological Reserve	592	139	22	431	15-Jun-04	532	0	532	60	22	38	570
San Elijo Lagoon Ecological Reserve	0			0								

Appendix B-3: Pair Estimation (Method II and III) (continued).

Site name:	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:
<b>Mission Bay</b>												
FAA Island	315			315								
North Fiesta Island	17	17	0	0	none	17	6	11	0	0	0	11
Mariner's Point	299	297	2	0	none	299	100	199	0	0	0	199
San Diego River Mouth (S)	42			42								
<b>San Diego Bay</b>												
Lindbergh Field & Former Naval Training Center	76			76								
USN Totals	1207			1207								
NI MAT	172			172								
DBN	263			263								
DBS	195			195								
NABO	577			577								
D Street Fill/Sweetwater Marsh NWR	111			111								
Chula Vista Wildlife Reserve	66			66								
South San Diego Bay Unit, SDNWR - Saltworks	49			49								
Silver Strand State Beach	1			1								
Tijuana Estuary NERR	520			520								

## Appendix B-4: Productivity, 2004.

Site name:	Total nests:	Total eggs:	No. of eggs hatched:	D/C = Hatching Success:	Date of first chick:	Date of first fledgling:	Fledgling estimate method:	Total fledglings:
<b>San Francisco Bay Area</b>								
Pittsburg Power Plant	15	24 min	4-10	0.167-0.417	20-Jun-04	16 July 2004	Young identified through fledgling	1
Albany Central Ave. Mitigation Island	0	0	n/a	n/a	n/a	n/a	n/a	0
Alameda Point	440	755	554	0.7338	29-May-04	21-Jun-04	3wd (gives min #), (max count is total number chicks hatched-dead chicks and fledglings-predated chicks and fledglings)	268 (155min-380 max)
<b>San Luis Obispo/Santa Barbara Counties</b>								
Oceano Dunes SVRA	63							25
Guadalupe-Mussel Rock	8	18	7	0.3889	2-Jul-04	n/a	n/a	0
Vandenberg AFB	1	1	0	0	n/a	n/a	n/a	0
Purisima Pt	1	1	0	0	n/a	n/a	n/a	0
Beach 2	0	0	0	0	n/a	n/a	n/a	0
Coal Oil Point Reserve	6	6 min	0	0	n/a	n/a	n/a	0
<b>Ventura County</b>								
Santa Clara River/McGrath State Beach	83	143	89	0.6224	19-Jun-04	15-Jul-04	Max evening count	27
Hollywood Beach	48	82		0	16-Jul-04	23-Jul-04	3WD	31
Ormond Beach	29	43	5	0.1163	20-Jun-04	11-Jul-04	counted them	4
Pt Mugu- Totals	617	1048	253	0.2245	18-Jun-04	unknown		121
Holiday Beach	12	23	14	0.6087	8-Jul-04	unknown	evening census index and counts during window surveys	9
Ormond Beach East	453	755	193	0.2556	21-Jun-04	mid July	Evening census index	110
Nesting Islands	25	49	11	0.2245	22-Jun-04	unknown	scanned for fledglings in or nearby islands	0
Eastern Arm	127	221	35	0.1584	18-Jun-04	unknown	counted from outside and within colony	2 min
<b>Los Angeles/Orange Counties</b>								
Venice Beach	17	19	0	0	n/a	n/a	n/a	0
LA Harbor - Pier 400	1071	1748	1380	0.7895	7-Jun-04	28-Jun-04	R	556
Seal Beach NWR - Anahiem Bay	206	335	285	0.8507	2-Jun-04	23-Jun-04	R*	73
Bolsa Chica Ecological Reserve	229	338	80	0.2367	12-Jun-04	2-Jul-04	window count	60
Huntington State Beach	323	444	79	0.1779	14-Jun-04	12-Jul-04	3WD	38
Upper Newport Bay Ecological Reserve	89	57	15 min	0.2632 min	9-Jun-04	unknown	n/a	unknown

Appendix B-4: Productivity, 2004 (continued).

Site name:	Total nests:	Total eggs:	No. of eggs hatched:	D/C = Hatching Success:	Date of first chick:	Date of first fledgling:	Fledgling estimate method:	Total fledglings:
<b>San Diego County</b>								
MCB Camp Pendleton	1430	2588	1876	0.7249	29-May-04			47-60
Red Beach	1	2	0	0	n/a	n/a	n/a	0
White Beach	102	175	92	0.5257	5-Jun-04			7-9
Santa Margarita River - North Beach N	450	797	479	0.6010	1-Jun-04			12-15
Santa Margarita River - North Beach S	801	1444	1195	0.8276	29-May-04			25-30
Santa Margarita River - Saltflats	39	101	55	0.5446	5-Jun-04			2-4
Santa Margarita River - Saltflats Island	37	69	55	0.7971	5-Jun-04			1-2
Batiquitos Lagoon Ecological Reserve	592	1032	858	0.8314	3-Jun-04	24-Jun-04	3WD	110
San Elijo Lagoon Ecological Reserve	0	0	n/a	n/a	n/a	n/a	n/a	
<b>Mission Bay</b>								
FAA Island	315	423	95	0.2246	25-Jun-04	8-Jul-04		10-12
North Fiesta Island	17	20	0	0	n/a	n/a	n/a	0
Mariner's Point	299	455	2	0.0044	9-Jun-04	n/a	n/a	0
San Diego River Mouth (S)	42	58	26	0.4483	16-Jun-04	12-Jul-04		10
<b>San Diego Bay</b>								
Lindbergh Field & Former Naval Training Center	76	126	78	0.6190				10-17 (12)
USN Totals	1207	1861	1097	0.5895	2-Jun-04	30-Jun-04		42
NI MAT	172	283	152	0.5371	2-Jun-04	2-Jul-04		8
DBN	263	410	272	0.6634	4-Jun-04	30-Jun-04		9
DBS	195	289	200	0.6920	7-Jun-04	2-Jul-04		4
NABO	577	879	473	0.5381	5-Jun-04	7-Jul-04		21
D Street Fill/Sweetwater Marsh NWR	111	163	105	0.6442				4-11 (9)
Chula Vista Wildlife Reserve	66	103	73	0.7087				11-18 (13)
South San Diego Bay Unit, SDNWR - Saltworks	49	78	30	0.3846				4-6 (4)
Silver Strand State Beach	1	2	2	1		n/a	n/a	0
Tijuana Estuary NERR	520	804	127	0.1580				16-26 (19)

# Appendix B-5: Non Predation Mortality.

Appendix 2 of Non-Predation Mortality:

	No. of eggs					No. of nests					No. of dead			
Site name:	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:	Comments on cause(s) of non-predation mortality:
San Francisco Bay Area														
Pittsburg Power Plant	0	0	0	0	0	0	0	0	0	0	0	0	0	n/a
Albany Central Ave. Mitigation Island														
Alameda Point	0	0	76	66	27	0	0	63	20	8	156	1	2	Nine salvaged terns were sent to the USGS National Wildlife Health Center for analysis because the Alameda Point colony experienced high chick mortality (30%) for a second year. The six chicks in the best post mortem condition were necropsied. The results from the National Wildlife Health Center do not provide conclusive answers to cause of death. Three chicks had moderate to abundant body fat, indicating adequate nutritional condition; however two small chicks had no fat and one had only minimal amount of fat in the neck region. Food material was found in the stomach of only one chick. Most chicks had no gross or microscopic abnormalities; however one chick had mild kidney damage (mild nephrosis), possibly associated with urate retention. Urate retention can be seen with dehydration in birds, or with some viral infections. Virus isolation attempts, including West Nile virus screening were negative. No significant bacteria were isolated from lung or liver samples. No parasites were found in the GI tracts. The cause for the excessive least tern chick mortality was not determined by postmortem examination.
San Luis Obispo/Santa Barbara Counties														
Oceano Dunes SVRA														
Guadalupe-Mussel Rock	0	0	2	0	0	0	0	1	0	0	0	0	0	none observed
Vandenberg AFB														
Purisima Pt	0	0	1	0	0	0	0	1	0	0	0	0	0	
Beach 2	0	0	0	0	0	0	0	0	0	0	0	0	0	
Coal Oil Point Reserve						0	0	2	0	0	0	0	2	Great-horned owl killed one adult from two nest, the nests were abandoned



## Appendix B-5: Non Predation Mortality (continued).

[illegible]

Appendix B-5: Non Predation Mortality (continued).

Site name:	No. of eggs					No. of nests					No. of dead			Comments on cause(s) of non-predation mortality:
	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:	
Mission Bay														
FAA Island	0	0				0	0							
North Fiesta Island	0	0	1	0	0	0	0	1	0	0	0	0	0	n/a
Mariner's Point	0	0	144	0	0	0	0	96	0	0	2	0	0	Adults deserted site about 9 June, possibly because of Peregrine Falcon in the area.
San Diego River Mouth (S)	0	9					5							
San Diego Bay														
Lindbergh Field & Former Naval Training Center	0	0	23	1	19	0	0	16	1	14	17	0	0	2 unknown chicks may have died due to predator injuries
USN Totals	0	1	257	169	165						62	0	2	
NI MAT	0	0	55	65	4						14	0	0	
DBN	0	0	55	26	39						25	0	0	
DBS	0	0	34	4	28						9	0	1	
NABO	0	1	113	74	94						14	0	1	
D Street Fill/Sweetwater Marsh NWR	0	0	26	4	23	0	0	22	4	19	11	0	0	1 unknown chick may have died due to predator injuries
Chula Vista Wildlife Reserve	0	0	13	4	13	0	0	7	4	11	1	0	0	
South San Diego Bay Unit, SDNWR - Saltworks	0	0	4	0	39	0	0	3	0	25	2	0	2	1 unknown adult may have died due to predator injuries
Silver Strand State Beach														
Tijuana Estuary NERR	4	85	178	5	328	2	59	136	5	207	2	1	2	1 unknown chick may have died due to predator injuries

Appendix B-6: Predation.

Species	Predation		
	Possible	Suspected	Documented
Black widow spider	X		
Ants	X		X
Snakes		X	
Great blue heron		X	
Black-crowned night heron	X		
Black-bellied plover	X		
Gulls	X	X	X
Gull-billed tern		X	X
Osprey	X		
Northern harrier	X	X	X
Red-tailed hawk	X	X	
American kestrel	X	X	X
Peregrine falcon	X	X	X
Barn owl		X	
Great-horned owl	X		X
Burrowing owl		X	
Owls	X		X
Black-billed magpie			X
American crow	X	X	X
Common raven	X	X	X
Loggerhead shrike	X	X	X
Unknown avian spp.		X	X
Unknown mammal spp.		X	X
Opossum	X		
Black-tailed jackrabbit	X	X	
California ground squirrel	X	X	X
Rats			X
Rodents	X		
Canids			X
Domestic dog	X		
Coyote	X	X	X
Gray fox	X		
Raccoon	X	X	X
Striped skunk	X		X
Domestic cat	X		X
Unknown			X

## Appendix B-6: Predation (continued).

Site name	Predation			Number of					Total number documented				
	Possible	Suspected	Documented	Eggs	Nests	Chicks	Fledglings	Adults	Eggs	Nests	Chicks	Fledglings	Adults
<b>San Francisco Bay Area</b>													
Pittsburg Power Plant		GTBH, rac		rac 2D, 12S+4-6 (or chicks)S	rac 1D, 8-11S	GTBH 0-1S+ 0-2 (or eggs)S, rac 2- 3S + 4-6 (or eggs)S			14-22	9-12	4-12	0	0
Albany Central Ave. Mitigation Island									0	0	0	0	0
Alameda Point	bw spider	RTHA, AMKE, PEFA, BAOW, CORA, LOSH	NOHA, AMKE, owls, CORA, avian	CORA 1D 7S, avain 8D		bw spider 1P, AMKE 2D 1- 9S, BAOW 1S, owls 1D, avian 9D	NOHA 1D, AMKE 1D, avian 2D	PEFA 1S, avian 1D	16	0	15-23	4	2
<b>San Luis Obispo/Santa Barbara Counties</b>													
Oceano Dunes SVRA													
Guadalupe-Mussel Rock	BBPL, gull, OSPR, NOHA, RTHA, AMKE, PEFA, GHOW, AMCR, CORA, LOSH, btj rabbit, coyote		coyote	BBPL 0-6P, gull 0-6P, GHOW 0-6P, AMCR 0-6P, CORA 0-6P, coyote 3	BBPL 0-3P, gull 0-3P, GHOW 0-3P, AMCR 0-3P, CORA 0-3P, coyote 1	BBPL 0-7P, gull 0-7P, OSPR 0-7P, NOHA 0-7P, RTHA 0-7P, AMKE 0-7P, PEFA 0-7P, GHOW 0-7P, AMCR 0-7P, CORA 0-7P, LOSH 0-7P, coyote 0-7P			9	4	7	0	0
Vandenberg AFB									0	0	0	0	0
Purisima Pt									0	0	0	0	0
Beach 2									0	0	0	0	0
Coal Oil Point Reserve			GHOW, skunk		skunk 4			GHOW 2	0	4	0	0	2

## Appendix B-6: Predation (continued).

Site name	Predation			Number of					Total number documented				
	Possible	Suspected	Documented	Eggs	Nests	Chicks	Fledglings	Adults	Eggs	Nests	Chicks	Fledglings	Adults
<b>Ventura County</b>													
Santa Clara River/McGrath State Beach									0	1	0	0	0
Hollywood Beach	gull, AMKE, AMCR, CORA								0	0	0	0	0
Ormond Beach	gull			PEFA				PEFA 1	0	0	0	0	1
Pt Mugu- Totals									417	244	2	0	0
Holiday Beach		coyote		coyote 4	coyote 2				4	2	0	0	0
Ormond Beach East		LOSH, avian, mammal, gs, coyote	LOSH, avian, mammal, gs, coyote	avian 28, mammal 15, gs 17, coyote 216	LOSH 2, avian 17, mammal 9, gs 11, coyote 124	LOSH 2			276	162	2	0	0
Nesting Islands			coyote	coyote 22	coyote 16				22	16	0	0	0
Eastern Arm		coyote	avian, mammal, gs, coyote	avian 2, mammal 4, gs 3, coyote 106	avian 1, mammal 2, gs 1, coyote 60				115	64	0	0	0
<b>Los Angeles/Orange Counties</b>													
Venice Beach			AMCR		AMCR 17				0	17	0	0	0
LA Harbor - Pier 400	BCNH, gull	BUOW, AMCR	AMKE, PEFA, BBMA, cat						0	0	0	0	0
Seal Beach NWR - Anahiem Bay	owl, AMCR, CORA, LOSH, rodent		avian, owl				avian 1	owl 2	0	0	1	0	2
Bolsa Chica Ecological Reserve	RTHA, AMKE, PEFA, AMCR	AMKE	gs, coyote, rac						250	160	20	0	0
Huntington State Beach		PEFA, AMCR, CORA, gs	gs	AMCR 42?, gs 158S 10D	AMCR 66?, gs 253S 10D	PEFA 10?			263	168	10	0	0
Upper Newport Bay Ecological Reserve		snake, rac	ant, CORA, canid	ant 2, CORA many, canids many	ants 2, CORA many, canids many	canids many	canids many		2 + many	2 + many	many	many	0

## Appendix B-6: Predation (continued).

Site name	Predation			Number of					Total number documented				
	Possible	Suspected	Documented	Eggs	Nests	Chicks	Fledglings	Adults	Eggs	Nests	Chicks	Fledglings	Adults
<b>San Diego County</b>													
MCB Camp Pendleton									165	108	3	5	4
Red Beach									2	1	0	0	0
White Beach									21	12	2	1	0
Santa Margarita River - North Beach North									103	66	0	1	1
Santa Margarita River - North Beach South									34	26	1	2	1
Santa Margarita River - Saltflats									5	3	0	0	1
Santa Margarita River - Saltflats Island									0	0	0	1	1
Batiquitos Lagoon Ecological Reserve		NOHA, RTHA, AMKE, PEFA, AMCR, CORA, opossum, gs, rodent, coyote, rac, skunk, cat	gull						0	0	0	0	0
San Elijo Lagoon Ecological Reserve									0	0	0	0	0
<b>Mission Bay</b>													
FAA Island			PEFA, AMCR, gull	AMCR/ Gull 211	AMCR/ Gull 106			PEFA 4-5	211	106	0	0	4-5
North Fiesta Island		AMCR, CORA, snake		snake 0-20, AMCR 0-20, CORA 0-20	snake 0-17, AMCR 0-17, CORA 0-17				20	17	0	0	0
Mariner's Point		Gull	AMCR, rat	gull 1, AMCR 1-309, rat 1-309	gull 1, AMCR 1-201, rat 1-201				309	201	0	0	0
San Diego River Mouth (S)									0	0	0	0	0

## Appendix B-6: Predation (continued).

Site name	Predation			Number of					Total number documented				
	Possible	Suspected	Documented	Eggs	Nests	Chicks	Fledglings	Adults	Eggs	Nests	Chicks	Fledglings	Adults
San Diego Bay													
Lindbergh Field & Former Naval Training Center	ants	CORA, Gull	AMKE, ants	gull or CORA 4S, ant 1P	gull or CORA 4S, ant 1P	AMKE 5D 38-45S, ant 1D			5	5	44-51	0	0
USN Totals									113		51	3	7
NI MAT									1		9	2	0
DBN									12		6	0	2
DBS									9		18	0	0
NABO									91		18	1	5
D Street Fill/Sweetwater Marsh NWR	gfox	rabbit, GBTE, AMKE, NOHA, PEFA	GBTE, ants	GBTE 2S, rabbit S gfox P 3	GBTE 2S, rabbit S gfox P 3	GBTE AMKE NOHA PEFA S gfox P 71-79, GBTE 4D, ants 2D			5	5	77-85	0	0
Chula Vista Wildlife Reserve	gull	GBTE, PEFA, NOHA				GBTE 2D, GBTE PEFA NOHA S gull P 52-59		PEFA 2	0	0	54-61	0	2
South San Diego Bay Unit, SDNWR - Saltworks	AMKE, NOHA	GBTE, PEFA, gull	PEFA	gull 5D	gull 2D 1S, PEFA 1D	GBTE PEFA S or NOHA AMKE P 22-24		PEFA 1	5	4	22-24	0	1
Silver Strand State Beach													
Tijuana Estuary NERR	NOHA, PEFA, AMKE, gull, dog, coyote	GBTE	GBTE, CORA, gull, cat, coyote, op	GBTE 1S, GBTE 0-68D, gull 0-68D, CORA 1D, cat 1D, coyote 0-68D, unknown 5D	GBTE 0-47D, gull 0-47D, CORA 1D, cat 2D, coyote 0-47D, unknown 4D	GBTE 8D 2S, GBTE S NOHA PEFA AMKE gull dog coyote gs op cat P 87-94			76	54	97-104	0	0

Appendix B-6: Predation (continued).

Legend:			
P: Possible	S: Suspected	D: Documented	
GTBH: Great blue heron		PEFA: Peregrine falcon	avian: Unknown avian species
BCNH: Black-crowned night heron		BAOW: Barn owl	op: Opossum
BBPL: Black-bellied plover		GHOW: Great-horned owl	btj rabbit: Black-tailed jackrabbit
GBTE: Gull-billed tern		BUOW: Burrowing owl	gs: California ground squirrel
NOHA: Northern harrier		AMCR: American crow	gfox: Gray fox
RTHA: Red-tailed hawk		CORA: Common raven	rac: Raccoon
AMKE: American kestrel		LOSH: Loggerhead shrike	mammal: Unknown mammal species