

**State of California
The Resources Agency
Department of Fish and Game
Wildlife Branch**

California Least Tern Breeding Survey

2009 Season

**by
Daniel A. Marschalek**

Final Report

To

State of California
Department of Fish and Game
South Coast Region
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ABSTRACT

Monitoring to document breeding success of California least terns (*Sternula antillarum browni*) continued in 2009, with observers at 41 nesting sites providing data. An estimated 7130-7352 California least tern breeding pairs established 8037-8045 nests and produced 1734-2132 fledglings at 51 documented locations. The fledgling to breeding pair ratio was 0.24-0.30. Statewide, 13,965 eggs were reported, with a Site Mean clutch size of 1.77 eggs per nest (St Dev = 0.110) and the Statewide clutch size of 1.76 eggs (St Dev = 0.455) for Type 1 sites. Numbers of nesting least terns were not uniformly distributed across all sites. Camp Pendleton, Naval Base Coronado, Batiquitos Lagoon, Pt. Mugu, and Huntington Beach represented 64% of the breeding pairs while Bolsa Chica Ecological Reserve, Alameda Point, and Batiquitos Lagoon Ecological Reserve produced 42% of the fledglings. The 2009 chick mortality rate of 15% is similar to the rate observed in 2004 (14%). LA Harbor, Camp Pendleton, and Batiquitos Lagoon Ecological Reserve represented 79% of the total reported chick deaths, but only 37% of the total chicks. The predators responsible for the greatest number of depredated least terns in 2009 were gull-billed terns (*Gelochelidon nilotica*) and American crows (*Corvus brachyrhynchos*). Gulls (*Larus* sp.), American crows, common ravens (*Corvus corax*), American kestrels (*Falco sparverius*), and peregrine falcons (*Falco peregrinus*) were reported from the most sites. The monitoring effort of 2009 is scheduled to continue in 2010.

¹ Marschalek, D.A. 2010. California least tern breeding survey, 2009 season. California Department of Fish and Game, Wildlife Branch, Nongame Wildlife Program Report, 2010-03. Sacramento, CA. 25 pp. + app.

INTRODUCTION

The California least tern (*Sternula antillarum browni*) is the subspecies of least terns nesting along the west coast of North America, from Baja California, Mexico, north to the San Francisco Bay area (USFWS 1980). Two other subspecies, Interior (*S. a. athalassos*) and Eastern (*S. a. antillarum*), are recognized in the United States (American Ornithologists' Union: AOU 1957); however, there is little genetic variation among the subspecies which questions the validity of this division (Whittier et al. 2006). A recent taxonomic change by the AOU (Banks et al. 2006) resurrected the genus *Sternula* for the least tern based on the work of Bridge et al. (2005).

California 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 the U.S. Secretary of the Interior in 1970 (USFWS 1973) and the California Fish and Game Commission in 1971 (CDFG 1976) due to a population decline resulting from loss of habitat (Craig 1971, Cogswell 1977). The endangered status prompted wildlife agencies to initiate monitoring efforts to estimate the breeding population size 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 emphasis 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.

Since 1971, the frequency of monitoring at breeding colonies increased from one to three visits per year to more than one visit per week. 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 effort 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). In an attempt to provide a more accurate statewide (rather than site specific) method of estimating the number of breeding pairs, calculations consider the number of renesting pairs a site may produce rather than the number of renesting pairs actually at the site (Caffrey 1998). These equations have been used to some extent since the 1998 nesting season (Keane 2000). Over the last decade, monitors continued to provide comparable data of California least tern breeding success and these data were compiled into annual summary reports. These latest monitoring efforts were continued for the 2009 breeding season in California.

METHODS

Monitors for each site that had least tern nesting in 2008 or who planned monitoring activities for 2009 were provided datasheets prior to the arrival of adult terns (Appendix A). These forms were similar to those used since the 1998 nesting season 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 throughout the breeding season and distributed to California Department of Fish and Game (CDFG) and U.S. Fish and Wildlife Service (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), or (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, or (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.

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.

pairs first wave = # nests prior to 15 June - estimated renesters prior to 15 June

pairs second wave = # nests 15 June or after - estimated renesters 15 June or after

Total Pairs = pairs first wave + 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.

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 (Site Mean clutch size). To reduce the influence of sites with only a couple nests of small or large clutch size, only the sites totaling more than 50 eggs are included. 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 (Statewide clutch size). 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.

To quantify the impact of each predator species on the reproductive success and survivorship of least terns, two statistics are provided. The first ranks the species by the number of sub-colonies they were documented as predators. The second quantifies mortality by calculating the proportion of total least tern eggs, chicks, fledglings, and adults depredated by specific predators. The number of eggs, rather than the number of nests, was used in calculations since they more accurately represent individual terns. For the few cases when the number of eggs was not reported, the number of nests was used as a conservative estimate of the number of eggs depredated. When a range of individuals depredated by a species was reported, the average was used. Past analysis with minimum, average, or maximum values resulted in only slight differences (Marschalek 2005). Only the numbers of terns lost to a suspected or documented predator (possible category excluded) were used in calculating the proportion of least terns lost to predators. Past data shows little difference between only documented predation and combining suspected and documented predation (Marschalek 2008).

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-eight of 41 sites monitored in 2009 were Type I sites, 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.

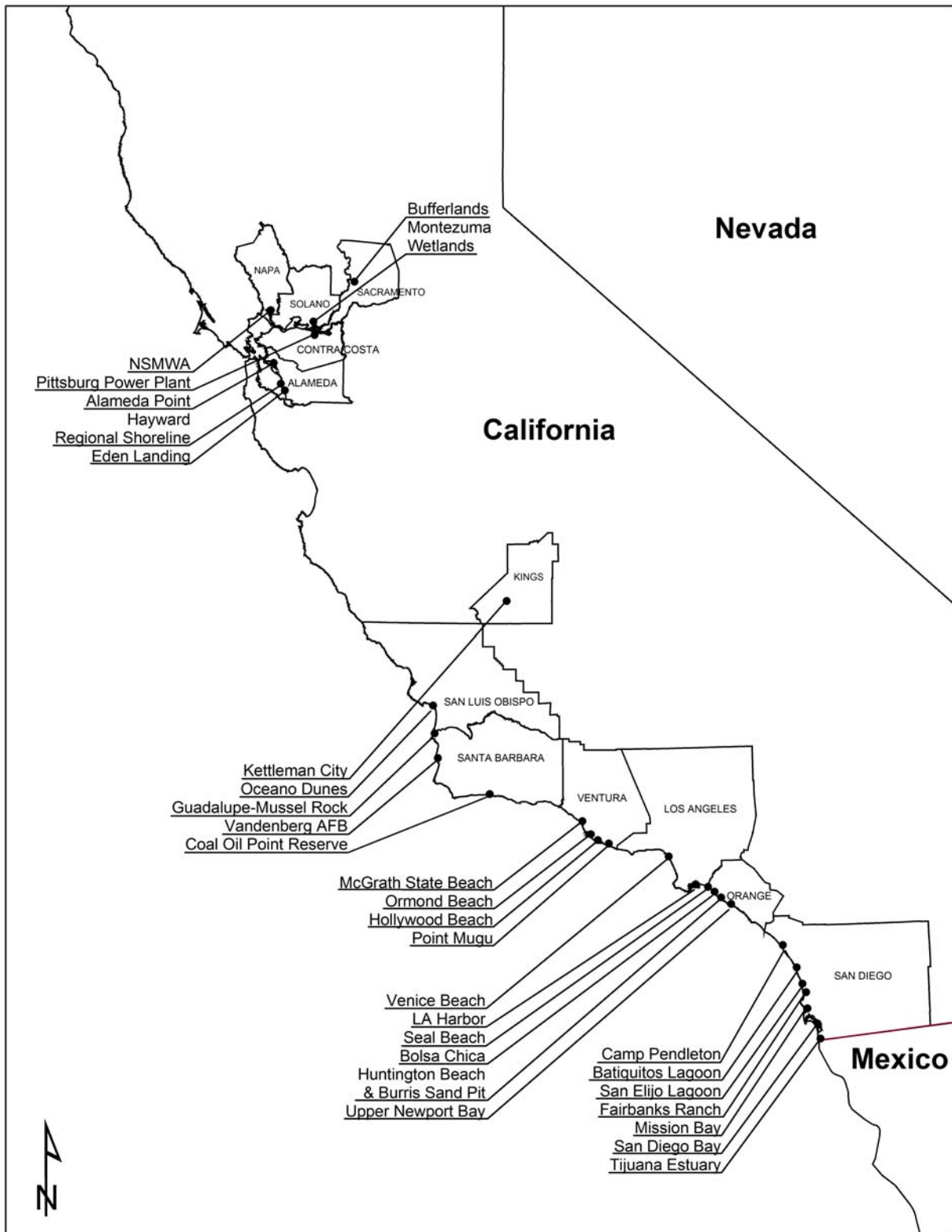


Figure 1. California sites monitored for California least tern nesting in 2009. Some listed areas include multiple sites, sites with nesting at more than one location, or both.

Productivity

At least partial data were received and analyzed for all monitored least tern nesting areas in California for 2009. An estimated 7130-7352 California least tern breeding pairs established 8037-8045 nests and produced 1734-2132 fledglings at 51 documented locations (Table 2). The fledgling to breeding pair ratio was 0.24 to 0.30 fledglings per pair. Statewide, 13,965 eggs were reported, with a Site Mean clutch size of 1.77 eggs per nest (St Dev = 0.110) and a Statewide clutch size of 1.76 eggs (St Dev = 0.455).

The 2009 California least tern nesting season lasted approximately five and a half months. The first recorded least tern at a nesting site was on 14 April at Bolsa Chica Ecological Reserve and Hayward Regional Shoreline and the last observed on 25 September at Saltworks. The first nest was detected on 1 May at NIMAT, the first chick at Delta Beach North on 25 May, and first fledgling at NAB Ocean on 14 June. Least terns did not nest at three sites used in 2008 (Pittsburg Power Plant, Coal Oil Point Reserve, and San Diego River Mouth), however, they nested at four locations not used last year (Guadalupe-Mussel Rock, Fairbanks Ranch, FAA Island, and Glendale, AZ). The three locations used in 2008 and not in 2009 had three nests total. Site-specific and complete productivity data are located in Appendix B-3 (breeding pair estimation) and B-4 (productivity).

The 7130 recorded minimum breeding pairs in 2009 was about 2% higher than the 6998 total in 2008 (Marschalek 2009). This represents the 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, 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; Marschalek 2005, 2006, 2007, 2008, 2009). Due to concerns regarding late nesting, any technique monitors determined to be most representative of the actual number of breeding pairs was used as the estimate. Late nest initiation will often result in an underestimation when calculating the number of breeding pairs using any of the three traditional estimates. For consistency, the traditional estimates are provided in the appendices. Fledgling numbers were about 23% lower than the 2008 count (Marschalek 2009), representing a substantial drop compared to the last three years but similar to counts of 2005.

The majority of breeding pairs nested in San Diego County (4482 pairs, 62.9%) and the fewest in San Luis Obispo, Santa Barbara, and King Counties (59 pairs, 0.8%) (Table 3). Breeding pairs were not a predictor for fledgling numbers, however. The fledgling-to-pair ratio ranged from a low of 0.126 in San Diego County to a high of 1.169 in San Luis Obispo, Santa Barbara, and King Counties.

Table 2. California least tern productivity in 2009.

2009 Site	Estimated Number of Breeding Pairs		Number of Nests	Estimated Number of Fledglings		Fledgling per Pair Ratio	
	Minimum	Maximum		Minimum	Maximum	Minimum	Maximum
Sacramento Area							
Bufferlands	1	1	1	2	2	2.00	2.00
San Francisco Bay Area							
Napa Sonoma Marsh Wildlife Area- Totals	42	52	52	2	unknown	0.04	unknown
Montezuma Wetlands	11	27	22-27	6	7	0.22	0.64
Pittsburg Power Plant	0	0	0	0	0	0.00	0.00
Alameda Point	314	318	346	252	461	0.79	1.47
Hayward Regional Shoreline	48	72	80	63	67	0.88	1.40
Eden Landing	1	1	1	0	0	0.00	0.00
Kings County							
Kettleman City Evaporation Ponds	1	1	1	1	1	1.00	1.00
San Luis Obispo/Santa Barbara Counties							
Oceano Dunes SVRA	25	25	26	28	33	1.12	1.32
Guadalupe-Mussel Rock	3	3	3	3	3	1.00	1.00
Vandenberg AFB	30	31	31	37	37	1.19	1.23
Coal Oil Point Reserve	0	0	0	0	0	0.00	0.00
Ventura County							
Santa Clara River/McGrath State Beach	77	85	85	56	56	0.66	0.73
Ormond Beach	43	44	44	24	24	0.55	0.56
Hollywood Beach	4	4	4	4	4	1.00	1.00
Pt Mugu- Totals	495	567	628	133	133	0.23	0.27
Los Angeles/Orange Counties							
Venice Beach	295	295	295	0	0	0.00	0.00
LA Harbor	371	385	435	75	75	0.19	0.20
Seal Beach NWR - Anahiem Bay	168	177	177	80	80	0.45	0.48
Bolsa Chica Ecological Reserve-Totals	285	285	317	265	363	0.93	1.27
Huntington State Beach	413	413	434	132	132	0.32	0.32
Burriss Sand Pit/Buriss Basin	12	16	16	5	9	0.31	0.75
Upper Newport Bay Ecological Reserve	7	7	7-10	0	0	0.00	0.00
San Diego County							
MCB Camp Pendleton- Totals	1639	1639	1718	179	204	0.11	0.12
Batiquitos Lagoon Ecological Reserve- Totals	576	620	649	212	233	0.34	0.40
San Elijo Lagoon Ecological Reserve	0	0	0	0	0	0.00	0.00
Fairbanks Ranch	2	2+	2+	0	1	0.00	0.50
Mission Bay							
FAA Island	25	32	38	0	0	0.00	0.00
North Fiesta Island	36	39	45	12	15	0.31	0.42
Mariner's Point	8	13	14	0	0	0.00	0.00
Stony Point	0	0	0	0	0	0.00	0.00
San Diego River Mouth	0	0	0	0	0	0.00	0.00
San Diego Bay							
Lindbergh Field & Former Naval Training Center	136	136	145	36	38	0.26	0.28
NI MAT	122	122	125	30	35	0.25	0.29
Naval Base Coronado- Totals	1463	1463	1741	42	42	0.03	0.03
D Street Fill/Sweetwater Marsh NWR	129	129	132	19	29	0.15	0.22
Chula Vista Wildlife Reserve	37	37	48	4	5	0.11	0.14
South San Diego Bay Unit, SDNWR - Saltworks	62	62	78	4	7	0.06	0.11
Tijuana Estuary NERR	247	247	294	27	33	0.11	0.13
Arizona							
101 Freeway Ponds- Near Glendale Exit	2	2	3	1	1	0.50	0.50
Totals:	7130	7352+	8037-8045+	1734	2132	0.24	0.30

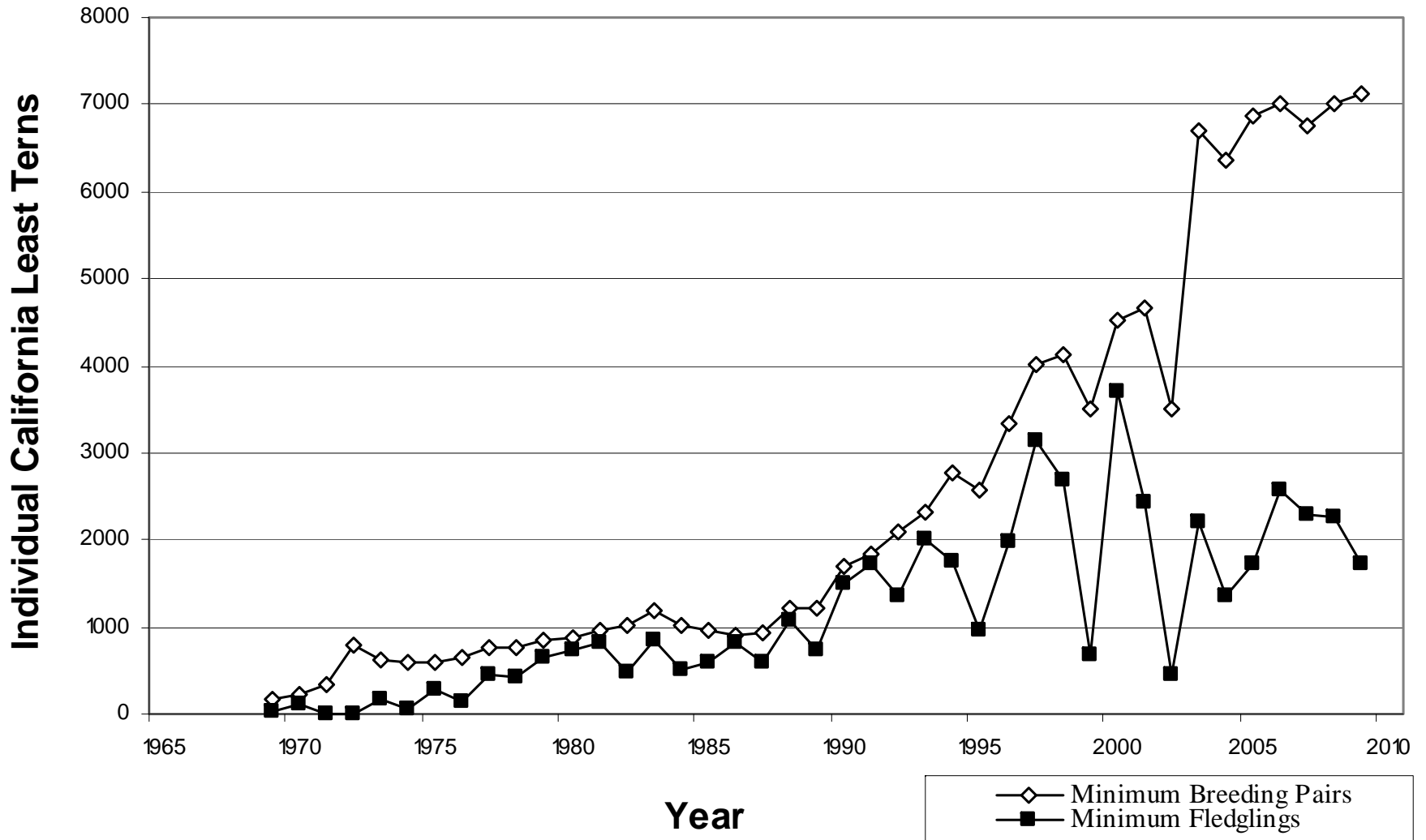


Figure 2. Number of documented California least tern breeding pairs and fledglings in California during annual surveys, 1969-2009. (Data from: Craig 1971; Bender 1974a, 1974b; Massey 1975, 1988, 1989b; Atwood *et al.* 1977; Jurek 1977; Atwood *et al.* 1979; Collins 1984, 1986, 1987; Gustafson 1986; Johnston and Obst 1992; Obst and Johnston 1992; Caffrey 1993, 1994, 1995b, 1997, 1998; Keane 1998, 2000, 2001; Patton 2002, 2004 unpubl. Table; Marschalek 2005, 2006, 2007, 2008, 2009).

Table 3. Regional productivity comparison, 2009.

Region	Breeding Pairs**	Proportion of Total	Fledglings**	Proportion of Total	Fledgling:Pair*
San Francisco Bay Area (w/Bufferlands)	417	0.059	327	0.188	0.784
San Luis Obispo/Santa Barbara/King Counties	59	0.008	69	0.040	1.169
Ventura County	619	0.087	217	0.125	0.351
Los Angeles/Orange County	1551	0.218	557	0.321	0.359
San Diego County	4482	0.629	565	0.326	0.126
Total	7128	1.000	1735	1.000	0.243

* This is not the minimum fledgling-to-breeding pair ratio since the maximum number of pairs is not used.

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

As in the past, the number of breeding pairs generally corresponds more closely to the number of nests, eggs, and chicks than the number of fledglings (Table 4). Camp Pendleton, Naval Base Coronado, Batiquitos Lagoon Ecological Reserve, and Pt. Mugu had the highest number of breeding pairs, nests, eggs, and chicks in the state in 2009. The five sites with the most fledglings produced differed due to different survival rates at each site. Bufferlands (2.00), Vandenburg AFB (1.19), and Oceano Dunes (1.12) are the only three sites that had a minimum fledgling-to-pair ratio greater than one.

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

Breeding Pairs	Nests	Eggs	Chicks	Fledglings
Camp Pendleton (1639)	Naval Base Coronado (1741)	Camp Pendleton (3031)	Naval Base Coronado (2184)	Bolsa Chica (265)
Naval Base Coronado (1463)	Camp Pendleton (1718)	Naval Base Coronado (3002)	Camp Pendleton (2123)	Alameda Point (252)
Batiquitos (576)	Batiquitos (649)	Batiquitos (1178)	Batiquitos (975)	Batiquitos (212)
Pt. Mugu (495)	Pt. Mugu (628)	Pt. Mugu (1081)	Pt. Mugu (593)	Camp Pendleton (179)
Huntington Beach (413)	LA Harbor (435)	Huntington Beach (759)	Huntington Beach (578)	Pt. Mugu (133)

A few sites constituted the majority of breeding activity for the state in 2009, which is a trend observed in the past (Caffrey 1994, 1995b, 1997, 1998; Marschalek 2005, 2006, 2007, 2008, 2009). Five sites (Camp Pendleton, Naval Base Coronado, Batiquitos Lagoon Ecological Reserve, Pt. Mugu, and Huntington State Beach) had over 400 minimum breeding pairs, which

represented 64% 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. There was a four-egg clutch observed at Lindbergh Field in 2009. Fledgling numbers were also unevenly distributed as the three sites with over 200 fledglings each (Bolsa Chica Ecological Reserve, Alameda Point, and Batiquitos Lagoon Ecological Reserve) contributed 42% of the state's production. Only six sites produced over 100 fledglings, contributing 68% of the state's production.

Mortality and Predation

The 2009 chick mortality rate of 15% is similar to the 2008 rate of 14% (Marschalek 2009) (Table 5). Several larger nesting colonies continued to experience rates greater than the average. At LA Harbor, Camp Pendleton, and Batiquitos Lagoon Ecological Reserve 41, 36, and 29% of chicks were found dead, respectively. These three sites represented 79% of the total reported chick deaths, but only 37% of the total chicks hatched in California. Least tern mortality due to non-predation factors was greater than mortality due to predation in 2009.

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
Non-predation	2075	1381	1389	93	10
Predation	2037+	923+	437-455	65-66	81-91

Abandonment prior to the expected hatching date was the second highest death rate from non-predation events behind chick mortality, leading to the loss of 1100 eggs, 53% of eggs lost due to non-predation mortality. Abandonment post-term or failure to hatch is often difficult to distinguish from pre-term abandonment and contributed a slightly lower rate (22%) to the non-predation mortality.

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. Uncertainty is also reflected in a predation event reported as either suspected or documented in some cases, based on the evidence available and the conservative nature of the biologist. For this reason, the proportion of least terns lost to each predator species includes both suspected and documented species. Previous calculations show similar trends when using only documented predator species (Marschalek 2008).

Forty-two species were reported as possible, suspected, or documented predators of least terns (Table 6). The most commonly reported predators were gulls (*Larus* sp.), American crows (*Corvus brachyrhynchos*), common ravens (*Corvus corax*), American kestrels (*Falco*

sparverius), and peregrine falcons (*Falco peregrinus*). As in past years, most reported predators were avian species.

Table 6. Reported species documented or thought to have depredated least terns. Number of sub-colonies each species was reported from in parenthesis.

Species	Species	Species
Canada goose (1)*	Peregrine falcon (12)	Opossum (5)
Mallard (1)*	Black-bellied plover (1)	River otter (1)
Great blue heron (6)	Barn owl (4)	Raccoon (5)
Great egret (2)	Great-horned owl (3)	Skunk (6)
Black-crowned night heron (4)	Burrowing owl (1)	Red fox (1)
California gull (1)	Owls (2)	Coyote (8)
Gulls (14)	American crow (13)	Domestic dog (2)
Caspian tern (2)	Common raven (13)	Domestic cat (5)
Gull-billed tern (10)	Corvids (1)	California ground squirrel (6)
Black skimmer (3)	Horned lark (1)	Rats (6)
Northern harrier (7)	Loggerhead shrike (2)	Mouse (1)
White-tailed kite (2)	European starling (3)	Rodents (2)
Cooper's hawk (4)	Western meadowlark (2)	Unknown mammal (3)
Red-tailed hawk (3)	Unknown avian (6)	Snakes (4)
Osprey (1)	Long-tailed weasel (1)	Ants (9)
American kestrel (12)	Black-tailed jackrabbit (3)	Black widow spider (1)

* competition

Predation led to the loss of 2037 eggs, 437-455 chicks, 65-66 fledglings, and 81-91 adults (Table 5). A total of 1968 least tern individuals (including eggs) were reported with a documented or suspected predator species, meaning most depredated least terns were due to unknown species (56%). Of those lost to suspected or documented predator species, gull-billed terns (*Gelochelidon nilotica*, 813 total individuals, 40%) and American crows (615 total individuals, 30%) (Table 7) depredated the most least terns. This is the second consecutive year that American crows depredated a large number of eggs at Venice Beach (Marschalek 2009). All other species each represented less than 4% of the depredation. Nests were excluded from this analysis since the number of eggs better represents the loss of individuals. Abandonment was also excluded from depredation data but can be driven by a predator. Site-specific and complete mortality data are located in Appendix B-5 (non-predation) and B-6 (predation).

Table 7. Species responsible for greatest proportion of known depredated least tern eggs, chicks, fledglings or adults.

Species	Proportion of Least Tern Individuals Depredated (Documented and Suspected Predators)*
Gull-billed tern	0.3971
American crow	0.3004
Common raven	0.0352
Black skimmer	0.0200
Coyote	0.0200
Peregrine falcon	0.0171

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

As in past years, most predation was a result of American crows, gull-billed terns, common ravens, and coyotes (*Canis latrans*) (Marschalek 2007, 2008). The foraging area of gull-billed terns appears to be expanding since 2007 and the predation rate is increasing as well. Predator species varied in importance among each least tern age class. American crows had the largest depredation rate of eggs, while gull-billed terns, red-tailed hawks (*Buteo jamaicensis*), and peregrine falcons depredated the most chicks, fledglings, and adults, respectively (Table 8). In addition, fledgling and adult predation was almost exclusively restricted to avian predators. It should be noted that reporting of predation data was not as complete as it was for the 2008 breeding season.

Table 8. The five species responsible for greatest proportion of depredated least tern for each age class, excluding predation from unknown species. Total least terns of each age class depredated in parentheses.

Eggs		Chicks		Fledglings		Adults	
Predator	Proportion*	Predator	Proportion*	Predator	Proportion*	Predator	Proportion*
American crow (615)	0.4192	Gull-billed tern (321)	0.7858	Red-tailed hawk (21)	0.5316	Peregrine Falcon (23)	0.4299
Gull-billed tern (491)	0.3347	American kestrel (26)	0.0636	Peregrine falcon (11.5)	0.2911	Unknown avian (8.5)	0.1589
Common raven (72)	0.0491	Gull species (12)	0.0294	Seven different species (1)	0.0253	Great horned owl (5)	0.0935
Coyote (41)	0.0279	Burrowing owl (11)	0.0269			Owl species (5)	0.0935
Black Skimmer (39)	0.0268	Northern harrier (9)	0.0220			Two different species (3.5)	0.0654

*This value represents the proportion of least terns within the particular age class depredated by the particular predator 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, but is not meant to be all inclusive. Site-specific reports produced by the site biologist may be referred to if additional details are desired.

Sacramento Area

Bufferlands

One pair established a nest on a gravel road situated between two treatment ponds associated with the Sacramento Regional Wastewater Treatment Plant for the second consecutive

year. This appears to be the second recorded nesting of least terns in Sacramento County but the first successful nest, producing two fledglings.

San Francisco Bay Area

Napa Sonoma Marsh Wildlife Area (NSMWA)

This was the third year least tern nesting was documented at NSMWA-Green Island Unit (Napa Plant). In 2009, 38-48 pairs established 48 nests. Due to weekly monitoring, the number of fledglings produced is unknown. The three habitat islands are being formed and will have some wood debris and LETE decoys. The islands have a core area with a slight depression around the rim to keep any salts on the island for attracting birds as well as depressing vegetation growth. Core portions of each island will consist of differing substrate (base rock mixed with a little soil, oyster shells, and scrapes from the levee where least terns nested in previous years).

This was the first year least tern nesting was documented at Huichica (Pond 7/7A), discovered during snowy plover (*Charadrius nivosus*) surveys. In 2009, four pairs established four nests and produced two fledglings. Sub-colony data:

Sub-colony	Breeding Pairs		Nests	Fledglings		Fledgling per Pair Ratio	
	minimum	maximum		minimum	maximum	minimum	maximum
Green Island Unit	38	48	48	unknown	unknown	unknown	unknown
Huichica Unit	4	4	4	2	2	0.50	0.50

Montezuma Wetlands

At Montezuma Wetlands, 11-27 pairs established 22-27 nests and produced 6-7 fledglings. Monitoring every other week and from an off-site location resulted in difficulties tracking individuals throughout the breeding season. While least terns have used one area for nesting the last three years, the other nesting locations have shifted each year despite appearing to be suitable nesting habitat or first using a location that appeared suitable in the past.

Pittsburg Power Plant

There was no least tern nesting at Pittsburg Power Plant in 2009. This is the second time in the last three years that least terns did not nest at this site. Aerial predators were common. This includes a pair of Peregrine falcons observed nesting within a couple miles of the site for the first time in five years. The pair was regularly observed at the least tern nesting site early in the breeding season.

Alameda Point

At the Alameda Point site, 314-318 breeding pairs established 346 nests and produced 252-461 fledglings. The food source appeared to be good, with appropriate size and species of fish brought to the nesting colony throughout the season. Fledgling and adult predation by red-tailed hawks and peregrine falcons was relatively high in 2009.

Hayward Regional Shoreline

In 2009, 48-72 breeding pairs established 80 nests and produced 63-67 fledglings. Vegetation cover of 74% and an average vegetation height of 25.25 cm (10.1 in) was obtained with a line intercept method. This is a two fold increase in vegetative cover on the site as compared to previous years (2007 and 2008). Aquatic surveys surrounding the island suggest that fish populations will support this least tern colony, with top smelt (*Atherinops affinis*) and rainwater killifish (*Lucania parva*) abundant. The top smelt sampled were primarily young of the year, which indicates spawning in the open water surrounding the tern nest island. Dropped fish at the tern colony in 2007 and 2008 were mostly topsmelt (90% and 82% respectively), but mostly jacksmelt (84%) in 2009.

To date, East Bay Regional Park District biologist and 2,900 volunteers who have contributed 11,100 hours in support of this stewardship effort. More than \$60,000 in grant funds and donations were secured for the Tern Island Project from various sources, including the community. Riensche (2007) provides additional information.

Eden Landing

This was the third year that least terns nested at Eden Landing and the second consecutive year nesting was unsuccessful due to predation. In 2009, one pair established one nest with both chicks depredated by northern harriers.

Kings County

Kettleman City Evaporation Ponds

The Kettleman City Evaporation Ponds had one breeding pair establish one nest and produce one fledgling at the Westlake Farms South Evaporation Basin sub-colony. Least terns have not nested at the TLDD Hacienda Evaporation Basin sub-colony since 2004. Data from the from this site was not included in recent annual reports and is included below:

	2004*	2005**	2006**	2007**	2008**	2009**
Breeding Pairs	2	1	2	2	1	1
Nests	2	1	2	2	1	1
Fledglings	2	0	2	2	2	1

* Least tern nesting at the TLDD Hacienda Evaporation Basin sub-colony only

** Least tern nesting at the Westlake Farms South Evaporation Basin sub-colony only

San Luis Obispo/Santa Barbara Counties

Oceano Dunes SVRA

The Oceano Dunes State Vehicular Recreational Area (SVRA) site had 25 breeding pairs, 26 nests, and produced 28-33 fledglings. This site had one of the highest fledgling to pair ratios (1.12-1.32) in the state. Pair estimation by counting the number of concurrently active broods and nests was determined to be most reliable.

Guadalupe-Mussel Rock

Guadalupe-Mussel Rock had three pairs establish three nests and produced three fledglings in 2009. These represent the highest counts of pairs and nests since 2005 and the highest fledgling count since 2001.

Vandenberg AFB

At Vandenberg AFB, 30-31 breeding pairs established 31 nests and produced 37 fledglings. This represents the most breeding pairs since 2005 and most fledglings since 2002. This site had one of the highest fledgling to pair ratios (1.19-1.23) in the state.

Coal Oil Point Reserve

There were no least tern nesting attempts at Coal Oil Point Reserve in 2009, following two years of unsuccessful nesting due to predation.

Ventura County

Santa Clara River/McGrath State Beach

The Santa Clara River site had 77-85 breeding pairs establish 85 nests and produce 56 fledglings. Counts in the last three years have increased to the level of those in 2004 after very low nesting numbers in 2005.

Ormond Beach

At Ormond Beach, 43-44 breeding pairs established 44 nests and produced 24 fledglings.

Hollywood Beach

At Hollywood Beach, four breeding pairs established four nests and produced four fledglings. This is the fifth year of least tern nesting at this site.

NAS Point Mugu

Point Mugu had a total of 495-567 breeding pairs, 628 nests, and at least 133 fledglings. As in the last three years, Ormond Beach East had the highest number of pairs, nests and fledglings of the sub-colonies. Sub-colony data:

Sub-colony	Breeding Pairs		Nests	Fledglings		Fledgling per Pair Ratio	
	minimum	maximum		minimum	maximum	minimum	maximum
Ormond Beach E	316	373	409	111	111	0.30	0.35
Holiday Beach	145	153	170	22	22	0.14	0.15
Holiday Beach Salt Panne	21	24	26	unknown	unknown	unknown	unknown
Eastern Arm	10	20	23	unknown	unknown	unknown	unknown

Los Angeles/Orange Counties

Venice Beach

Venice Beach had 295 breeding pairs establish 295 nests, but did not produce any fledglings. Predation due to American crows was extremely high and resulted in 100% failure of nesting attempts.

Los Angeles Harbor

The Los Angeles Harbor site had 371-385 breeding pairs, 435 nests, and 75 fledglings.

Seal Beach NWR

At Seal Beach NWR, 168-177 breeding pairs established 177 nests and produced 80 fledglings. The number of pairs and nests were similar to those in 2008, but nearly twice the number of fledglings were produced.

Bolsa Chica Ecological Reserve

At Bolsa Chica Ecological Reserve, 285 breeding pairs established 317 nests and produced 265-363 fledglings. This site had the highest fledgling to pair ratio (0.93-1.27) of any site in the state with more than 31 pairs or nests. Sub-colony data (breeding pairs for each sub-colony unknown):

Sub-colony	Nests	Fledglings	
		minimum	maximum
Nest Site 1	240	225	289
Nest Site 2	1	0	0
South Tern Island	76	40	74

Huntington State Beach

At Huntington State Beach, 413 breeding pairs established 434 nests and produced 132 fledglings.

Burriss Sand Pit (Burriss Basin)

At Burriss Sand Pit, 12-16 breeding pairs established 16 nests and produced five to nine fledglings. A reconfiguration project began in 2009 that will result in construction of a 2.4 acre, elevated bird nesting site so that the area will not be inundated during water management. During construction, a sand-capped floating island (3500 square feet in size) was provided for nesting and will be present at least until the project is complete, after the 2010 nesting season. It appeared that Forster's terns (*Sternula forsteri*) defended the floating island, resulting in least terns nesting along a levee.

Upper Newport Bay Ecological Reserve

At Upper Newport Bay Ecological Reserve, seven breeding pairs established at seven to 10 nests and did not produce fledglings. This was a Type 2 site so specific reproductive data are not available.

San Diego County
MCB Camp Pendleton

At Camp Pendleton, a total of 1639 breeding pairs established 1718 nests and produced 179-204 fledglings, the highest number of breeding pairs of any site within the state for 2009. As in the last four years, the Santa Margarita River North Beach sites (North and South) had the majority of the least tern nesting and production, representing 89% of the nests and 90% of the fledglings at Camp Pendleton. Sub-colony data:

Sub-colony	Breeding Pairs		Nests	Fledglings		Fledgling per Pair Ratio	
	minimum	maximum		minimum	maximum	minimum	maximum
Red Beach	0	0	0	0	0	0.00	0.00
White Beach	85	85	86	16	16	0.19	0.19
Delta Beach	12	12	12	0	0	0.00	0.00
Santa Margarita River- N Beach N	413	413	442	30	34	0.07	0.08
Santa Margarita River- N Beach S	1037	1037	1082	130	150	0.13	0.14
Santa Margarita River- Saltflats	56	56	59	2	3	0.04	0.05
Santa Margarita River- Saltflats Island	36	36	37	1	1	0.03	0.03

Batiquitos Lagoon Ecological Reserve

At Batiquitos Lagoon Ecological Reserve, 576-620 breeding pairs established 649 nests and produced 213-233 fledglings. Sub-colony data:

Sub-colony	Breeding Pairs		Nests	Fledglings		Fledgling per Pair Ratio	
	minimum	maximum		minimum	maximum	minimum	maximum
W1	28	28	28	29	31	1.04	1.11
W2	381	385	404	170	185	0.44	0.49
E1	153	187	195	9	12	0.05	0.08
E2	0	0	0	0	0	0.00	0.00
E3	14	20	22	4	5	0.20	0.36

San Elijo Lagoon Ecological Reserve

There was no nesting activity at San Elijo Lagoon Ecological Reserve in 2009. Currently, a restoration project is underway that may provide additional least tern nesting habitat in the future.

Fairbanks Ranch

Least terns were first discovered nesting at a location near the San Dieguito River, about four miles upstream from the coast. On 11 June, seven least terns were seen flying. Later monitoring confirmed two nests and suggested at least a third.

Mission Bay

- FAA Island

At FAA Island, 25-32 breeding pairs established 38 nests but no fledglings.

- North Fiesta Island

The North Fiesta Island site had 36-39 breeding pairs establish 45 nests and produced 12-15 fledglings. While not documented, relatively high predation was suspected.

- Mariner's Point

At Mariner's Point, eight to 13 breeding pairs established 14 nests. All nesting attempts failed due to nest abandonment or predation. While not documented, relatively high predation was suspected.

- Stony Point

No least tern nesting was detected at Stony Point in 2009.

- San Diego River Mouth (S)

The San Diego River Mouth (S) site did not have least tern nesting attempts in 2009.

San Diego Bay

- Lindbergh Field

At Lindbergh Field, 136 breeding pairs established 145 nests and produced 36-38 fledglings. Pair and nest numbers are nearly identical to those of 2007 and 2008; however fledgling production was similar to 2007, about a third of the 2008 count.

- NAS North Island

At North Island, 122 breeding pairs established 125 nests and produced 30-35 fledglings.

-Naval Base Coronado

Naval Base Coronado had 1463 breeding pairs, 1741 nests, and 42 fledglings, with most of the production at the Naval Amphibious Base Ocean sub-colony. This site had the most nests of any site in 2009. South Delta Beach had the fewest numbers of the three sub-colonies for the

fourth consecutive year. Gull-billed tern predation resulted in the documented loss of 501 least tern eggs and 285-287 chicks. Sub-colony data:

Sub-colony	Breeding Pairs		Nests	Fledglings		Fledgling per Pair Ratio	
	minimum	maximum		minimum	maximum	minimum	maximum
Delta Beach N	344	344	413	10	10	0.03	0.03
Delta Beach S	206	206	235	10	10	0.05	0.05
NAB Ocean	913	913	1093	22	22	0.02	0.02

- D Street Fill/Sweetwater Marsh NWR

At D Street, 129 breeding pairs established 132 nests and produced 19-29 fledglings.

- Chula Vista Wildlife Reserve

Chula Vista NWR had 37 breeding pairs establish 48 nests and produced four to five fledglings.

- South San Diego Bay Unit, SDNWR - Saltworks

At Saltworks NWR, 62 breeding pairs established 78 nests and produced four to seven fledglings. Predation due to several predator species resulted in the loss of at least 42 eggs.

Tijuana Estuary NERR

At Tijuana Estuary, 247 breeding pairs established 294 nests and produced 27-33 fledglings. Mortality in the egg stage was relatively high, with abandonment prior to hatching resulting in the loss of 75 eggs, depredation resulting in the loss of 29 eggs, and the outcome of 83 eggs were unknown.

Glendale, Arizona

Least terns were first discovered nesting at a location near Glendale, Arizona and are thought to be California least terns. Two pairs established three nests and successfully produced one fledgling in 2009.

Conclusion

Biologists recorded the highest total of California least tern breeding pairs in 2009. After an increase in the breeding population through the 1990s, it appears the population is stabilizing around 7000 breeding pairs based on counts of 2005-2009. Chick mortality continues to be a factor at specific sites, possibly a result of limited or inappropriate food sources. Many of the same predator species, such as American crows, common raves, and coyotes, continued to be an issue in 2009. The gull-billed tern predation rate continues to increase, as well as the range of sites where this species has been observed foraging on least tern eggs or chicks. In addition, the minimum fledgling-to-minimum breeding pair ratio (counts shown in Figure 2) continues to be

low, at 0.24 in 2009. Since 1977, this ratio has been less than 0.50 in only ten years but this includes the last eight years.

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LITERATURE CITED

American Ornithologists' Union. 1957. Check-list of North American Birds, 5th Ed. American Ornithologists' Union, Ithaca.

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.
- Banks, R.C., C. Cicero, J.L. Dunn, A.W. Kratter, P.C. Rasmussen, J.V. Remsen Jr., J.D. Rising and D.F. Stotz. 2006. Forty-seventh supplement to the American Ornithologists' Union checklist of North American birds. *The Auk*. 123(3): 926-936.
- 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.
- Bridge, E.S., A.W. Jones and A.J. Baker. A phylogenetic framework for the terns (Sternini) inferred from mtDNA sequences: Implications for taxonomy and plumage evolution. *Molecular Phylogenetics and Evolution*. 35: 459-469.
- 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.
- 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.
- Marschalek, D.A. 2006. California least tern breeding survey, 2005 season. California Department of Fish and Game, Habitat Conservation and Planning Branch, Species Conservation and Recovery Program Report, 2006-01. Sacramento, CA. 21 pp. + app.

- Marschalek, D.A. 2007. California least tern breeding survey, 2006 season. California Department of Fish and Game, Wildlife Branch, Nongame Wildlife Unit Report, 2007-01. Sacramento, CA. 22 pp. + app.
- Marschalek, D.A. 2008. California least tern breeding survey, 2007 season. California Department of Fish and Game, Wildlife Branch, Nongame Wildlife Unit Report, 2008-01. Sacramento, CA. 24 pp. + app.
- Marschalek, D.A. 2009. California least tern breeding survey, 2008 season. California Department of Fish and Game, Wildlife Branch, Nongame Wildlife Unit Report, 2009-02. Sacramento, CA. 23 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. California Department of Fish and Game, San Diego, CA.
- Riensch, D.L. 2007. California least tern habitat enhancement and nesting in the East Bay Regional Park District, California. Transactions of the Western Section of the Wildlife Society. 43:62-71.

U.S. Fish and Wildlife Service. 1973. Threatened wildlife of the United States. Bureau of Sport Fisheries and Wildlife. Resource Publication 114. U.S. Government Printing Office, Washington, D.C. 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.

Whittier, J.B., D.M. Leslie and R.A. Van Den Bussche. 2006. Genetic variation among subspecies of least tern (*Sterna antillarum*): Implications for conservation. *Waterbirds*. 29(2): 176-184.

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=unkown. Circle Nest Number if new or if status has changed.

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											
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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 (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:
San Luis Obispo/Santa Barbara Counties											
Oceano Dunes SVRA		J Iwanicha	M Przybylski, A Clark, S Little, D Costello, C Lish, J Miller, K Tokatlian, T Carmona, B Wagner, E Krygsman, D Murray, K Duffield, S Murphy, D George.		1 Yes	Yes- 85 T-shape, 91 L-shaped, 73 A-shaped.	No	No	5. The least tern breeding site is open to off-highway vehicular recreation use during the non-breeding season and this prevents or removes most vegetation.	Limited amounts of 1) branches and driftwood put in enclosure, 2) surf-cast wrack placed on shoreline, 3) woodchips spread in enclosure. Seed broadcast or buried and some plants put out to encourage some vegetation for cover. Management for both snowy plo	California Department of Parks and Recreation (Oceano Dunes State Vehicular Recreation Area)
Guadalupe-Mussel Rock		Tom Applegate	none	Symbolic rope	seasonal closure signs on fence	No	No	No	No	None	
Vandenberg AFB	Purissima Pt	D Robinette	J Howar	2- electric	Yes	Yes- 45	No	No	7	None	
Coal Oil Point Reserve											
Ventura County											
Santa Clara River/McGrath State Beach		R Smith	D Glenn		3 Yes	No	No	No	No		
Ormond Beach		R Smith	C Hartley		3 Yes	No	No	No	7		
Hollywood Beach		R Smith			1 Yes	No	No	No	No		
Pt Mugu- Totals		M Ruane	F Ferrara, R Kelley, S Vogel, K Cyran, K Martinez, N Lang								
Holiday Beach	Holiday Beach				4 Yes	Yes- 25	No	No	7		
Holiday Salt Panne	Holiday Salt Panne				4 Yes	No	No	No	7		
Eastern Arm	Eastern Arm				4 Yes	No	No	No	7		
Ormond Beach East	Ormond Beach East				4 Yes	Yes- 50	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:
San Diego County											
MCB Camp Pendleton- Totals		B Foster									
Red Beach		B Foster									
White Beach		B Foster									
Delta Beach		B Foster									
Santa Margarita River - North Beach North		B Foster									
Santa Margarita River - North Beach South		B Foster									
Santa Margarita River - Saltflats		B Foster									
Santa Margarita River - Saltflats Island		B Foster									
Batiquitos Lagoon Ecological Reserve- Totals		S Wolf	L Squires, A Copper, L Hofsteen								
W1	BAT-W1				3 Yes	Yes	No	Yes	Yes		
W2	BAT-W2				3 Yes	Yes	No	Yes	Yes		
E1	BAT-E1				3 Yes	Yes	No	Yes	Yes		
E2	BAT-E2				3 Yes	Yes	No	Yes	Yes		
E3	BAT-E3				4 Yes	Yes	No	Yes	Yes		
San Elijo Lagoon Ecological Reserve		R Patton									
Fairbanks Ranch		E Copper	B Foster								
Mission Bay											
FAA Island		J.Jackson		Island- gated	Yes	Yes-12	Yes- 40	No	4		CDFG
North Fiesta Island		G Johnson			1 Yes	Yes- 60	Yes- 39	Yes	4		San Diego City Parks Dept
Mariner's Point		G Johnson			1 Yes	Yes- 40	Yes- 34	Yes	4	& signs 150' from site between parking lot & site to keep out vehicle traffic	San Diego Audubon Society volunteers, San Diego City Parks Dept
Stony Point		G Johnson			1 Yes	Yes- 40	Yes- 40	Yes	4	Improved grid, permanent buffer fence installed 400' from nesting site fence.	San Diego City Parks Dept
San Diego River Mouth		G Johnson			1 Yes	No	No	No	7	Temporary black plastic mesh fence plus chick fence at bottom	San Diego City Parks Dept

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:
San Diego Bay											
Lindbergh Field & Former Naval Training Center		R Patton									
NI MAT		E Copper									
Delta Beach North		E Copper									
Delta Beach South		E Copper									
NAB Ocean		E Copper									
D Street Fill/Sweetwater Marsh NWR		R Patton									
Chula Vista Wildlife Reserve		R Patton									
South San Diego Bay Unit, SDNWR - Saltworks		R Patton									
Tijuana Estuary NERR		R Patton									
Arizona											
101 Freeway Ponds- Near Glendale Exit		M Herring	T Corman								

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 2009
- 7- None Needed

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:
Sacramento Area								
Bufferlands								
San Francisco Bay Area								
NSMWA-Green Island Unit	1							
NSMWA-Huichica Creek Unit	1							
Montezuma Wetlands	2							
Pittsburg Power Plant	2	1-May-09	7-Jul-09	13	No	No	No	N/A
Alameda Point	1 & 3	12-May-09	11-Aug-09	87	Yes	No	No	N/A
Hayward Regional Shoreline	3	1-Apr-09	19-Aug-09	360	Yes	Yes	No	N/A
Eden Landing	1	11-May-09	15-Jun-09	6	Yes	No	No	N/A
Kings County								
Kettleman City Evaporation Ponds								
San Luis Obispo/Santa Barbara Counties								
Oceano Dunes SVRA	1	1-Mar-09	30-Sep-09	Site received some degree of monitoring on a daily basis.	Yes	No	Yes- chicks	White over blue band on R leg, USFWS aluminum band on L leg- tape in different colors on this band for unique combinations (of one color or bicolor).
Guadalupe-Mussel Rock		1-Mar-09	2-Sep-09	64	No	No	No	N/A
Vandenberg AFB	3	15-Apr-09	10-Aug-09	77	Yes	No	No	N/A
Coal Oil Point Reserve								
Ventura County								
Santa Clara River/McGrath State Beach	1	6-May-09	27-Aug-09	26	Yes	No	No	N/A
Ormond Beach	1				Yes			
Hollywood Beach	1	26-May-09	12-Aug-09	13	Yes	No	No	N/A
Pt Mugu- Totals	1 & 3	30-Apr-09	18-Aug-09	24	Yes	No	No	N/A
Holiday Beach	1	30-Apr-09	17-Aug-09	24	Yes	No	No	N/A
Holiday Salt Panne	1	30-Apr-09	27-Jul-09	18	Yes	No	No	N/A
Eastern Arm	1	30-Apr-09	18-Aug-09	23	Yes	No	No	N/A
Ormond Beach East	3	30-Apr-09	18-Aug-09	24	Yes	No	No	N/A

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:
Los Angeles/Orange Counties								
Venice Beach	1	20-Apr-09	11-Jul-09	14	Yes	No	No	N/A
LA Harbor	1	29-Apr-08	18-Aug-08	50	Yes	No	No	N/A
Seal Beach NWR - Anahiem Bay	1	10-May-09	29-Jul-09	13	Yes	No	Yes	Yellow/black split color band on left leg.
Bolsa Chica Ecological Reserve-Totals	1	12-May-09	25-Jul-09	21	Yes	No	No	N/A
Nest Site 1 (NS1)								
Nest Site 3 (NS3)								
South Tern Island (STI)								
Huntington State Beach	1	12-May-09	24-Jul-09	18	Yes	No	No	N/A
Burris Sand Pit/Buris Basin								
Upper Newport Bay Ecological Reserve								
San Diego County								
MCB Camp Pendleton- Totals	1							
Red Beach	1						Yes	
White Beach	1						Yes	
Delta Beach	1						Yes	
Santa Margarita River - North Beach North	1						Yes	
Santa Margarita River - North Beach South	1						Yes	
Santa Margarita River - Saltflats	1						Yes	
Santa Margarita River - Saltflats Island	1						Yes	
Batiquitos Lagoon Ecological Reserve- Totals	1							
W1	1	26-Feb-09	22-Sep-09		Yes		Yes	White/red.
W2	1	26-Feb-09	29-Sep-09		Yes		Yes	Red/white.
E1	1	26-Feb-09	29-Sep-09		Yes		Yes	Red/white.
E2	1	26-Feb-09	29-Sep-09		Yes		Yes	Red/white.
E3	1	12-Mar-09	29-Sep-09		Yes		Yes	Red/white.
San Elijo Lagoon Ecological Reserve	1							
Fairbanks Ranch	2							

Appendix B-2: Monitoring (continued).

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, Yellow/Green, White/Blue	G/Y, Y/G, W/B
Seal Beach	Yellow/Black	Y/K
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
2005 Captive*	Anodized Red	-
2004 Captive*	Anodized Red	-
2003 Captive*	Anodized Green	-
2002 Captive*	Anodized Blue	-

* "Captive" refers to rehabilitated birds (Project Wildlife) released to the wild (no releases in 2006-2009)

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 in first wave:	Total nests in second wave:	Total pairs:
Sacramento Area							
Bufferlands							1
San Francisco Bay Area							
NSMWA-Green Island Unit							38-48
NSMWA-Huichica Creek Unit							4
Montezuma Wetlands							11-27
Pittsburg Power Plant	N/A	N/A			0	0	0
Alameda Point	28-Apr-09	11-Aug-09	12-May-09	7-Jul-09	290	56	318
Hayward Regional Shoreline	14-Apr-09	19-Aug-09	12-May-09	5-Jul-09	58	22	69
Eden Landing	11-May-09	8-Jun-09	18-May-09	18-May-09	1	0	1
Kings County							
Kettleman City Evaporation Ponds							1
San Luis Obispo/Santa Barbara Counties							
Oceano Dunes SVRA	2-May-09	24-Sep-09	6-Jun-09	21-Jul-09	2	24	14
Guadalupe-Mussel Rock	9-May-09	12-Aug-09	12-Jun-09	16-Jun-09	1	2	3
Vandenberg AFB	11-May-09	8-Aug-09	4-Jun-09	10-Jul-09	31	0	31
Coal Oil Point Reserve							0
Ventura County							
Santa Clara River/McGrath State Beach	6-May-09	20-Aug-09	22-May-09	23-Jul-09	85	0	85
Ormond Beach	6-May-09	9-Aug-09	22-May-09	17-Jun-09	44	0	44
Hollywood Beach	26-May-09	5-Aug-09	1-Jun-09	15-Jun-09	4	0	4
Pt Mugu- Totals	30-Apr-09	18-Aug-09	18-May-09	10-Jul-09	505	123	566.5
Holiday Beach	30-Apr-09	14-Aug-09	18-May-09	24-Jun-09	136	34	153
Holiday Salt Panne	30-Apr-09	14-Aug-09	21-May-09	25-Jun-09	16	10	21
Eastern Arm	30-Apr-09	18-Aug-09	19-May-09	10-Jul-09	17	6	20
Ormond Beach East	30-Apr-09	18-Aug-09	18-May-09	9-Jul-09	336	73	372.5
Los Angeles/Orange Counties							
Venice Beach	20-Apr-09	11-Jul-09	11-May-09	20-Jun-09	295	0	295
LA Harbor	24-Apr-09	13-Aug-09	19-May-09	6-Jul-09	334	101	385
Seal Beach NWR - Anahiem Bay	unknown	unknown	10-May-09	1-Jul-09	159	18	168
Bolsa Chica Ecological Reserve-Totals	14-Apr-09	23-Aug-09	7-May-09	30-Jun-09	254	63	285.5
Nest Site 1 (NS1)							
Nest Site 3 (NS3)							
South Tern Island (STI)							
Huntington State Beach	24-Apr-09	24-Jul-09	12-May-09	30-Jun-09	391	43	412.5
Burris Sand Pit/Buris Basin							12-16
Upper Newport Bay Ecological Reserve							7

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 in first wave:	Total nests in second wave:	Total pairs:
San Diego County							
MCB Camp Pendleton- Totals	21-Apr-09	25-Aug-09	5-May-09	14-Jul-09			1639
Red Beach	28-Apr-09	15-Aug-09	N/A	N/A			0
White Beach	25-Apr-09	13-Aug-09	5-May-09	9-Jul-09			86
Delta Beach	28-Apr-09	14-Jul-09	2-Jun-09	27-Jun-09			12
Santa Margarita River - North Beach North	23-Apr-09	11-Aug-09	5-May-09	11-Jul-09			413
Santa Margarita River - North Beach South	21-Apr-09	25-Aug-09	5-May-09	14-Jul-09			1037
Santa Margarita River - Saltflats	25-Apr-09	25-Jul-09	12-May-09	14-Jul-09			56
Santa Margarita River - Saltflats Island	25-Apr-09	25-Jul-09	9-May-09	28-Jun-09			36
Batiquitos Lagoon Ecological Reserve- Totals	21-Apr-09	22-Aug-09	2-May-09	24-Jun-09	578	71	613.5
W1	21-Apr-09	25-Jul-09	9-May-09	11-Jun-09	28	0	28
W2	21-Apr-09	22-Aug-09	2-May-09	23-Jun-09	366	38	385
E1	23-Apr-09	25-Jul-09	7-May-09	24-Jun-09	178	17	186.5
E2	23-Apr-09	7-Jul-09	N/A	N/A	0	0	0
E3	23-Apr-09	11-Aug-09	19-May-09	23-Jun-09	6	16	14
San Elijo Lagoon Ecological Reserve	27-Apr-09	10-Aug-09	N/A	N/A	0	0	0
Fairbanks Ranch							2-2+
Mission Bay							
FAA Island	1-May-09	15-Jul-09	4-Jun-09	9-Jul-09	11	27	24.5
North Fiesta Island	4-May-09	22-Jul-09	16-May-09	5-Jul-09	29	16	37
Mariner's Point	1-May-09	15-Jul-09	11-May-09	11-Jul-09	6	8	10
Stony Point	6-May-09	16-Jul-09	N/A	N/A	0	0	0
San Diego River Mouth	3-May-09	30-Jul-09	N/A	N/A	0	0	0
San Diego Bay							
Lindbergh Field & Former Naval Training Center	21-Apr-09	11-Aug-09	10-May-09	2-Jul-09			136
NI MAT	22-Apr-09	3-Aug-09	1-May-09	22-Jun-09	119	6	122
Delta Beach North	20-Apr-09	12-Aug-09	4-May-09	8-Jul-09	274	139	343.5
Delta Beach South	17-Apr-09	3-Aug-09	4-May-09	27-Jun-09	178	57	206.5
NAB Ocean	20-Apr-09	17-Aug-09	5-May-09	8-Jul-09	733	360	913
D Street Fill/Sweetwater Marsh NWR	21-Apr-09	28-Jul-09	8-May-09	27-Jun-09			129
Chula Vista Wildlife Reserve	24-Apr-09	4-Aug-09	12-May-09	19-Jul-09			37
South San Diego Bay Unit, SDNWR - Saltworks	22-Apr-09	25-Sep-09	27-Jul-09	27-Jul-09			62
Tijuana Estuary NERR	23-Apr-09	3-Sep-09	7-May-09	23-Jul-09			247
Arizona							
101 Freeway Ponds- Near Glendale Exit							2

Appendix B-4: Productivity, clutch sizes 2009.

Site name:	Number of nests					
	Nest total	Egg total	1 egg clutch	2 egg clutch	3 egg clutch	4 egg clutch
Sacramento Area						
Bufferlands	1	3	0	0	1	0
San Francisco Bay Area						
NSMWA-Green Island Unit	0	0	0	0	0	0
NSMWA-Huichica Creek Unit	0	0	0	0	0	0
Montezuma Wetlands	0	0	0	0	0	0
Pittsburg Power Plant	0	0	0	0	0	0
Alameda Point	346	669	38	290	17	0
Hayward Regional Shoreline	80	160	13	54	13	0
Eden Landing	1	2	0	1	0	0
Kings County						
Kettleman City Evaporation Ponds						
San Luis Obispo/Santa Barbara Counties						
Oceano Dunes SVRA	26	51	1	25	0	0
Guadalupe-Mussel Rock	3	5	1	2	0	0
Vandenberg AFB	31	63	1	28	2	0
Coal Oil Point Reserve	0	0	0	0	0	0
Ventura County						
Santa Clara River/McGrath State Beach	85	136	34	51	0	0
Ormond Beach	44	75	15	27	2	0
Hollywood Beach	4	7	1	3	0	0
Pt Mugu- Totals	628	1081	182	439	7	0
Holiday Beach	170	286	56	112	2	0
Holiday Salt Panne	26	45	7	19	0	0
Eastern Arm	23	37	9	14	0	0
Ormond Beach East	409	713	110	294	5	0
Los Angeles/Orange Counties						
Venice Beach	295	585	unknown	unknown	unknown	unknown
LA Harbor	435	685	185	250	0	0
Seal Beach NWR - Anaheim Bay	178	318	39	138	1	0
Bolsa Chica Ecological Reserve-Totals	317	561	79	232	6	0
Nest Site 1 (NS1)						
Nest Site 3 (NS3)						
South Tern Island (STI)						
Huntington State Beach	434	759	111	321	2	0
Burriss Sand Pit/Burris Basin						
Upper Newport Bay Ecological Reserve						
San Diego County						
MCB Camp Pendleton- Totals	1718	3031	411	1301	6	0
Red Beach	0	0	0	0	0	0
White Beach	86	159	14	71	1	0
Delta Beach	12	23	1	11	0	0
Santa Margarita River - North Beach North	442	814	71	370	1	0
Santa Margarita River - North Beach South	1082	1878	290	788	4	0
Santa Margarita River - Saltflats	59	97	21	38	0	0
Santa Margarita River - Saltflats Island	37	60	14	23	0	0
Batiquitos Lagoon Ecological Reserve- Totals	649	1177	132	505	12	0
W1	28	53	3	25	0	0
W2	404	737	72	330	2	0
E1	195	357	43	142	10	0
E2	0	0	0	0	0	0
E3	22	30	14	8	0	0
San Elijo Lagoon Ecological Reserve	0	0	0	0	0	0
Fairbanks Ranch						

Appendix B-4: Productivity, clutch sizes 2009 (continued).

Site name:	Nest total	Egg total	Number of nests			
			1 egg clutch	2 egg clutch	3 egg clutch	4 egg clutch
Mission Bay						
FAA Island	38	68	8	30	0	0
North Fiesta Island	45	79	13	30	2	0
Mariner's Point	14	20	8	6	0	0
Stony Point	0	0	0	0	0	0
San Diego River Mouth	0	0	0	0	0	0
San Diego Bay						
Lindbergh Field & Former Naval Training Center	145	268	26	116	2	1
NI MAT	125	230	20	105	0	0
Delta Beach North	413	698	129	283	1	0
Delta Beach South	235	395	75	160	0	0
NAB Ocean	1093	1909	279	812	2	0
D Street Fill/Sweetwater Marsh NWR	132	229	35	97	0	0
Chula Vista Wildlife Reserve	48	86	11	36	1	0
South San Diego Bay Unit, SDNWR - Saltworks	78	136	21	56	1	0
Tijuana Estuary NERR	294	490	98	196	0	0
Arizona						
101 Freeway Ponds- Near Glendale Exit						

Appendix B-5: Non Predation Mortality.

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	
Sacramento Area														
Bufferlands														
San Francisco Bay Area														
NSMWA-Green Island Unit														
NSMWA-Huichica Creek Unit														
Montezuma Wetlands														
Pittsburg Power Plant	0	0	0	0		0	0	0	0		0	0	0	
Alameda Point	0	0	69	37	17	0	0	46	30	12	50	4	1	Unknown.
Hayward Regional Shoreline	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	1	0	0	
Eden Landing	0	0	0	0	0	0	0	0	0	0	0	0	0	
Kings County														
Kettleman City Evaporation Ponds														
San Luis Obispo/Santa Barbara Counties														
														Two eggs from one nest were abandoned, unknown if pre- or post-term. Two nests had one egg in the clutch that hatched and the other egg was abandoned (incubated to term). One nest was abandoned, unknown if pre- or post-term. Two nests had one egg in the clutch that hatched and the other egg was abandoned. One juvenile W/G:W/B previously seen flying was seen with an injured right wing at 25 days old. On 11 August it was captured and taken to a rehabilitation facility at 27 days old and it did not survive.
Oceano Dunes SVRA	0	0	4	4	0	0	0	2	3	0	0	1	0	
Guadalupe-Mussel Rock	0	0	0	0	0	0	0	0	0	0	0	0	0	
Vandenberg AFB	0	0	5	1	0	0	0	3	1	0	2	5	0	Likely food shortage at end of breeding season.
Coal Oil Point Reserve														

Appendix B-6: Predation.

Predator Species	Predation		
	Possible	Suspected	Documented
black widow spider	X		
ants (spp.)	X	X	X
snakes (spp.)	X		
Canada goose*	X		
mallard*	X		
great blue heron	X		
great egret	X		
black-crowned night heron	X		
California gull			X
gulls (spp.)	X	X	X
Caspian tern	X		
gull-billed tern	X	X	X
black skimmer	X	X	X
northern harrier	X	X	X
white-tailed kite	X		
Cooper's hawk	X	X	X
red-tailed hawk	X	X	X
osprey	X		
American kestrel	X	X	X
peregrine falcon	X	X	X
black-bellied plover	X		X
barn owl	X	X	
great-horned owl	X	X	X
burrowing owl	X	X	X
owls (spp.)	X	X	X
American crow	X	X	X
common raven	X	X	X
corvids	X		
horned lark		X	
loggerhead shrike	X		
European starling	X	X	
western meadowlark	X		
unknown avian spp.	X	X	X
unknown mammal spp.	X	X	X
opossum	X	X	X
river otter	X		
long-tailed weasel	X		
black-tailed jackrabbit	X	X	X
California ground squirrel	X	X	X
mouse (spp.)		X	X
rats (spp.)	X	X	X
rodents		X	X
domestic dog	X	X	
coyote	X	X	X
red fox	X		X
raccoon	X	X	X
striped skunk	X	X	X
domestic cat	X	X	X

* competition

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
Sacramento Area													
Bufferlands													
San Francisco Bay Area													
NSMWA-Green Island Unit													
NSMWA-Huichica Creek Unit													
Montezuma Wetlands													
Pittsburg Power Plant	BW spider, snake, GBHE, gull, WTKI, NOHA, AMKE, PEFA, BAOW, AMCR, CORA, LOSH, avian, It weasel, otter, GREG, CAGO, MALL								0	0	0	0	0
Alameda Point			RTHA, PEFA, AMCR, CORA	AMCR 0-2D, CORA 0-2D			RTHA 11S 10D, PEFA 1D	PEFA 10D	2		0	22	10
Hayward Regional Shoreline			CAGU, rfox	CAGU 20D, rfox 20D	CAGU 8D, rfox 8D	CAGU 8D, rfox 8D	rfox?	rfox?	40	16	16	unknown	0
Eden Landing			NOHA			NOHA 2D			0	0	2	0	0
Kings County													
Kettleman City Evaporation Ponds													
San Luis Obispo/Santa Barbara Counties													
Oceano Dunes SVRA									0	0	0	0	0
Guadalupe-Mussel Rock			unknown	unknown 1D	unknown 1D				1	1	0	0	0
Vandenberg AFB			PEFA				PEFA 3D	PEFA 2D	0	0	0	3	2
Coal Oil Point Reserve									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
Ventura County													
Santa Clara River/McGrath State Beach			AMCR, mammal	AMCR 7D, mammal 2D	AMCR 4D, mammal 2D				9	6	0	0	0
Ormond Beach									0	0	0	0	0
Hollywood Beach									0	0	0	0	0
Pt Mugu- Totals	avian	HOLA, rodent, mammal	gull, GHOW, gs, coyote, rodent, unknown	gull 3D, avian 4P, mammal 24S, gs 12D, coyote 18D, HOLA 23S, unknown 57D	gull 2D, avian 2P, mammal 14S, gs 7D, coyote 11D, HOLA 15S, unknown 33D	gull 6D		GHOW 1D, avian 2P	140	84	6	0	3
Holiday Beach		HOLA, rodent	gs, rodent, unknown	gs 5D, HOLA 23S, unknown 5D	gs 3D, HOLA 15S, unknown 3D				33	21	0	0	0
Holiday Salt Panne	avian		unknown	unknown 1D	unknown 1D			avian 2P	1	1	0	0	2
Eastern Arm		gull	gull, coyote	gull 2D, coyote 7D	gull 2D, coyote 4D				9	6	0	0	0
Ormond Beach East	avian	mammal, rodent	gull, GHOW, gs, coyote, unknown	avian 4P, mammal 24S, gs 7D, coyote 11D, unknown 51D	avian 2P, mammal 14S, gs 4D, coyote 7D, unknown 29D	gull 6D		GHOW 1D	97	56	6	0	1

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 County													
MCB Camp Pendleton- Totals									500	338	58	24	19
Red Beach									0	0	0	0	0
White Beach									19	13	3	1	3
Delta Beach									6	3	0	0	0
Santa Margarita River - North Beach													
North									37	31	4	8	6
Santa Margarita River - North Beach													
South									379	251	48	15	10
Santa Margarita River - Saltflats									44	26	2	0	0
Santa Margarita River - Saltflats													
Island									15	14	1	0	0
Batiquitos Lagoon Ecological Reserve- Totals									68	42	20	4	23-33
W1			unknown					unknown 2S	0	0	0	0	0-2
W2			ant, BLSK, gull	gull 1S	gull 1S	BLSK 2D	ants 1D		1	1	5	1	0
E1		owl, cat	GHOW, owl, AMCR, CORA, coyote, rac, skunk, unknown	GHOW 2D, owl 8D, AMCR 19D, CORA 2D, coyote 13D, rac 2D, skunk 17D	GHOW 1D, owl 4D, AMCR 13D, CORA 2D, coyote 7D, rac 1D, skunk 10D	skunk 4D, cat 4S, unknown 6D	unknown 3D	GHOW 4D, owl 1S 3D, avian 8-11D	65	40	15	3	21-29
E2									0	0	0	0	0
E3		COHA	BLSK, avian	BLSK 2D	BLSK 1D			COHA 1S, avian 1D	2	1	0	0	2
San Elijo Lagoon Ecological Reserve									0	0	0	0	0
Fairbanks Ranch									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
Mission Bay													
FAA Island		ant, gull, AMKE		ant 2S	ant 2S	gull ?S, AMKE 2S		AMKE ?S					
North Fiesta Island	snake, gull, AMCR, WEME, skunk	GBTE, AMKE, CORA, EUST		snake 0-7P, gull 0-14P, AMCR 0- 14P, CORA 0-14S, WEME 0-6P, skunk 0-7P, EUST 0-6S	snake 0-7P, gull 0-11P, AMCR 0- 11P, CORA 0-11S, skunk 0-7P, EUST 0-5S	GBTE 0-30S, AMKE 0-30S	GBTE ?P, AMKE ?P		0	0	0	0	0
Mariner's Point	gull, AMCR, CORA, rat, rac	op, cat		gull 0-10P, AMCR 0-8P, CORA 0-8P, op 0-8S, rat 0-10P				rac 1P, cat 3S	0	0	0	0	0
Stony Point	GBHE, gull, GBTE, AMCR, CORA, rats								0	0	0	0	0
San Diego River Mouth									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	ant, gull, AMKE, PEFA, AMCR, CORA, op, rat, EUST, COHA	ant, PEFA, CORA, EUST	ant, PEFA	ant 4D, CORA 3S, EUST 3S	ant 2D, CORA 2S, EUST 2S		PEFA 3D	PEFA 2D	11	7	0	3	2
NI MAT		AMKE, PEFA, avian, mouse, unknow n	AMKE, PEFA, avian, mouse, unknow n	avian 1S/D, unknow n 1S/D, mouse 1S/D		AMKE 1S/D	PEFA 1S/D, avian 1S/D	unknow n 3S/D	3		1	2	3
Delta Beach North		gull, GBTE, btj rabbitt, unknow n	gull, GBTE, btj rabbitt, unknow n	gull 1S/D, GBTE 130S/D, btj rabbit 2S/D, unknow n 2S/D		GBTE 81S/D, unknow n 1S/D	unknow n 1S/D	unknow n 2S/D	135		82	1	2
Delta Beach South		GBTE	GBTE	GBTE 49S/D		GBTE 34S/D			49		34		
NAB Ocean		GBTE, avian, btj rabbit, skunk	GBTE, avian, btj rabbit, skunk	GBTE 310S/D, avian 1S/D, btj rabbitt 2S/D, skunk 4S/D		GBTE 169-171S/D			317		169-171		

Appendix B-6: Predation (continued).

Legend:	P: Possible	S: Suspected	D: Documented	S/D: Suspected or Documented	
CAGO: Canada goose		BLSK: Black Skimmer		BAOW: Barn owl	RWBL: Red-winged blackbird
MALL: Mallard		NOHA: Northern harrier		GHOW: Great-horned owl	BRBL: Brewer's blackbird
GBHE: Great blue heron		WTKI: White-tailed kite		BUOW: Burrowing owl	avian: Unknown avian species
GREG: Great Egret		COHA: Cooper's hawk		ROPI: Rock pigeon	op: Opossum
BCNH: Black-crowned night-heron		RTHA: Red-tailed hawk		AMCR: American crow	btj rabbit: Black-tailed jackrabbit
CAGU: California gull		GOEA: Golden eagle		CORA: Common raven	gs: California ground squirrel
WEGU: Western gull		OSPR: Osprey		HOLA: Horned lark	lt weasel: long-tailed weasel
CATE: Caspian tern		AMKE: American kestrel		LOSH: Loggerhead shrike	gfox: Gray fox
ELTE: Elegant tern		PEFA: Peregrine falcon		EUST: European starling	rac: Raccoon
GBTE: Gull-billed tern		BBPL: Black-bellied plover		WEME: Western meadowlark	mammal: Unknown mammal species