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CALIFORNIA LEAST TERN BREEDING SURVEY

1995 SEASON

by

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ABSTRACT

In 1995, a minimum of approximately 2,585-2,611 pairs of the endangered California least tern (Sterna antillarum browni) nested at 37 sites along the coast of California. This 7% decrease in breeding population size from 1994 brings to an end the trend since 1987 of continued growth of the population, and is likely attributable, at least in part, to the poor fledgling production experienced statewide in 1992. In addition to the drop in pair numbers, heavy predation pressure at many sites, an apparent shortage of food at two large sites, and a heavy storm in mid-June across the State, combined with a variety of human-related constraints on tern reproductive success, resulted in the lowest statewide fledgling-to-pair ratio recorded since fledgling production estimates were incorporated into monitoring protocol (1978). A minimum of approximately 963-1,174 fledglings was produced, 41% fewer than in 1994, resulting in a statewide fledgling per pair ratio of 0.37-0.45.

As usual, successful and unsuccessful sites were distributed rather evenly throughout the State. Terns themselves were more unevenly distributed: 50% of the statewide population bred at only five sites (Venice Beach, Santa Margarita River/North Beach, Mission Bay/Mariner's Point and FAA Island, and Tijuana River/South); inclusion of an additional four sites (NAS Alameda, Bolsa Chica, Huntington Beach, and Delta Beach/North) accounted for 73% of all breeding pairs, and the inclusion of two more (Ormond Beach/Edison and Seal Beach) accounted for 81%. The fledglings produced at Santa Margarita River/North Beach, Mission Bay/Mariner's Point, and Delta Beach/North constituted 33% of the State total; the balance were distributed relatively evenly among sites.

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[1] Caffrey, C. 1997. California least tern breeding survey, 1995 season. Calif, Dep. Fish and Game, Wildl. Manage. Div., Bird and Mammal Conservation Program Rep. 97-6, Sacramento, CA. 57 pp.

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INTRODUCTION

The California least tern (Sterna antillarum browni) is a State- and federal-listed endangered species that nests each spring and summer along the coast from the San Francisco Bay area in the north, south into Baja California, Mexico. Annual estimation of least tern breeding population size and monitoring of breeding activities in the State of California began in 1973; estimation of total annual fledgling production was incorporated into monitoring protocol in 1978. Habitat loss due to human development and climatic events (e.g., storms and flooding), other types of human-related disturbance, predation, local food shortages, and adverse environmental conditions, including storms and El Niño, continue to negatively affect tern reproductive success. However, the concerted efforts at identifying, enhancing, protecting, and monitoring least tern breeding areas by state and federal agencies, and the many dedicated individuals working therein, have greatly contributed to the huge increase in breeding population size from approximately 600 pairs in 1973 to approximately 2792 pairs in 1994. These efforts were continued in 1995, and the data are summarized herein.

METHODS

The following criteria are used to distinguish least tern breeding "sites" from "colonies" (used interchangeably prior to 1992): A site is the name of the location of a discrete and contiguous group of nesting birds. A colony is the name of the general location of a breeding area, where colony members may share the same foraging and roosting areas, and the same general nesting areas. If all pairs in the colony nest within a single, contiguous area, then colony name and site are the same. In recent years, terns have expanded nesting ranges within colonies, and particular colonies have come to comprise two or more "islands" of nesting areas, i.e., they now include two or more sites. Separate sites within the same colony appear as indentations under colony location in Table 1, except those under "San Diego Bay"; terns in this cluster of colonies may share foraging areas, yet nesting areas are distinctly separate. (Official names for military sites can be found in Appendix A; throughout this report, they are referred to as in Table 1.)

As part of the Batiquitos Lagoon Enhancement/Restoration Project, two sites historically used but in need of help underwent significant renovation in time for the 1995 season. In the process, Batiquitos Lagoon/Mouth was given the no-frills name W-2, and Batiquitos Lagoon/Park and Ride became E-l; so drastic were the improvements that they are listed as "new" sites in Table 1. Construction on both took place in November 1994: substrate was enhanced, permanent fencing was erected, chick fencing was installed, and signs were posted.

Statewide censuses of known California least tern breeding sites have been conducted since 1973. A network of paid and volunteer monitors check all sites on a regular basis and compile data into final Site Reports. The present report integrates and summarizes data from all least tern breeding sites in the state of California for which information was received for 1995. Further details on methodology (e.g., data collection, fledgling counts, and predator-related issues) are available in the California Department of Fish and Game (CDFG) Least Tern Monitoring Packet (Caffrey 1995a). Additionally, the actual final Site Reports used to prepare this survey are available through CDFG offices in Sacramento. These reports contain many more details regarding site characteristics, site preparation, data collection, predation and disturbance problems and procedures than can be included here; readers interested in such additional information are encouraged to request copies.

For 1995, breeding data were collected at all known Californian sites (except possibly Pt. Mugu); requested data are reported here with the following exceptions: No reports or data were received from Pt. Mugu, thus the site is not included in this report. No reports were received from the monitor for the two Mission Bay sites FAA Island and North Fiesta Island; pair, fledgling, and nest numbers for these sites were estimated by other tern, and Animal Damage Control (ADC), personnel, based on numbers received from the monitor early in the season, and subsequent opportunistic observations. Site preparation information for Mission Bay/FAA Island and North Fiesta Island was provided by the City of San Diego Parks and Recreation Department (the entity responsible for preparation of Mission Bay sites); no other data are available. In addition, data for the two sites Saltflats and Saltflats Island at Santa Margarita River were combined in a single final Site Report, and only limited data are available for San Elijo Lagoon; due to funding constraints and the lack of both tern reproductive success and any beneficial effects of monitor presence in the past (other than allowing the continual reporting of all the problems with that problem-laden site), the monitor visited the site only nine times (all of them voluntarily, out of the goodness of his heart).

Least terns breed along the coast of California from the San Francisco Bay in the north to the southern border. Breeding site characteristics vary from site to site. Nesting sites are located in areas that experience high levels of human activity to little or none. Fences may be permanent, temporary, or nonexistent. Nests may be approached closely enough for monitors to mark them and actually count eggs/chicks directly, or are simply observed from afar. Thus monitoring protocol varies from site to site as well, although at all sites the following information is determined: occupancy status (terns breeding or not), an estimate of total number of breeding pairs present, and an estimate of total number of fledglings produced. Fledgling counts are generally made at nocturnal roosting areas at three-week intervals, and summed for the season (Massey

1989a, Caffrey 1995a). Throughout the season, attempts are also made at identifying the type and outcome of predation or other disturbance.

Given the diversity of site types, two very general monitoring approaches can be described. Type 1 sites are those that have historically been monitored quite closely. Monitors walk through nesting areas regularly, mark nests with numbered tongue depressors, and record data regarding the status of nests. Monitoring of this type throughout the season provides detailed information on the timing of nesting, the number of active nests, clutch size, and hatching success. In contrast, monitor presence within Type 2 sites is kept to a minimum or does not occur at all. Monitors at these sites observe terns from a distance and determine the presence of nests from the location of incubating adults; many types of data are therefore unavailable, e.g., clutch sizes and actual hatching dates. The "site" at Pismo Dunes is unusual enough to rate its own category (Type 3): the whole area is extremely large and no "traditional" nesting site exists; nesting pairs are very difficult to find. Monitors search/observe throughout the season for least terns. (Pismo Dunes is a state vehicular area, and otherwise suitable nesting areas are subject to high levels of vehicular disturbance; park officials cordon off particularly appropriate areas prior to tern arrival in the hope that those will be chosen by nesting terns.) If nests are found outside of protected areas, short-term protection policies go into effect. Individual nests are then monitored regularly. As such, "number of visits" to the site (Table 1) is somewhat meaningless.

Site preparation prior to the arrival of terns also varies from site to site. According to information included in final Site Reports, vegetation was cleared by hand (NAS Alameda, Oakland Airport, Santa Clara River/Mouth, Ormond Beach/Perkins Rd, Venice Beach, Seal Beach, Bolsa Chica, Batiquitos Lagoon/W-l, Mission Bay/Mariner's Point and North Fiesta Island, NAS North Island), mechanically (Seal Beach, Huntington Beach, Mission Bay/Mariner's Point, Naval Training Center, NAS North Island, Delta Beach/North and South, D Street Fill, Chula Vista Wildlife Reserve), or with the use of herbicides (PGE Pittsburg, NAS Alameda, Mission Bay/Mariner's Point). Accumulated litter or storm debris was removed (Santa Clara River/Mouth, Venice Beach), and water level control was attempted at San Elijo Lagoon. Sand was cleared away from fencing to expose the chick fence at Venice Beach, added to the site as substrate at NAS North Island, and pushed into berms to restrict human access at Tijuana River/South. Permanent fencing at sites was modified or repaired (NAS Alameda, VAFB Purisima Point, Santa Clara River/Mouth, Venice Beach, White Beach and Santa Margarita River/North Beach (both at MCB Camp Pendleton), Mission Bay/Mariner's Point, Naval Training Center, Tijuana River/North and South), temporary site fencing was erected (Ormond Beach/Edison, Terminal Island), and chick fencing was repaired and/or erected (Mission Bay/Mariner's Point, Lindbergh Field). Chick shelters were

laid out (Terminal Island, Huntington Beach, Batiquitos Lagoon/all 3 sites), and monitoring grids were set up (Huntington Beach, White Beach, Santa Margarita River/North Beach and Salt Flats, Batiquitos Lagoon/all 3 sites, Mission Bay/Mariner's Point and North Fiesta Island, D Street Fill); at Venice Beach, clay roofing tiles were laid out to serve as both. Signs were posted at Mussel Rock Dunes, Terminal Island, Santa Margarita River/North Beach, San Elijo Lagoon, Mission Bay/North Fiesta Island, Naval Training Center, NAB Ocean, D Street Fill, Chula Vista Wildlife Reserve,and Tijuana River/North and South. Decoys were laid out to attract terns to particular areas at VAFB/Beach 2 and Purisima Point, Batiquitos Lagoon/all 3 sites, Mission Bay/Mariner's Point and North Fiesta Island, Naval Training Center, NAS North Island, D Street Fill, and Chula Vista Wildlife Reserve. Crow carcasses were placed inside the perimeter fence at VAFB/Purisima Point, Venice Beach, and Huntington Beach to deter crows from entering the site.

Site preparation also included predator removal at several sites. All military sites have permanent ADC personnel who trap and relocate, or exterminate, a majority of actual or potential predators from least tern nesting areas prior to and throughout the breeding season. ADC was also on site at all Batiquitos Lagoon and Mission Bay sites prior to tern arrival. Pre-season predator removal occurred at Oakland Airport, Terminal Island, and Huntington Beach as well.

The following distinction is made between documented and suspected predator species: a documented predator is one actually observed taking a least tern egg, chick, fledgling, or adult, or one indicated according to the following criteria: (1) identifiable tracks led to least tern remains or an empty nest where eggs were not expected to hatch for at least three more days, (2) if expected hatching date was unknown, tracks led to more than one empty nest, and (3) any evidence left had to be consistent with that expected from the indicated predator. Suspected predators are animals believed to have preyed on terns or eggs, based on substantial but not conclusive evidence (e.g., tracks throughout the site, tern remains characteristic of a particular predator, or predators observed foraging at the site).

In this report, unless otherwise cited, data for the following years were taken from the indicated sources: 1987 and 1988 (Massey 1988), 1989 (Massey 1989b), 1990 (Obst and Johnston 1992), 1991 (Johnston and Obst 1992), 1992 (Caffrey 1993), 1993 (Caffrey 1994), and 1994 (Caffrey 1995b).

RESULTS

Distribution - In 1995, California least terns were reported to have nested at 37 sites from the San Francisco Bay area south to the Mexican border (Table 1). Terns returned to Oakland Airport after a hiatus of two years, and to Tijuana River/North after one. Two new sites were added to our list in 1995: Batiquitos Lagoon/W-2 and E-I (the new names for the renovated and significantly improved sites Batiquitos Lagoon/Mouth and Park and Ride, respectively).

Of historical sites not used by breeding terns in 1995, several have been tern-less for at least five years but are still checked at the beginning of the season for tern activity ("unused1" in Table 1). For others, although they remain on our "wish" list, the combination of an abundance of predators and/or humans in the area, vegetation overgrowth, and the lack of financial resources and effort on the part of agencies with the power to enhance, and enforce the protection of, these areas has led to their being pretty much ignored by the financially-strapped Monitoring Program ("unused3" in Table 1). Others ("unused2") were sites at which nesting had occurred within the last five years, yet for one reason or another (usually one or more of those mentioned above) went unused in 1995.

Breeding Chronology - First-wave breeders began arriving at breeding areas from mid- to late April through mid-May; nesting began 1-3 weeks later at many sites, but was delayed for up to a month at a few sites in San Diego (Table 2). Most sites had eggs in nests by mid- to late May, chicks by early to mid-June, and fledglings by late June to early July. Definitive second wave nesting was reported to have occurred at 16 sites; at four sites the second wave was said to be minor, and no second wave was evident at 15 sites. Three sites apparently had primarily second wave nesters (Santa Clara River/Mcgrath Lake, Ormond Beach/Edison, and San Elijo Lagoon). Terns began departing some breeding areas in early July but most sites still had terns through early to mid-August, while at a few, terns were still present in early September.

In an attempt to discern the pattern of nesting across the State, I mistakenly asked monitors (on final Site Report forms) to report the number of active nests ("active" defined as a scrape with eggs or chicks, attended by adult terns, Caffrey 1995a) at each site on each Saturday (±l day) throughout the season. Realizing I should have requested the number of **new** nests each Saturday, I called monitors throughout the State (albeit once the season was already underway) to inform them of the change. Data from only 23 of 37 sites were usable, or available; even so, emergent patterns were so interesting that I include the raw data

(Appendix B). Figure 1 depicts statewide data pooled as well as separated into the three "clusters" (north, central, south). Nesting began in earnest earliest at sites in Los Angeles and Orange counties. Venice Beach had 86% of all nests for the week ending May 13 (102/117), with Seal Beach and Bolsa Chica accounting for most of the rest (PGE Pittsburg had one). Although nesting began at several other sites within the following week, at many sites in the State, especially those in San Diego County, nesting did not really get underway until two weeks later. Figure 2 depicts some of the diversity in the timing of nesting at three sites; in Figure 3, differences in "first" and "second wave" patterns are clear.

First Wave - Although statewide the number of first wave pairs was similar to that of 1994, dramatic increases and decreases, relative to 1994, occurred at several sites (Table 3); at a few, this translated into a substantial number of birds (e.g., increases: Mission Bay/Mariner's Point, Tijuana River/South; decreases: Huntington Beach).

Season Totals - Excluding data from Pt. Mugu, approximately 2585-2611 pairs of California least terns nested statewide in 1995 (Table 4). Relative to 1994, some sites experienced dramatic increases in the total number of nesting pairs present; at others, dramatic decreases (Table 4). As the 1995 statewide population size was only slightly smaller than that in 1994 (93%), many of the increases and decreases reflect simply the shuffling around from one site to another (e.g., the total number of pairs at sites at Batiquitos Lagoon, Mission Bay, and NAB Coronado (Delta Beach/North and South, and NAB Ocean) remained approximately the same), although overall breeding population size north of San Diego County (83% of 1994 numbers) declined more than that of the State as a whole. The drastic increase in the number of pairs at Ormond Beach/Edison was at least in part due to the erection of a barrier, on July 1, denying Off-Highway Vehicles (OHVs) beach access (it was destroyed on July 18); 61 of the 93 nests (based on the information in Appendix A) were initiated between those two dates. For Mission Bay/Mariner's Point, the reconfiguration of the west side of the site (the obliteration of the "beach" (the steep slope down to the water and the accessible shoreline) and the addition of riprap, creating a larger site), plus ADC's keeping the local rat population (a serious problem in 1994) under control likely contributed to the large increase in pairs at that site. For Tijuana River/South, the increase was thought to be due to the significant decrease in human disturbance through the construction of sand berms and the closing of beach sections to the public, but more importantly through the Border Patrol's stepped-up "Operation Gatekeeper" minimizing the disturbance caused by illegal migrants, particularly at night.

In 1995, 50% of the statewide population bred at only five sites (Venice Beach, Santa Margarita River/North Beach, Mission

Bay/Mariner's Point and FAA Island, Tijuana River/South). The addition of four sites (NAS Alameda, Bolsa Chica, Huntington Beach, Delta Beach/North) accounts for 73% of the breeding population of California least terns, and two more (Ormond Beach/Edison, Seal Beach) 81%.

Approximately 963-1174 fledglings, again excluding any from Pt. Mugu, were produced in 1995, resulting in a statewide fledgling-to-pair ratio of 0.37-0.45 (this may be a slight underestimate, as the roost at Upper Newport Bay (0 fledglings) may not have been located by the monitor). Many sites experienced declines in their F/Ps from 1994, some pretty dramatic (e.g., NAS Alameda, Venice Beach, Seal Beach, Santa Margarita River/North Beach and Saltflats\Saltflats Island). Impressive increases in F/Ps occurred only at Lindbergh Field and Delta Beach/South, the latter having only one pair. The fledglings produced at Santa Margarita River/North Beach, Mission Bay/Mariner's Point, and Delta Beach/North constituted 33% of the State total; the balance were distributed relatively evenly among sites.

Clutch Size - Clutch size at Type 1 sites ranged from 1 to 4 (Table 5), with a statewide $\overline{X}$ = 1.71 (n=2597 nests). Hatching success at Type 1 sites ranged from 37-100%, with a mean of approximately 76.5% (n=20 sites, omitting Bolsa Chica and D Street Fill).

Sources of Breeding Failure - Predation was the major cause of breeding failure at most sites in 1995 (Table 6); documented and suspected predators included by-now-familiar species. Monitors at NAS Alameda, Oakland Airport, Seal Beach, Mission Bay/Mariner's Point, NAS North Island, D Street Fill, and Tijuana River/South all indicated predation as having a major impact on productivity at their sites. NAS Alameda was hit hard by several predators (Table 6), including a pair of red-tailed hawks thought responsible for taking 99 of the 176 chicks hatched by June 20. An owl began visiting the site in mid-July, causing not only direct mortality but disturbance such that many nests were abandoned. At Oakland Airport (Type 2 site), no predation was documented but all eggs disappeared from the 1-6 nests, and ravens, crows, northern harriers, cats, kestrels, opossums, raccoons, and striped skunks were all seen on site, in addition to the ubiquitous red foxes (the total of 46 individual mammals trapped, including 20 red foxes, put a mere dent in the pressure). At Seal Beach, intense predation by loggerhead shrikes, crows, and probably kestrels (seen foraging on site) resulted in its worst year since 1979 (its inaugural year, F/P=0/6). At Mission Bay/Mariner's Point, a kestrel took approximately 30 chicks before it was removed; at one point it was found with three chicks in its talons. Predation was also believed to underlie the majority of losses at Mussel Rock Dunes, VAFB/Purisima Point, Terminal Island, Saltworks, and Tijuana River/North. (No mortality data other than the necropsy results for two individuals (see below) were provided for the sites at Camp Pendleton, and no information regarding the severity of predation

was provided for Naval Training Center, Delta Beach/North or South, or NAB Ocean.)

A shortage of food resulted in the lowest fledgling-to-pair ratio at Venice Beach ever. The season started out dismally and never let up. The first chicks hatched on May 26. On May 29, two chicks looked in bad shape. By May 30, two were dead and two more dying. By June 2, 18 were dead, by June 3 there were 26, and June 7 45. We picked up between two and 18 chick carcasses almost every day, for a total of 281 by July 17, at which point no more were left alive and all unhatched eggs had been abandoned (n=72). One chick was found dead with a 4 1/2" fish halfway down its throat; that plus chicks being left untended for long periods of time, the fact that the majority of chicks were dying when only days old, observations of intense kleptoparasitism when adults **did** return with fish, and the preponderance of large and odd fish found dead on site (a list of several I had identified is included as Appendix C) indicated small fish were hard to come by locally. Necropsy results for three chicks brought to the Chief of Veterinary Services, Orange County, indicated all findings were consistent with a diagnosis of emaciation/starvation; no evidence of trauma or infectious disease was found.

Although not as clear-cut, the monitors at both Bolsa Chica and Upper Newport Bay reported the following observations as suggestive of possible resource limitation: at Bolsa Chica, 42% of nests were one-egg clutches, and several dead adults were found with no external evidence as to cause of death. Additionally, 81 chick carcasses were picked up, however, a majority of these were found in the days following a heavy storm (see below), complicating the speculating regarding cause of death. At Upper Newport Bay, there was no evidence of predation (as the cause for the apparent lack of success), and eggs were often seen untended at all times of the day, including evening hours, suggesting possibly that adults were having a difficult time finding food.

At NAS Alameda too, evidence suggested that a local shortage of food may have contributed to the poor success experienced at that site. Sixty-nine to 74 chick and fledgling carcasses were observed, the majority consisting of small, downy chicks. Although some of these deaths were probably the direct result of hypothermia, that chicks (and eggs as well) were left untended for long periods of time likely made them more susceptible to the cold temperatures. (Chicks and eggs were left untended in both mild and inclement weather, usually the times of good foraging (so parents not gone for long) and required parental attention, respectively.) One chick that was watched for eight hours one day was not fed at all. On June 21, from 0530 to 1700, only two fish (total) were delivered to all of the chicks present on site. Parents would often return with no fish, or fish too big for their chicks; these were quickly pirated by fledglings and other, larger chicks. One fledgling that had been attempting to pirate fish picked up a small, torpid chick,

and appeared to try to swallow it. It walked around a bit, stopping periodically to reposition the chick, refused to let go when approached and contacted by the chick's parent, then flew off with it still in its bill and subsequently dropped it.

Adverse weather took its toll this year, particularly a major storm with very heavy rain occurring in mid-June. The rains hit on the 14th and 15th in Los Angeles and Orange counties; on the 16th, 42 chicks were found dead at Venice Beach, and on the 17th, 57 at Bolsa Chica. Monitors at Seal Beach, Terminal Island, and Upper Newport Bay also reported losses as the result of this storm. The same storm (?) hit more northerly sites on the 15th and 16th; many chicks died during those and the following days at NAS Alameda (the effects of the inclement weather being exacerbated by intense predation pressure coming from red-tailed hawks, possibly causing chicks to become separated from parents), and several nests were lost at Mussel Rock Dunes. Any first wave attempts at San Elijo Lagoon were likely lost to this storm as well. High winds took one nest at Pismo Dunes and were probably the cause of the egg abandonments (found at the end of the season) at VAFB/Purisima Point, and several nests were lost to high tides at Tijuana River/South.

Humans continue to directly cause tern mortality (Table 6). Pedestrians crushed eggs at Tijuana River/South, and a dog gained access to the site at Santa Clara River/Mouth through the vandalized fence (either alone or with the vandal; human footprints were also found inside) and took one nest. Fledglings were killed by aircraft at both NAS Alameda and NAS North Island.

Less clear-cut were the reasons underlying the abandoned eggs and carcasses found at many sites. At Huntington Beach 115 eggs (48% of the total) were left on site, and at Mission Bay/Mariner's Point, 44 eggs and 65 chick carcasses were found. Smaller numbers of chick and fledgling carcasses were found at Terminal Island, NAS North Island, and D Street Fill, and several nests were abandoned at Santa Clara River/Mouth and Ormond Beach/Perkins Rd and Edison. At Tijuana River/South, debilitated and dying chicks were observed, and 22 chick and 6 adult carcasses were picked up. Monitors at a couple of sites suspected disease may have played a part in the deaths they observed, and necropsy results for some San Diego sites indicated that may, in fact, have been the case in some cases. At Delta Beach/North, the bacterial pathogens *Vibrio parahaemolyticus*, *V. cholera*, and *V. alginolticus* were found in three different individuals (of five examined). Avian salmonellosis was found in one individual (of one) from NAS North Island; *V. cholera*, *Escherichia coli*, and *Streptococcus* in two individuals (of three) from Mission Bay/Mariner's Point; and *V. cholera* and *V. parahaemolyticus* in two individuals (of two) from Camp Pendleton.

Sources of Disturbance - Sources of site disturbance (Table 7) were believed to either underlie the abandonment of nests, or to

otherwise contribute directly or indirectly to egg or chick mortality, although unequivocal evidence of the connection was lacking. Because the presence of all tern predators causes disturbance and may cause abandonment, all potential predators observed by monitors in tern nesting areas should be listed here. However, for the sake of unclutteredness, species known or suspected to have preyed on terns (so listed in Table 6) are not included in Table 7.

Disturbance resulting from human intrusion continues to ill-affect terns. Pedestrians and/or their pets cause disturbance/flushing, if not direct mortality. OHV riders drive through nesting areas. Monitors reported many other types of human-generated problems, including low-flying helicopter disturbance (Terminal Island), boaters releasing a dog onto the site (Terminal Island), fences being damaged or destroyed (Santa Clara River/Mouth, Ormond Beach/Edison), people entering the site with a wheeled cart and via a hot air balloon (San Elijo Lagoon), and equestrians who wouldn't take "no" for an answer (Tijuana River/South). Construction activities, jetblast from nearby planes, a broken floodgate, military training exercises, July 4th festivities, illegal migrant traffic, and even monitor presence were all reported to cause disturbance to nesting terns in 1995. All of the above notwithstanding, the two boys intentionally throwing rocks at terns at Huntington Beach speaks to the inexcusable side of our relationship with these birds.

DISCUSSION

The steep yearly increase in the statewide number of California least terns that had been the predominant pattern of the recent past came to a halt in 1995 (Figure 4); the estimate of 2598 pairs (excluding any at Pt. Mugu) is approximately seven percent fewer than the number of breeding pairs in the State of California in 1994. Not only were pair numbers down, but despite the efforts of people working on behalf of terns to enhance and protect breeding areas, intense predation, food shortages, bad weather, and a variety of human-related constraints on tern reproductive success across the State resulted in the lowest fledgling-to-pair ratio recorded since 1978 (the year fledgling production estimation became incorporated into monitoring protocol). Approximately 1069 fledglings (midpoint of range) were added to the population in 1995 (again, excluding those, if any, from Pt. Mugu); 41% lower than the number of fledglings produced in 1994.

The number of sites used by nesting terns throughout the State fluctuates from year to year, as potential nesting areas become either suitable, available, or more attractive (naturally or through site preparation efforts), or unsuitable or unavailable, as a function of human, predator, or other environmental disturbance.

The increase to 37 active sites in 1995 from 36 in 1994 reflects the return of terns to previously used, but recently unoccupied sites (Oakland Airport, Tijuana River/North), and the reclaiming of two much-improved "new" sites (Batiquitos Lagoon/W-2 and E-l). Although the site name "Park and Ride" (my personal favorite) will be missed, E-1 is already off to a better (and very successful) start than ever in Batiquitos Lagoon/Park and Ride's history. That terns returned to Oakland Airport, nesting in the face(s) of the indomitable red foxes, and not only earlier than at NAS Alameda but earlier than ever before at Oakland Airport, may have presaged the disaster that was about to befall NAS Alameda (see Results/Sources of Breeding Failure). Three sites used in 1994 went unused in 1995 (VAFB/Beach 2, Ormond Beach/Middle Site, Chula Vista Wildlife Reserve). At Chula Vista Wildlife Reserve, terns were on site in late April but no nesting occurred. When ADC began trapping on 6/13, they caught five grey foxes, six skunks, and eight squirrels within two weeks; no wonder terns went elsewhere. At VAFB/Beach 2, a single pair of terns arrived and made at least one scrape before departing for reasons unknown.

Statewide chronological data are puzzling, to say the least. Why nesting begins up to weeks earlier at sites north of San Diego County than at those in the southern part of the State is mysterious enough (this pattern was first observed in 1994 (Caffrey 1995b), the first year these data were requested); why terns begin nesting earlier at Venice than anywhere else (also observed in 1994), particularly in light of the devastating shortage of food experienced at that site (evident in 1994 as well (Caffrey 1995b), yet much less severe than in 1995) is truly baffling.

One of the long-standing tenets of least tern breeding biology is the existence of a "second wave" of nesting (occurring later in the season than the earlier "first wave"), composed primarily of 2-year-olds nesting for their first time. Although ensconced as if the pattern of a first-wave (early) influx of terns, followed by a lull (in days-weeks) in nest initiation and then a second influx of breeders was typical, in recent years, this scenario has come to be questioned at pre- and post-season meetings (e.g., many monitors describe the number of new nests per day after the initial peak as trailing off over an extended period, or there being no real "lull" but then a second, smaller, peak, rather than adhering to the pattern described above; "not really" or "minor" second waves: Caffrey 1993, 1994, 1995b, this report). The single published study addressing the differences between early and late nesters (Massey and Atwood 1981) involved primarily one site in one year and 15 banded individuals of known age. Massey and Atwood observed a clear-cut first versus second wave of nesting, with approximately two weeks of no new nests between the two. One hundred percent of marked 2-year-olds nested in the second wave (n=12), accounting for 10 of 33 second wave nests. Three marked 3-year-olds, renesting after failed first attempts, were also part of the second wave (accounting for 2 nests). No banded 2-year-olds nested at that site

in the first wave of that study year. Pooling observations of marked breeders across the State from 1976-1980, Massey and Atwood (1981) reported two 2-year-olds nesting in the first wave, accounting for only 5% of marked first-wave breeders (n=41), and 16, or 76% (n=21) of marked second-wave breeders. This suggested that 2-year-olds breeding for their first time tend to nest later enough in the season than older, more experienced individuals that they can be distinguished. A look at the data in Appendix B and in Figures 2 and 3 makes clear that this first wave/second wave scenario indeed exists, but is only one of a whole range of nesting patterns exhibited by California least terns.

Throughout the State, most sites experienced a decrease in the number of breeding pairs present, with a few notable exceptions: Ormond Beach/Edison with (finally, albeit it only temporarily) an OHV-excluding barricade, Mission Bay/Mariner's Point (see Results/ Season Totals), Lindbergh Field, NAB Ocean, D Street Fill, and Tijuana River/South (see Results/Season Totals). The increase in numbers at NAB Ocean was particularly sweet in this otherwise pretty dismal year. A lone pair first nested at NAB Ocean (unenticed) in 1994; the jump to 22 pairs, on land protected by the Navy, with a F/P=0.77 for a season apparently without intense predator management (in San Diego, where most sites are almost always hit hard by predation, and intense predator management often underlies **any** success) gives hope to us all.

The decrease in overall breeding population size can at least in part be attributed to the poor fledgling production experienced statewide in 1992, as the result of predation and El Nido-related food shortages (Caffrey 1993b). Until recently, many of us were under the impression that most least terns breed for their first time at two years old. This impression likely stemmed from the the article discussed above (Massey and Atwood 1981), documenting breeding two-year-olds, and was then perpetuated (e.g., Fancher 1992) due to the lack of any additional, available information. It is now known that for the majority of individual least terns, the age at first breeding is three (B. Massey, pers. comm.). These three-year-olds apparently tend to nest in the latter half of the first wave; the second wave thus comprises those anomalously precocious terns breeding for the first time at two, as well as renesters from the first wave. At any rate, that most terns do not breed until three years old at first glance explains both (1) the steep increase in the number of breeding pairs in 1994 over 1993 (the source of some perplexity; Caffrey 1995b) - 1991 was a banner year (1830 pairs, F/P=0.98) - and (2) the drop in population size in 1995 from 1994. Not only was 1992 a relatively unsuccessful year (2106 pairs, F/P=0.54), but the presumably weakened state of at least some individuals that fledged, as the result of limited food availability, may have led to greater subsequent mortality than in non-food-limited years. However, closer inspection of the 1995 data reveals that the first wave numbers (supposedly including the three-year-olds breeding for their first time) are similar to the

first wave numbers for 1994 (even slightly higher); it is in the second wave that the decline is manifested. Huh? (Statewide F/P for 1993 = 0.87; a good year.) Yet another odd aspect of the decrease in statewide population size has to do with the geographical bias (north of San Diego County, 1995 population size was 83% of that in 1994; in San Diego County, 98%). Preceding under the assumption that the decrease must somehow be related to the poor fledgling production in 1992, in that year, sites in San Diego county were hit hardest by food shortages, and predation, and had lower fledgling-to-pair ratios, on average, than sites north of San Diego county (north of SD County, mean F/P=0.85 (n=16); SD County, mean F/P=0.46 (n=20)). Data collected from the three sites at Santa Margarita River (MCB Camp Pendleton; Table 1) over several years indicate that at least approximately 50% of terns return to their natal site to breed for their first time (K. Keane, pers. comm.). Thus, all else being equal, one would expect the decrease in pair numbers in 1995 to have been felt more strongly in the southern part of the State. Not knowing how to interpret this, either, let me just acknowledge my love/hate relationship with these seemingly endless conundrums...

Speaking of conundrums, mean clutch size for Type 1 sites throughout the state (1.71) was considerably lower than in any of at least the last seven years, including 1992 (the most recent El Niño year): 1988 $\bar{X}$=1.93, 1989 $\bar{X}$=1.84, 1990 $\bar{X}$=1.94, 1991 $\bar{X}$=2.0, 1992 $\bar{X}$=1.87, 1993 $\bar{X}$=1.91, 1994 $\bar{X}$=1.87 (overall mean for those seven years =1.91). The low average clutch size across the State was strongly influenced by two large sites experiencing extreme breeding failure in 1995, one clearly related to a food shortage (Venice Beach), and the other weirdly unexplained (Huntington Beach). Yet even without these two sites, statewide mean clutch size was still low: 1.79.

Predation continues to be the major factor constraining the fledging of terns across California. Monitors from the northernmost to the southernmost sites in the State reported predation as having a significant effect on tern reproductive success; at many other sites, predation was the primary source of breeding failure, yet the losses were not as excessive. At only nine sites (of those for which data were received) did monitors **not** list predation as impacting fledgling production: Santa Clara River/Mouth, Ormond Beach/Perkins Rd, Venice Beach, Bolsa Chica, Upper Newport Bay, all three sites at Batiquitos Lagoon, and Lindbergh Field. At Seal Beach (heavily hit by predation), members of 16 predator species were observed on 16 of 16 site visits (prior to terns abandoning the site), often 3 different species per visit; terns abandoned the site in early July. That virtually every predator species known to take terns was listed as present at San Elijo Lagoon, NAS North Island, Naval Training Center, Delta Beach/North and South, NAB Ocean, Saltworks, and Tijuana River/South is testament to the relentless pressure felt at many sites in San Diego county. At NAS North Island, except for a 5-day respite in late May, avian

predators were present almost daily. On one occasion, five peregrine falcons were observed simultaneously, and by late July, new burrowing owl tracks were sighted every other day. The lack of relevant data from all other military sites in San Diego county precludes any examination of the effects of predation at those sites.

"Food shortage" has been the other major statewide factor limiting tern reproductive success, yet until recently, the effects of limited prey availability have generally only been demonstrable in El Niño years, when the associated losses are relatively obvious, and widespread. However, the local "food problem" that first made an appearance at Venice Beach late in the season in 1994 was back in 1995 (or never left), this time resulting in the lowest fledgling-to-pair ratio ever recorded at that usually very productive site, and one of the lowest in the State. Similarly, strong circumstantial evidence indicated that a local food shortage contributed to the lowest fledgling-to-pair ratio in NAS Alameda's very successful recent past (since 1985). Whether or not food was actually scarce at Bolsa Chica and Upper Newport Bay, or Huntington Beach (my supposition: mean clutch sizes for the "clustered" Venice Beach, Bolsa Chica, and Huntington Beach (Table 5) were the lowest in the State), "food shortage" on a local level has now become a serious factor limiting tern breeding success.

Humans, too, remain a major constraint on tern breeding success. Foot, vehicular, and pet traffic in and around nesting areas cause the loss of eggs and chicks directly through trampling or predation, and indirectly through disturbance, resulting in nest or site abandonment, or exacerbation of predation pressure. Military exercises and the unavoidable disturbance associated with monitoring efforts notwithstanding, people and their pets, OHVs, helicopters, fireworks, carts, hot air balloons, belligerent attitudes, and their penchants for juvenile behavior and ignoring unenforced wildlife protection signs, continue to negatively impact the reproductive success of California least terns.

In addition to predation, food shortages, and human-related factors, bad weather played a part in the breeding failure experienced by terns in 1995: heavy rain in mid-June from Upper Newport Bay to NAS Alameda contributed to, or caused, many chick deaths and the loss of uncounted nests. And then there were those "unknowns:" the unprecedented disaster at Huntington Beach, devoid of any clues as to its cause; the die-off at Mission Bay/Mariner's Point; the to-some-extent-unexplained dismal totals at many other San Diego sites, with "disease" looming as a possible culprit, yet also possibly being only incidental to something more profound. At any rate, the statewide fledgling-to-pair ratio of 0.37-0.45 is the lowest ever recorded since this index of success has been available (1978), and to some extent reflects the poor to miserable fledgling production at several large sites (in terms of pair numbers) that are usually reliable contributers of large numbers of fledglings to

the statewide population: NAS Alameda, Venice Beach, Seal Beach, and Santa Margarita River/North Beach (the last for which the lack of mortality data precludes attribution of the cause of failure). As such, for 1995, predation, local food shortages, and adverse weather were the major factors underlying the low fledging success experienced across the State by California least terns.

Ending on a positive note, there were a couple of bright spots in this grimmest of years. VAFB/Purisima Point, Terminal Island, and Saltworks all had notably reasonably good years (for Terminal Island, the change in location of the site to south of the previous location apparently reduced the local foraging opportunities for both crows and kestrels, and gave the terns a bit of a break). At Bolsa Chica, even though fledgling production was as bad as usual, Caspian tern invasion of the island was not a factor this year (they arrived but then departed). Despite predation pressure (and thanks to ADC), D Street Fill had its best year in years, and Lindbergh Field (through pure luck regarding the lack of predators) set its all-time high for fledgling production. And at Ormond Beach/Perkins Rd and Edison, long beset by human disturbance, the monitor noted in his final Site Report that for the first time ever at these sites there were "...no catastrophes of 4WD vehicles, fireworks/4th of July revelry, or [other unfortunate consequences of human naivete]." Yippee.

RECOMMENDATIONS

Funding - Underlying many of the limits on tern reproductive success is the lack of funds available for site preparation, site maintenance, site enhancement, monitoring, and predator control. Sites throughout the State need new fencing, fencing repair, vegetation control, lagoon water level control, educational signs, predator control, and above all, monitor presence, as it is monitors who are familiar with tern breeding requirements as well as the particulars and weaknesses of individual sites. Sources of funding must be found not only for site enhancement and the establishment of new sites, but also to simply maintain the status quo (e.g., the site at Venice Beach continues to deteriorate). Sources of funding for predator management would also help to alleviate some of the intense predation pressure at CDFG sites without access to ADC. And again, funding for adequate monitor presence must be secured.

Nesting Sites - Enhancement of well-established, incipient, and potential sites remains a priority. Human-related threats to terns are ostensibly mollifiable; educating the public is one solution. Efforts to educate the public at Mussel Rock Dunes, including signs depicting nesting terns along with educational information, in both English and Spanish, plus information dispensed at the kiosk upon entering the preserve, **and** the exclusion of dogs during the tern

breeding season, have all greatly reduced the number of nests lost to human-related disturbance. Enclosing nesting areas within fencing so as to exclude humans, in addition to educating the public, might be the best we could do under current civilization-related conditions, yet is not always possible in practice. With an eye toward approaching that ideal, however, fencing repair or better fencing, better enforcement, and/or bilingual signs are badly needed at Ormond Beach, Venice Beach, San Elijo Lagoon, and Tijuana River. A fox-proof fence is still badly needed at Oakland Airport, and chicken wire along the base of the gate at Chula Vista Wildlife Reserve might help to exclude mammals from tern nesting areas. In addition, some new kind of chick enclosure is needed at Lindbergh Field (the fencing is blown down every day).

The creation of new sites would help to buffer the potentially devastating effects, on a local level, of predation, limited food availability, and human disturbance. Individual sites are often either successful or not regarding fledgling production, and a single predator can be enough to tip the balance toward the latter. In 1995, the breeding failure experienced at several large sites strongly influenced statewide fledgling production; for both NAS Alameda and Venice Beach, there are no nearby alternatives. This points to the vulnerability of the species' recovery to local threats, and begs the establishment of new sites.

Because terns seek flat, open, sandy areas with little vegetation as nesting sites, overgrown vegetation can constrain, or even prohibit, breeding at otherwise suitable sites. Oakland Airport, Venice Beach, Seal Beach, Bolsa Chica, Upper Newport Bay, D Street Fill, and Chula Vista Wildlife Reserve are becoming overgrown and could use some help clearing vegetation as part of site preparation. Clearing all vegetation in a buffer zone around nesting areas decreases the attractiveness to predators, and is strongly recommended in appropriate situations. Adding some sand to the known nesting levees at Saltworks would increase the available substrate, and (I say this every year) we are losing control of beleaguered San Elijo Lagoon; getting a handle on the lagoon water level, people-related problems, and especially predation is absolutely required in order to maintain this area as a California least tern nesting site.

In the past, terns have returned to breed in areas unused for variable periods of time (e.g., Mission Bay/North Fiesta Island in 1992, Santa Clara River, Terminal Island, Batiquitos Lagoon/Park and Ride, and Naval Training Center in 1993, Guadalupe Dunes and Lindbergh Field in 1994), and 1995 saw the return of terns to Oakland Airport and Tijuana River/North, as well as the refurbished sites at Batiquitos Lagoon; this underscores the importance of continued protection and enrichment of such sites. The use of decoys has been successful in efforts to attract terns back to previously used areas, such as the Naval Training Center, as well as to new sites, for example Mission Bay/Mariner's Point and Delta

Beach South in the past, and Batiquitos Lagoon/W-2 and E-1 in 1995. Their use at sites used year after year can direct terns to particularly suitable areas.

Monitoring - Because monitors not only collect data but serve as the direct link between recovery efforts and tern life during the breeding season, it is crucial that monitoring continue at least at current levels, and **recommended that those levels increase.** It is a given that the more closely a site is monitored, the better the troubleshooting and problem intervention/solving. As often as possible, and for as long as possible, monitors should visit sites, assess the impact of all things that impinge on breeding success and, when possible, respond to negative influences in ways that promote tern survival and reproduction. San Elijo Lagoon and Tijuana River/North and South are in particular need of increased monitoring levels. Again, we need more money to do this.

Predator Control - Predation on least tern eggs, chicks, fledglings, and adults has been, and will continue to be, a major problem at most sites. Wiping out all potential predators prior to the onset of nesting would clearly benefit terns, but is unnatural, unacceptable, and not possible anyway. Presently, at CDFG tern breeding sites, predator management consists mostly of "crisis control," where predators are removed only after damage is done and the predator(s) can be identified. Sometimes, even after predators have been identified, predator removal is not attempted. The decision as to the fate of the offender(s) is based on several criteria, including the status of the predator (e.g., "endangered" or "species of special concern"), the estimate of its potential effects on tern breeding success, the site history, and financial and local residential considerations. All of these are important variables, and in most cases, the ultimate decision is neither easy nor straightforward. Yet the time, and additional terns, lost in the decision-making process (as well as the paperwork quagmire), and the frustration and helplessness felt by monitors with no control over the situation are issues that can be addressed directly. Thus, some sort of ecologically- and ethically- sound predator management program must be worked out, and soon.

With an eye toward such a program, we have attempted to improve our base of information on predator behavior and effects, and site histories, by standardizing the reporting of actual or potential predation, and requesting the filling out of Predator Sighting Sheets (Caffrey 1995a) by all monitors, when appropriate. In the future, these will contribute to the establishment of a predator management program where site histories and documented predator effects dictate a more standardized approach to predator control than exists now.

In the meantime, increased ADC assistance at sites severely affected by predators in the past and at sites experiencing intense predation pressure during any particular breeding season is

desperately needed. At Chula Vista Wildlife Reserve, ADC presence prior to tern arrival would alleviate some of the predation pressure at that site, Saltworks could use ADC help with avian predators, and terns nesting at both sites at Tijuana River would benefit immensely from increased ADC presence. Ant control is needed at Mission Bay/Mariner's Point. Additionally, crow carcasses work so well at Venice Beach at keeping live crows out of the nesting area that I strongly recommend we pursue this means of non-lethal intervention at sites plagued by crows. Monitors at D Street Fill (where crow and raven carcasses were used in 1994) and VAFB/Purisima Point (crow carcassess used in 1995) reported that crow (and raven, at D Street Fill) presence on site appeared much reduced compared to previous years. I repeat (from the last two years): Can we get some stuffed ones made, so we can determine whether or not **they** work, and so that, if so, we can re-use them year after year?

Future Research and a Better Understanding of Demographic Mechanisms - Resumption of a large-scale banding program and the compilation of data on marked individuals would go a long way toward increasing our understanding of survivorship patterns, the mechanisms underlying population growth, the similarities among and the differences between sites with regard to nesting patterns, and maybe even breeding decisions made by individuals (e.g., choice of mate and/or breeding site). A coordinator for such a program, a necessary first step, is much needed.

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I repeat, from 1993 and 1994, that the people working on behalf of least terns in the state of California continue to be some of the nicest and most compassionate people I am privileged to know, and I remain honored to acknowledge the contributions of the many people listed here. Each one truly gave a piece of themselves to this work; their generosity and dedication was overwhelming. I am proud to be associated with all of you.

Field monitors remain the vital link between us and the terns, and the terns and their survival as a species. Monitors pull vegetation, erect fencing, shovel sand, pilot boats, wade through water, trudge through mud, educate the public, and endure whitewashing as they watch and walk to keep data up to date; moreover, they are forced to become coroners of sorts, like it or not, and are our first step in predator crisis management. Through it all, they somehow manage to remain open-minded, level-headed, and upbeat in the face of uncontrollable mortality, human recklessness, and that sometimes nightmarish phenomenon we call bureaucracy. Thanks to all of you: Laura Collins, Leora Feeney, Mary Perry, Jack Dougherty, Edla Enberg, Dan Codova, Katie Hughes, Paul Specht, Sandra Schultz, Jim Watkins, Tom Applegate, Phil

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APPENDIX A: MILITARY SITES

Naval Air Station, Alameda (NAS Alameda)
Vandenberg Air Force Base (VAFB Beach 2, and Purisima Point)
Marine Corps Base, Camp Pendelton (White Beach, and Santa Margarita River/North Beach, Saltflats, and Saltflats Island)
Naval Training Center, San Diego (Naval Training Center)
Naval Air Station, North Island (NAS North Island)
Naval Amphibious Base, Coronado (Delta Beach/North and South, and NAB Ocean)

APPENDIX B: Number of new nests initiated during the week ending each

	4/22	4/29	5/6	5/13	5/20	5/27	6/3
PGE Pittsburg	0	0	1	0	0	1	0
NAS Alameda	0	0	0	1	61	43	19
Mussel Rock D.	0	0	0	0	1	1	13
OB/Perkins Rd	0	0	0	0	0	0	1
OB/Edison	0	0	0	0	0	0	0
Venice Beach	0	0	15	102	85	69	19
Seal Beach	0	0	0	12	41	35	30
Bolsa Chica	0	1	0	4	29	56	33
Huntington Bch	0	0	0	0	5	29	18
Upper Newport	0	0	0	0	2	3	8
White Beach	0	0	0	0	0	1	1
SMR/North Bch	0	0	0	0	1	23	27
SMR/SF&SFI	0	0	0	0	0	3	3
BL/W-1	0	0	0	0	0	14	14
BL/W-2	0	0	0	0	0	0	2
BL/E-1	0	0	0	0	0	6	7
NTC	0	0	0	0	0	1	4
NAS North Isl	0	0	0	0	9	37	8
DB/North	0	0	0	0	29	67	36
DB/South	0	0	0	0	0	1	0
NAB Ocean	0	0	0	0	2	5	6
TR/North	0	0	0	0	1	0	0
TR/South	0	0	0	0	15	78	62
Total	0	1	16	119	281	473	311

Saturday (± 1 day)

6/10	6/24	7/1	7/8	7/15	7/22	7/29	8/5	8/12
0	0	0	1	0	0	0	0	0
10	10	41	23	2	0	0	0	0
10	12	3	2	2	2	0	0	0
0	0	0	0	0	0	0	0	0
9	9	32	19	10	0	1	0	0
8	15	11	4	0	0	0	0	0
13	8	9	0	0	0	0	0	0
20	2	1	0	0	0	0	0	0
25	27	5	2	0	0	0	0	0
4	0	9	0	0	0	0	0	0
14	1	3	1	1	1	0	0	0
151	17	28	20	2	0	3	0	0
18	7	5	2	1	0	0	0	0
23	4	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
6	5	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
1	3	5	4	1	1	0	0	0
5	12	6	12	2	0	0	0	0
0	0	0	0	0	0	0	0	0
0	6	4	2	0	1	0	1	0
1	0	0	0	0	0	0	0	0
78	10	25	8	4	1	0	0	0
396	148	187	100	25	6	4	1	0

APPENDIX C: A SAMPLING OF FISH DROPPED AT VENICE BEACH

Taxon	# (Size Range, in mm)
Atheriniformes	
Atherinidae	
Atherinops affinis (topsmelt)	1 (83.4)
Clupeiformes	
Engraulidae	
Engraulis mordax (northern anchovy)	3 (80.9 - 96.3)
Cyprinodontiformes	
Cyprinodontidae	
Fundulus parvipinnis (CA killifish)	3 (56.6 - 68.3)
Perciformes	
Ammodytidae	
Ammodvtes hexapterus (Pacific sand lance)	1 (100.2)
Embiotocidae	
Cymatogaster aggregata (shiner perch)	3 (50.6 - 58.6)
Hyperprosopon argenteum (walleye surf perch)	1 (46.4)
Scorpaeniformes	
Scorpaenidae	
Sebastes serriceps (treefish)	1 (46.3)

Table 1. Type, primary contact, and number of breeding season visits for each site in the state of California, 1995. Type 1 sites are monitored from inside; Type 2 from the outside (see Methods). Pismo Dunes unusual enough to rate its own category (Type 3; see Methods). An asterisk next to site name indicates it is either a new site this year, or one used for the first time in several years. "Unused" indicates historically-used site unoccupied by nesting terns in 1995 (1: site unused for at least five years, 2: site used in recent past, 3: site unused for many years and no longer monitored). NA indicates data were not available, NP indicates data were not provided. Primary contacts can be reached through CDF&G office in Sacramento.

Table 1.

	Type	Primary Contact	# Visits
San Francisco Bay Area			
PGE, Pittsburg	1&2	Laura Collins	16
Port Chicago (Allied)	unused1	Laura Collins	
NAS Alameda	1&2	Laura Collins	105
Oakland Airport*	2	Leora Feeney	141
San Luis Obispo/Santa Barbara Counties			
Pismo Dunes	3	Mary S Perry	NA
Santa Maria River Mouth:			
Guadalupe Dunes	unused2	Walter Wehtje	
Mussel Rock Dunes	1	Mary S Perry	34
San Antonio Creek	unused1	Nancy Read	
Vandenberg AFB: Beach 2	2	Nancy Read	50
Purisima Point	2	Nancy Read	51
Santa Ynez River Mouth	unused1	Nancy Read	
Ventura County			
Santa Clara River: Mouth	1	Morgan Boucke	66
McGrath Beach	unused2	Morgan Boucke	
McGrath Lake	2	Morgan Boucke	NP
Ormond Beach: Perkins Rd	2	Morgan Boucke	38
Middle Site	unused2	Morgan Boucke	
Edison	2	Morgan Boucke	44
Point Mugu	NP	Ron Dow	NP
Los Angeles/Orange Counties			
Venice Beach	1	Carolee Caffrey	53
Terminal Island	1	Kathy Keane	109
Seal Beach	1	Brian Collins	21
Bolsa Chica	1	Carolee Caffrey	39
Huntington Beach	1&2	Doreen Stadtlander	72
Newport Slough	unused2	Brian Collins	
Upper Newport Bay	2	Carolee Caffrey	30
San Diego County			
MCB Camp Pendleton:			
White Beach	1	Richard Griffiths	60

Santa Margarita River:			
North Beach	1	Richard Griffiths	66
Saltflats	1	Richard Griffiths	58
Saltflats Isl	1	Richard Griffiths	58
Buena Vista Lagoon	unused3	Elizabeth Copper	
Aqua Hedionda	unused3	Elizabeth Copper	
Batiquitos Lagoon:			
W-1	1&2	Adam Whelchel	85
W-2*	1&2	Adam Whelchel	85
E-1*	1&2	Adam Whelchel	85
San Elijo Lagoon	1	Robert Patton	9
San Diequito Lagoon	unused3	John Konecny	
Los Penasquitos	unused3	Elizabeth Copper	
Mission Bay:			
Mariner's Point	1	Ginger Johnson	49
Crown Point	unused3	Elizabeth Copper	
FAA Island	1	John Konecny	NP
North Fiesta Isl	1	John Konecny	NP
Stony Point	unused3	Elizabeth Copper	
South Shores	unused3	Elizabeth Copper	
Cloverleaf	unused3	Elizabeth Copper	
San Diego Bay:			
Lindbergh Field	1	Kenneth Andrecht	91
Naval Training Center	1	Elizabeth Copper	78
NAS North Island	1	Elizabeth Copper	116
Delta Beach: North	1	Elizabeth Copper	90
South	1	Elizabeth Copper	50
NAB Ocean	1	Elizabeth Copper	65
Grand Caribe Island	unused3	Elizabeth Copper	
D Street Fill	1	Kenneth Andrecht	49
Chula Vista Wldlf Res.	unused2	Kenneth Andrecht	31
Saltworks	1	Jennifer Price	34
Tijuana River: North	1	Robert Patton	>10
South	1	Robert Patton	>20

Table 2. Chronology of California least tern reproductive activities, 1995. For date of arrival, "earlier than or equal to" indicates terns present on that day, but may have arrived earlier. "Later than or equal to" for departure indicates last day terns observed, although actual departure date could be later. Second wave occurrence was determined for each colony: if yes, beginning date is provided; if no, date provided is that through which "lack of" determination was made; "minor" reflects a tough-to-distinguish situation (no clear-cut demarcation between waves existed). The "Yes" for a second wave at Santa Clara River/McGrath Lake is author's interpretation of the reported observation (included in the Santa Clara River/Mouth final Site Report) of a pair feeding chicks, in July, too young to have flown there (from SCR/Mouth). The "Yes" for a second wave at San Elijo Lagoon (*) reflects the lateness of the single (or one of two) pair's nesting, based on the age of a chick observed on August 1. First Egg, Chick, and Fledgling dates indicate actual date, if known, or the first date observed ("earlier than or equal to"). Blank spaces indicate no eggs, chicks, or fledglings produced. NA indicates data were not available, NP indicates data were not provided.

Table 2.

	Activity Period			Date of First		
	Arrive	**Depart**	**Second Wave?**	**Egg**	**Chick**	**Fledgling**
PGE, Pittsburg	≤4/21	7/26	yes,7/5	≤5/15	≤6/6	≤6/27
NAS Alameda	≤4/26	≥8/17	yes,6/16	≤5/11	≤6/6	≤6/30
Oakland Airport	4/8	9/11	yes,6/23	≤5/8		
Pismo Dunes	NP	NP	no			
Mussel Rock Dunes	≤4/30	≥8/10	minor,6/27	≤5/20	≤6/13	≤7/7
VAFB: Beach 2	≤6/18	6/21	no,9/1			
Purisima Point	≤5/10	8/10	yes,6/22	≤5/18	NA	≤6/29
Santa Clara Rv: Mouth	5/6	NP	no,9/1	≤6/9	6/25	7/21
McGrath Lake	NA	NP	yes*,NA	NA	<7/30	
Ormond Beach: Perkins	5/24	≥8/10	no,8/10	≤6/1	NA	7/16
Edison	5/24	≥8/10	yes,6/25	≤6/6	NA	7/13
Venice Beach	≤4/20	8/12-14	minor,8/14	5/2	5/26	≤6/20
Terminal Island	4/25	8/4	yes,6/14	5/18	6/14	7/8
Seal Beach	≤4/13	7/10	no,7/10	≤5/13	5/27	≤6/26
Bolsa Chica	≤4/21	7/31	minor,6/8	4/29	6/3	≤7/10
Huntington Beach	≤4/27	9/11	no,8/11	5/16	6/9	7/5
Upper Newport Bay	5/11	7/6	minor,6/27	NA	6/6	

White Beach	4/30	8/8	no,9/15	5/25	6/20	7/13
SM River: North Beach	4/23	8/29	no,9/15	5/16	6/6	7/9
Saltflats & SFI	4/30	7/18	no,9/15	5/25	6/17	7/18
Batiquitos Lagoon: W-1	4/30	8/10	no,9/15	5/22	6/12	7/3
W-2	5/17	8/21	no,9/15	5/30	6/20	7/10
E-1	5/10	8/10	no,9/15	5/24	6/14	7/3
San Elijo Lagoon	4/25	>8/1	yes*,6/28	5/31?	7/20?	
Mission Bay: FAA Isl	NP	NP	NP	NP	NP	NP
Mariner's Point	NP	NP	no,8/24	5/15	6/5	6/28
N Fiesta Isl	NP	NP	NP	NP	NP	NP
Naval Training Center	4/25	7/24	yes,6/12	5/23	6/14	7/4
Lindbergh Field	5/1	8/8	yes,6/16	5/17	6/9	6/30
NAS North Island	4/24	8/7	yes,6/22	≤5/18	6/9	6/29
Delta Beach: North	4/14	8/21	yes,6/9	5/14	6/7	6/26
South	4/14	6/30	no,8/30	5/22	6/10	6/30
NAB Ocean	≤5/19	9/15	yes,6/14	5/19	6/9	6/28
D Street Fill	4/25	7/28	yes,6/13	5/16	6/9	6/30
Chula Vista Wldlf Res	4/25					
Saltworks	4/26	8/7	yes,6/22	5/19	6/6	7/11
Tijuana River: North	5/1	>8/3	no,8/3	≤5/23	≤6/23	
South	5/1	>8/3	yes,6/23	≤5/16	≤6/8	≤6/27

Table 3. First wave totals for 1995 California Least Tern breeding season; included are all sites with nesting terns in 1995 or 1994. Total Nests includes known renests of first wave pairs. Total Pairs are followed by numbers of first wave pairs at each site in 1994 (in parentheses). Percent Change 1994 indicates increase or decrease in 1995 first wave pairs relative to 1994 numbers (for both years, if given, midpoints of ranges used in calculation). NA indicates data were not available, NP indicates data were not provided. Total Eggs generally not available at Type 2 colonies. Statewide Total Nests included this year for the first time; statewide Total Eggs not included due to the many sites for which those data were not available.

	Total Pairs	**% Δ 1994**	**Total Nests**	**Total Eggs**
PGE, Pittsburg	2 (2)	0	2	3
NAS Alameda	130 (129)	+1	138	264
Oakland Airport	1-4 (0)		1-4	NA
Pismo Dunes	1 (0)		1	NA
Guadalupe Dunes	0 (1)			
Mussel Rock Dunes	43 (36)	+19	43	90
VAFB: Beach 2	0 (1)		0	0
Purisima Point	26 (31)	-16	NA	NA
Santa Clara Rv: Mouth	16 (26)	-38	16	28
McGrath Lake	0 (0)	0		
Ormond Beach: Perkins	7 (7)	0	7	NA
Middle Site	0 (5)		0	0
Edison	32 (18)	+78	32	NA
Venice Beach	295 (345)	-14	295	431
Terminal Island	11 (25)	-56	11	NA
Seal Beach	117 (157)	-25	169	290
Bolsa Chica	125 (176)	-29	125	209
Huntington Beach	171 (274)	-38	175	240
Upper Newport Bay	≤24 (41)	-41	24	NA

White Beach	28 (NP)		34	58
Santa Margarita River:				
North Beach	294 (NP)		337	580
Saltflats	41 (NP)		49	84
Saltflats Island				
Batiquitos Lagoon: W-1	50 (72)	-31	60	105
W-2	3 (0)		3	5
E-1	29 (0)		30	55
San Elijo Lagoon	0-1 (10)	-90	0-1	NA
Mission Bay: FAA Island	NP (330)		NP	NP
Mariner's Point	200-220 (62)	+239	270	504
N. Fiesta Island	NP (8)		NP	NP
Naval Training Center	5 (13)	-61	5	11
Lindbergh Field	18 (10)	+80	18	42
NAS North Island	54 (42)	+29	54	106
Delta Beach: North	134 (94)	+43	134	255
South	1 (15)	-93	1	2
NAB Ocean	13 (1)	+1200	13	25
D Street Fill	22 (8)	+175	22	44
Saltworks	18 (52)	-65	18	35
Tijuana River: North	2 (0)		2	4
South	273 (129)	+112	273	515
Total	>>2186-2210 (2121)		>>2362	(>3386)

Table 4. Totals for 1995 California least tern breeding season; included are all sites with nesting pairs in either 1995 or 1994. Total Pairs and Fledglings/Pair numbers are followed by 1994 data (in parentheses; in cases where ranges were given for 1994, midpoints used here). Percent Change 1994 indicates increase or decrease in 1995 total pairs relative to 1994 number (midpoints of ranges used in calculation). Any discrepancy between 1995 Total Pairs and Total Nests reflects renesting attempts by pairs. Fledgling data for Ormond Beach sites combined in final Site Reports. Zeros for Upper Newport Bay Total Fledglings (*) and Fledglings/Pair (*) may underestimate production - the roosting area may not have been found by the monitor. Accurate fledgling counts for Ormond Beach and Chula Vista Wildlife Reserve in 1994 unavailable (see Caffrey 1995b).

Table 4.

	Total Pairs	% 1994	Total Nests	Total Fledglings	Fledglings/ Pair
PGE, Pittsburg	3 (2)	+50	3	2	0.67 (1.5)
NAS Alameda	150 (138)	+9	216	73	0.49 (1.42)
Oakland Airport	1-6 (0)		1-6	0	0
Pismo Dunes	1 (2)	-50	1	0	0 (0)
Guadalupe Dunes	0 (5)				(0.41)
Mussel Rock Dunes	52 (56)	-7	52	20-25	0.39-0.48 (0.85)
VAFB: Beach 2	0 (1)				(0)
Purisima Point	38 (38)	0	na	17	0.45 (0.08)
Santa Clara Rv: Mouth	16 (26)	-38	16	>17	>1.0 (1.31)
McGrath Lake	1 (0)		1?		
Ormond Beach: Perkins	7 (7-15)	-36	7		
Middle Site	0 (6)			>52	>0.53 (NA)
Edison	91 (22)	+314	96		
Venice Beach	310 (345)	-10	354	44	0.14 (0.65)
Terminal Island	15 (31)	-52	16	6-12	0.40-0.80 (0.10)
Seal Beach	117 (179)	-35	169	3	0.03 (1.26)
Bolsa Chica	134 (185)	-28	157	15	0.11 (0.16)
Huntington Beach	171 (282)	-39	175	≥57	≥0.33 (0.20)
Upper Newport Bay	≤38 (49)	-24	38	0*	0* (0.53)

Table 5. Clutch sizes and hatching success at Type 1 sites, 1995. "Unsure" denotes either the number of nests abandoned or preyed upon prior to completion at Type 1 sites (thus actual clutch size unknown), the total number of nests at Type 2 sites (thus Total Number of Eggs not available), or some combination of the above (at NAS Alameda, both Type 1 and Type 2 methods are used to monitor). Seal Beach had one 4-egg clutch (not shown). Mean clutch size provided for known clutch sizes only. Total Eggs for NAS Alameda includes those of "unsure" clutch size, and thus represents the minimum at that site. Hatching success unavailable for PGE Pittsburg, Seal Beach, and Tijuana River/North because of uncertainties associated with predation. NA indicates data were unavailable, NP indicates data were not provided.

Table 5.

Clutch Size

	1	2	3	Unsure	Mean	Total Eggs	% Hatch
PGE, Pittsburg	1	2			1.67	5	NA
NAS Alameda	51	161	3	1	1.78	383	78
Oakland Airport	NA	≥1	NA			NA	0
Pismo Dunes				1		NA	0
Mussel Rock Dunes	4	42	6		2.04	106	40-52
VAFB: Purisima Point				≥38		NA	NA
Santa Clara River	4	12			1.75	28	NP
McGrath Lake		1			2	2	NA
Ormond Beach: Edison				96		NA	NA
Perkins Rd				7		NA	NA
Venice Beach	203	149	3		1.42	504	86
Terminal Island	NP	NP	NP			26	77
Seal Beach	55	108	3		1.72	290	NA
Bolsa Chica	68	85	4		1.59	250	41-87
Huntington Beach	110	65			1.37	240	43
Upper Newport Bay				38		NA	NA

White Beach	10	24			1.71	58	63
SM River: North Beach	95	241	1		1.72	580	79
Saltflats	14	35			1.71	84	75
Saltflats Isl							
Batiquitos Lagoon: W-1	11	49			1.75	105	86
W-2	1	2			1.67	5	80
E-1	5	25			1.83	55	92
San Elijo Lagoon				1-2		NA	NA
Mission Bay: FAA Isl	NP	NP	NP			NP	NP
Mariner's Point	43	220	7		1.87	504	69
N Fiesta Isl	NP	NP	NP			NP	NP
Lindbergh Field	6	13	8		2.07	56	77-91
Naval Training Center		5	1		2.17	13	100
NAS North Island	5	53	2		1.95	117	84
Delta Beach: North	35	141	3		1.81	320	86
South		1			2	2	100
NAB Ocean	11	20			1.65	51	90
D Street Fill	1	25	1		2	54	48-88
Saltworks	4	20			1.83	44	75
Tijuana River: North		2			2	4	NA
South	56	255	5		1.84	581	37

Table 6. Causes of California least tern breeding failure, as reported, 1995. Documented and suspected avian and mammalian predators are indicated, as well as other sources of mortality. Birds: BwO - Burrowing Owl, Cr - American Crow, CT - Caspian Tern, Gl - gull species, GBH - Great Blue Heron, GbT - Gull-Billed Tern, GhO - Great Horned Owl, Ks - American Kestrel, LS - Loggerhead Shrike, NH - Northern Harrier, Ow - owl species, PF - Peregrine Falcon, Rv - Raven, RtH - Red-Tailed Hawk, WG - Western Gull, WM - Western Meadowlark. Mammals: Ct - Domestic Cat, Cy - Coyote, Dg - Domestic Dog, FC - Feral Cat, FD - Feral Dog, Fx - Fox species, GS - Ground Squirrel, JR - Jack Rabbit, On - Opossum, Rc - Raccoon, RF - Red Fox, RSp - rodent species, Stk - Striped Skunk. Other: An - Ant, Ds - Disease, Fl - Flooding (nests innundated as the result of high tides), FS - Food Shortage, Hpo - Hypothermia, Hu - Human-related mortality (1: pedestrians caused egg or chick mortality, 2: aircraft killed one, and possibly two, fledgling(s)), Rn - Rain and associated flooding of nests and mortality of chicks, Wd - Wind.

Table 6. **Predation**

	Documented		Suspected		Other
	Bird	**Mammal**	**Bird**	**Mammal**	
PGE, Pittsburg			Cr		
NAS Alameda	Ks,Rv,Ow,RTH		PF		Hu2,FS,Rn,Hpo
Oakland Airport				RF	
Pismo Dunes		Cy			
Mussel Rock Dunes			Gl	Cy,Rc	Wd,Rn
VAFB: Purisima Point			Gl,LS,NH		Wd
Santa Clara Rv: Mouth			Rv	Dg	
Ormond Beach: Perkins					
Edison				Op,Fx	
Venice Beach					FS,Rn
Terminal Island	PF	FC	Ks		Rn
Seal Beach	LS,Cr		Ks,Gl		Rn
Bolsa Chica			CT		Rn,FS?
Huntington Beach		Stk			
Upper Newport Bay					FS?,Rn?

White Beach					
SM River: North Beach					
Saltflats					
Saltflats Isl					
Batiquitos Lagoon: W-1			GhO		
W-2					
E-1					
San Elijo Lagoon					
Mission Bay: FAA Isl					
Mariner's Point	Ks,WG				Ds?
N Fiesta Isl					
Lindbergh Field					
Naval Training Center	RtH				
NAS North Island	BwO,Ks,Cr	FC,GS,JR	GBH,WG,RtH,PF,Rv	FC,GS	HU2
Delta Beach: North	Ks,BwO				An
South					
NAB Ocean			Ks,BwO		
D Street Fill	PF		RtH,NH,Rv,WG,Ks		An
Saltworks			PF,Ks,NH,Rv	Cy,Dg	
Tijuana River: North		Ct			
South	Ks,GbT,WG,GhO	RSp	WM,Gl	FD	HU1,Fl,Ds?

Table 7. Sources of nesting site disturbance: there was no direct evidence of actual predation or mortality caused by indicated sources, however, sources were believed to either have caused some undetected mortality, or to underlie nest abandonment. Sources of breeding failure (Table 6) biologically relevant here, but are not included because of space considerations. Predators listed here were either (1) present at site prior to or during season and removed (*), or (2) obvious to monitors during the season and suspected to be the cause of nest or site abandonment (Bc - Bobcat, BnO - Barn Owl, GF - Gray Fox, LtW - Long-tailed Weasel, Rt - Rat). Human disturbance: Cs - Construction activities (two days in May) occurred near nesting area, Im - Migrants crossing the border illegally walked through site, Jb - Jetblast from nearby taxiing planes blew down chick fence daily, J4 - July 4th activities, Mlt - Military training exercises on beach near nesting area, RE - Monitor and ADC presence caused disturbance to nesting terns (Recovery Effort), Rec1 - Pedestrians (beachgoers, surfers, joggers) with or without pets in and/or around nesting area, Rec2 - Bicycles and/or ORVs in and/or around nesting area, Rec3 - Helicopter disturbance (low flyovers), Rec4 - Boaters released dog onto site, Rec5 - Two young boys throwing rocks at hovering and roosting terns, Rec6 - Tracks indicating people with a wheeled cart were on site at least twice (monitor suspects they were hunting for tiger beetles), Rec7 - Hot air balloon landed on site, Rec8 - Beligerent equestrians on site repeatedly. Other: FF - Flooding of site (early in season) due to lagoon floodgate failure. All other abbreviations as in Table 6.

	Human	**Animal**	**Other**
PGE, Pittsburg			
NAS Alameda		NH*,FC*	
Oakland Airport		FC*,Op*,Stk*,Rc*	
Pismo Dunes	Rec1,Rec2		
Mussel Rock Dunes			
VAFB: Purisima Point	RE	Cy*,Rc*,Bc*,LS*,Ks*,NH	
Santa Clara Rv: Mouth	Rec1		
Ormond Beach: Perkins	Rec1		
Edison	Rec2		
Venice Beach	J4		
Terminal Island	Rec3,Rec4	Cr*,Rv*	
Seal Beach			
Bolsa Chica			
Huntington Beach	Rec5	Cr*	
Upper Newport Bay			

White Beach			
SM River: North Beach			
Saltflats			
Saltflats Isl			
Batiquitos Lagoon: W-1		Ks*,FC*	
W-2		FC*	
E-1		FC*	
San Elijo Lagoon	Rec6,Rec7		FF
Mission Bay: FAA Isl			
Mariner's Point	Rec1	Rt*	
N Fiesta Isl			
Lindbergh Field	Cs,JB	Rt*,Ks*	
Naval Training Center			
NAS North Island		FC*,GS*,WG*,Ks*,Rv*,Ow*	
Delta Beach: North			
South			
NAB Ocean	Rec1,Mlt		
D Street Fill		LS*,GhO*,BnO*,FC*,FD*,GS*	
Saltworks		GS*,FD*,Cy*	
Tijuana River: North	Rec1,Im	GS*	
South	Rec1,Rec2,Rec8	BwO*,Op,LtW,GF	

Figure 1. Number of new tern nests initiated during the week ending on each Saturday (± 1 day) of the breeding season, 1995. Data from the following sites: North: PGE Pittsburg, NAS Alameda, Mussel Rock Dunes, Ormond Beach/Perkins Rd and Edison. Central: Venice Beach, Seal Beach, Bolsa Chica, Huntington Beach, Upper Newport Bay. South: White Beach, Santa Margarita River/North Beach and Saltflats/Saltflats Island (combined), Batiquitos Lagoon/W-1, W-2 and E-1, Naval Training Center, NAS North Island, Delta Beach/North and South, NAB Ocean, Tijuana River/North and South.

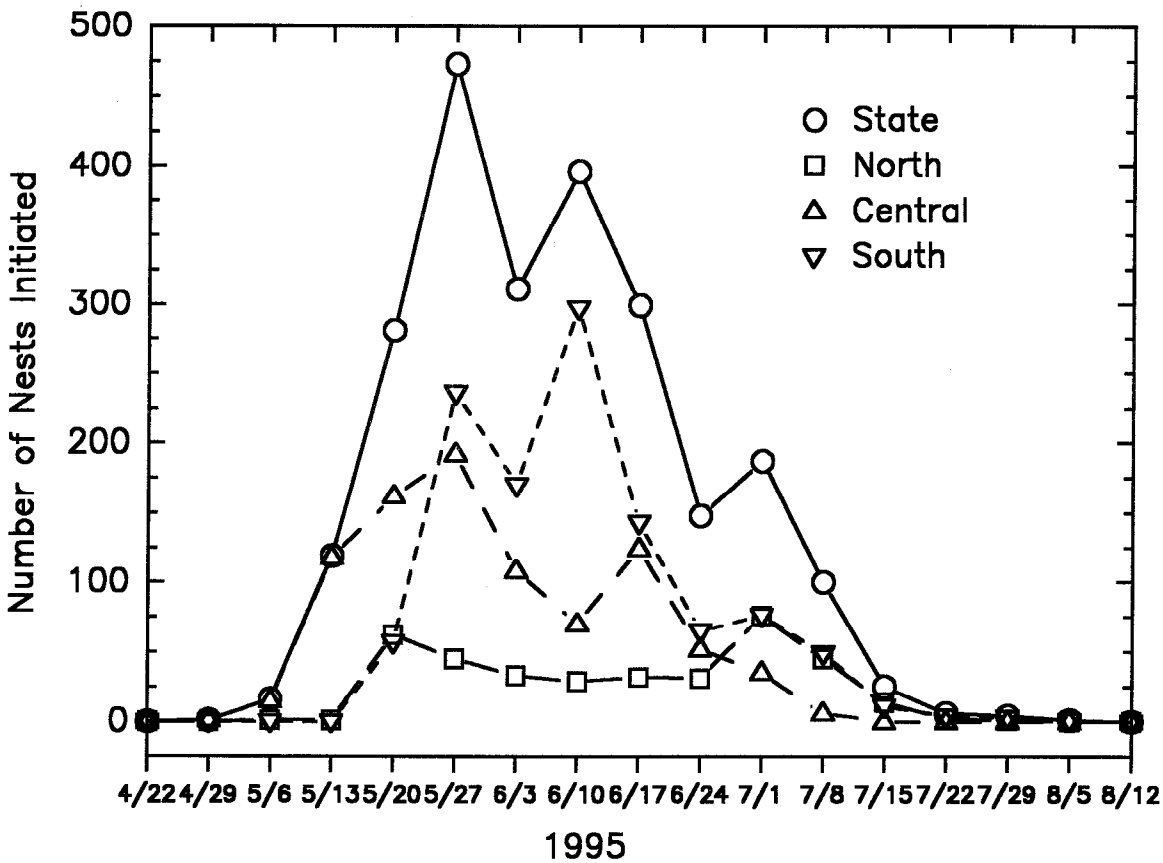

500
400
300
200
100
0
Number of Nests Initiated
State
North
Central
South
4/22 4/29 5/6 5/13 5/20 5/27 6/3 6/10 6/17 6/24 7/1 7/8 7/15 7/22 7/29 8/5 8/12
1995

Figure 2. Differences in the timing of nesting: number of new nests initiated during the week ending each Saturday (±l day) for the three sites Ormond Beach/Edison, Venice Beach, and Santa Margarita River/North Beach.

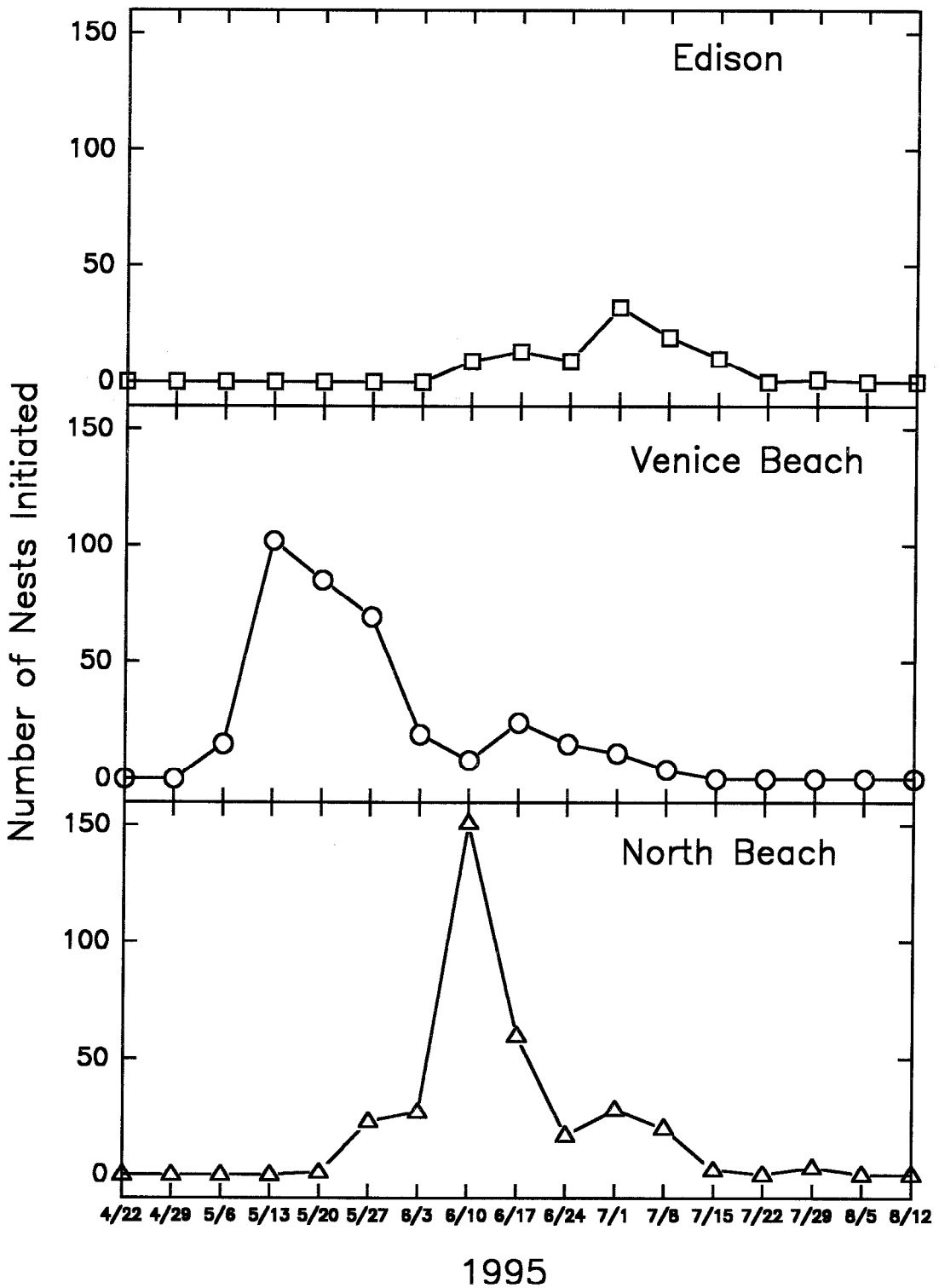

Edison
Venice Beach
North Beach
Number of Nests Initiated
150
100
50
0
4/22 4/29 5/6 5/13 5/20 5/27 6/3 6/10 6/17 6/24 7/1 7/8 7/15 7/22 7/29 8/5 8/12
1995

Figure 3. Differences in nesting patterns: number of new nests initiated during the week ending each Saturday (±l day) at NAS Alameda (a clear-cur "first" and "second wave"), Bolsa Chica (a "first wave" only), and NAS North Island (a "minor" second wave).

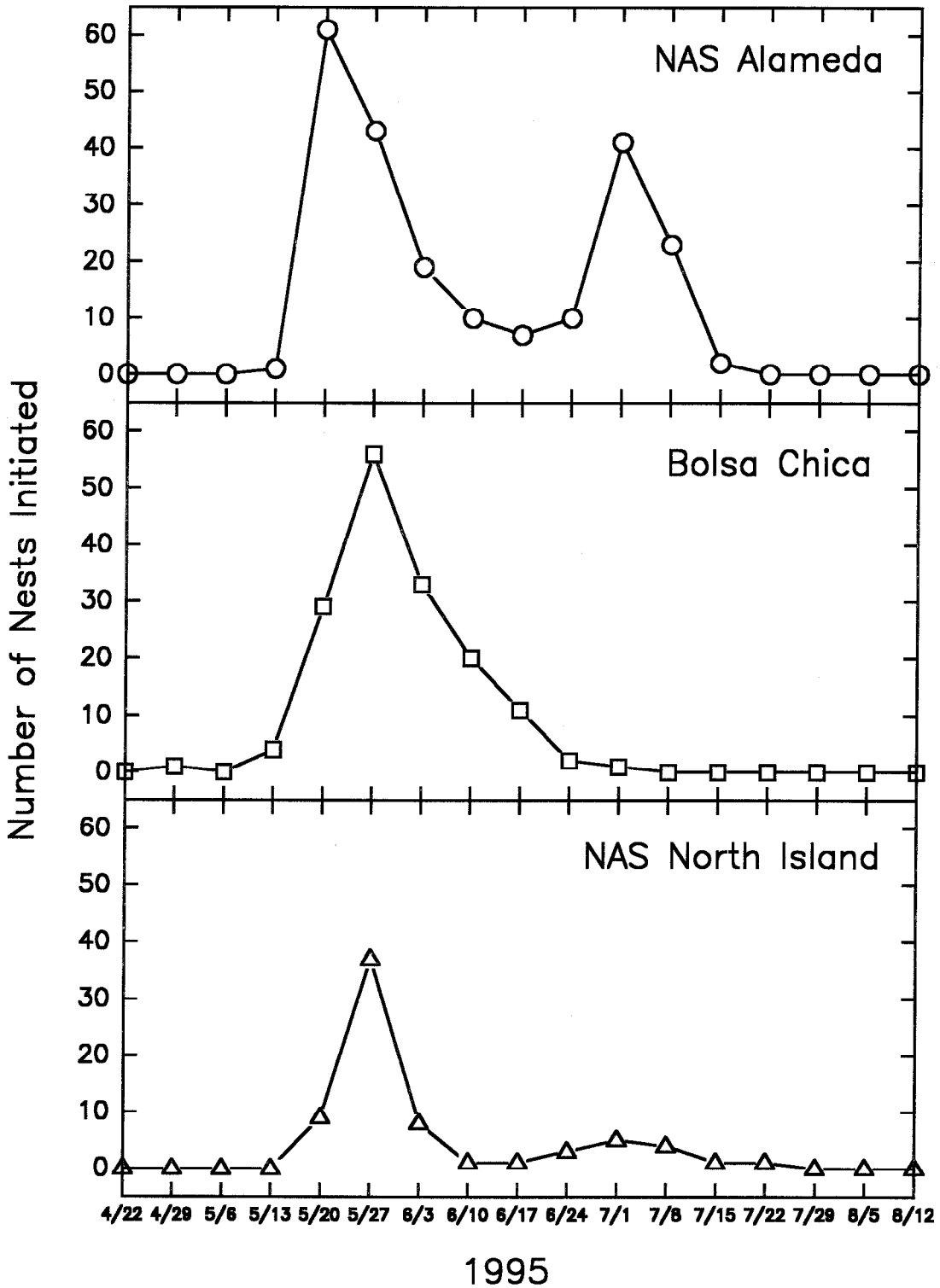
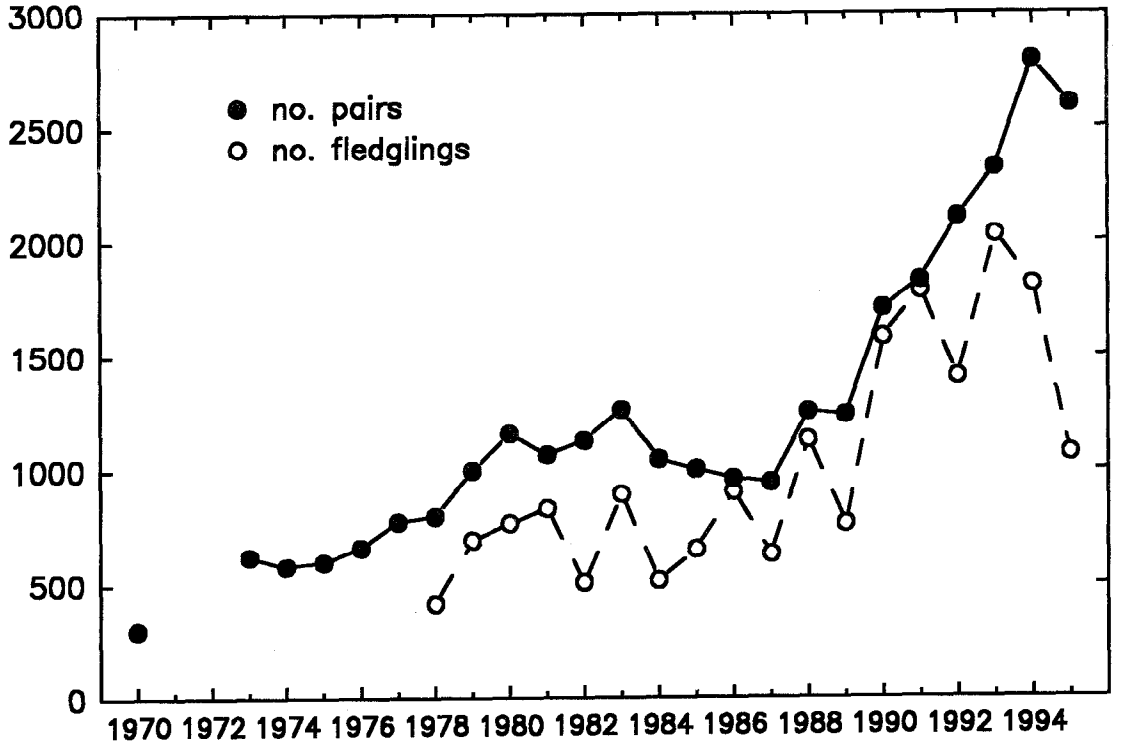

NAS Alameda
Bolsa Chica
NAS North Island
Number of Nests Initiated
0
10
20
30
40
50
60
4/22 4/29 5/6 5/13 5/20 5/27 6/3 6/10 6/17 6/24 7/1 7/8 7/15 7/22 7/29 8/5 8/12
1995

Figure 4. Statewide numbers of pairs and fledglings, 1973-1995. Data for 1973-1990 from Fancher 1992.


3000
2500
2000
1500
1000
500
0
no. pairs
no. fledglings
1970 1972 1974 1976 1978 1980 1982 1984 1986 1988 1990 1992 1994