

State of California
The Resources Agency
Department of Fish and Game
Wildlife Management Division

CALIFORNIA LEAST TERN BREEDING SURVEY
1991 SEASON

by

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and
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1992

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ABSTRACT

In 1991, an estimated 1830 pairs of California Least Terns (*Sterna antillarum browni*) nested in California at sites from San Francisco Bay south to the Tijuana River mouth. This number continues an apparent trend of a recently escalating population, first observed in 1990. 1990 marked a huge increase in population (36%) from the two previous years, and in 1991 the number is 6.8% higher than in 1990. The number of nesting pairs in 1991 is the highest since systematic monitoring began in 1973. The net number of breeding colonies used from 1990 to 1991 dropped by two, with three sites unused and one new site occupied. Actual nesting sites increased from 30 in 1990, to 34 in 1991, a result of monitoring reporting changes, habitat perturbation, and real expansion. Population increases were observed at most established colonies throughout the State, but especially in San Diego and Orange Counties.

An estimated 1784 (1729-1839) fledglings were produced in 1991, more than any year on record, including 1990, the previous record year. The ratio of fledglings:breeding pairs also increased slightly (0.97) compared to 1990 (0.93). These relatively high ratio values in both years indicate highly successful seasons.

Outstanding productivity (>1.0 fledgling per pair) was reported from NAS Alameda, Point Mugu, Venice Beach, Seal Beach NWR, White Beach, Santa Margarita River, Batiquitos Lagoon, and Mariner's Point. As in many other successful years, clutch size was high throughout the State, averaging 2.0 eggs/clutch (St. dev.=0.45).

Sources of egg and chick mortality varied from colony to colony. Reports of predator problems were down overall, however a few individual colonies experienced significant losses. Documented avian predators included Northern Harrier, American Kestrel, American Crow, Red-tailed Hawk, American Crow. Several avian species were also suspected as predators. Among mammals, only Raccoon and an unidentified mammal species were suspected predators. Disturbance by human intrusion (pedestrians or vehicles) remained a widespread problem, especially in Santa Barbara, Ventura, and southern San Diego Counties.

DEDICATION

Dr. Bryan S. Obst, Professor of Biology at the University of California, Los Angeles, died during the preparation of this report. His enthusiasm and sense of humor are now a part of the people fortunate enough to have known him. Without Bryan's dedicated efforts and inspiration, this report would not have been possible.

INTRODUCTION

The California Least Tern is a State and federally listed endangered species that nests on the beaches of central and southern California. Loss of habitat, increased predation, and human disturbance at breeding colonies are some of the factors that limit recovery. Statewide censuses have documented a gradual increase in population from approximately 650 known pairs in 1973 to 1250 pairs in 1988 and 1989, and a steeper increase to some 1700 pairs in 1990. This substantial increase of the known population in less than 20 years has been a direct consequence of an integrated program for the creation and enhancement, location, monitoring, and protection of breeding colonies throughout the State. This effort was continued in 1991, and the results are summarized herein.

METHODS

In past Final Reports, the terms "breeding" or "nesting" sites were used interchangeably with "colony" to describe specific geographic areas that terns use for nesting. In 1991, it became obvious that there should be an attempt to differentiate between a colony and apparent "satellite" nesting sites. This clarification is due, in large part, to minor variations in the way that some colonies are being reported by monitors. These changes reflect either real shifts by terns into previously unoccupied habitats or individual monitors have felt justified to report geographically separate nesting locations as individual sites instead of being reported as one colony. The differentiation between a "colony" and "breeding station" has been examined briefly, from an evolutionary perspective, with few conclusive definitions (Coulson and Dixon, 1979; Wittenberger and Hunt, 1985).

For this report, colonies are defined as a single contiguous nesting site OR discrete nesting sites that share some unique characteristics. The non-contiguous sites must be geographically close (within 1 km), share a common, inshore foraging area (e.g., bay or estuary, for example), and some evidence, or assumption, must exist that individual nesting birds show site fidelity or are philopatric to adjacent sites versus other breeding colonies (Atwood and Massey 1988). Roughly contiguous nesting sites separated by a jurisdictional boundary (e.g., military base boundary fence), or other administrative boundaries, are defined as separate colonies for ease of monitoring and reporting consistencies from past years. A nesting site is defined as a specific geographic area that terns use for nesting. One or several nesting sites may comprise a colony. These definitions are constrained by attempting to compare, when possible, historical information (e.g., where have birds been extirpated) with existing data in 1990 and 1991 that seem to demonstrate real increases in population size and expansion into these new, or former, breeding sites. Individual sites defined as either a

colony or site in 1991, need not be confined to those definitions in the future. A nesting site, at the time of this report, should be considered a colony in succeeding years if that site meets the criteria of a colony, defined for this report. With increasing numbers of birds and probable expansion into new areas, precise definitions of colonies and sites becomes very important when attempting to meet the primary objective of the Least Tern Recovery Plan (USFWS 1980). For comparison to other Final Reports, the terms "colony" and "breeding site" are roughly equivalent to the definition of a colony in this report.

Statewide censuses of the breeding population of California Least Terns have been conducted each year since 1973. Paid and volunteer monitors check all known colony sites on a regular basis (weekly to daily, depending on the site). The monitors are supervised by a "regional supervisor" responsible for a given geographic region. Monitors receive instructions on census methodology, report forms and, when possible, some history of the colony. Monitors submit completed mid and final season reports summarizing: 1) counts or estimates of the number of adults, breeding pairs, nests, eggs, chicks, and fledglings at each colony, 2) a chronology of breeding at the site, and 3) documented/suspected predators, other problems, and steps taken to alleviate them.

1990 marked the first year that the individual monitor reports were available, and interested individuals were encouraged to request copies. The individual reports, as noted in the 1990 Final Report, are rich in details of how problems were recognized and addressed in the field and their availability should serve as a welcome resource to those involved with management of the species. These reports should also prove useful to new monitors who are seeking experience and greater exposure to occurrences at other colonies within their cluster. The text of the 1991 Final Report, thus, serves mainly as an overview of these individual reports. The monitor reports are organized geographically, by cluster, from north to south following the list from Table 2. The reports are available from the CDFG offices in Sacramento.

RESULTS

Distribution - In 1991, breeding was observed at 26 colonies from Contra Costa County in the San Francisco Bay area south to the Mexican border in San Diego County (Table 1). Only one colony was used in 1991 and not in 1990, "D" Street in San Diego County. There was an increase in the number of nesting sites used in 1991 (34) compared to 1990 (30). This apparent increase was, in part, due to a change in the way some colonies were reported (see Introduction). At 4 different colonies observers reported two distinct nesting sites, where formerly only 1 site had been occupied. However, the increase does represent some real

expansion in the number of nesting sites utilized: two new nesting sites were occupied at McGrath State Beach in Ventura County. At one of the new sites a fencing enclosure was erected prior to nest initiation, providing the birds with a suitable, undisturbed nesting site that was used by nesting pairs. Three colonies used in 1990, Tern Island, Oakland Airport, and San Antonio Creek were not occupied in 1991. Tern Island was first reported as a colony in 1990. The three colonies unoccupied in 1991 accounted for only eight estimated nesting pairs in 1990 and no fledglings. "D" Street, an infrequently used site which was not used in 1990, had significant fledgling production in 1991. In 1990 and 1991, 16 colonies or sites that formerly hosted nesting pairs, had no nesting attempts.

Breeding Population - An estimated 1830 pairs nested within California during 1991 (Table 1). This number sustains a trend observed in 1990 of a dramatic increase from the approximately 1250 pairs in 1988 and 1989. In 1990, an estimated 1706 pairs of terns nested in the State. The slight increase in the 1991 population estimate occurred in most areas with the greatest increase in the San Diego cluster. (Table 2). Due to some expected error in the number of nesting pairs estimated, the increase in the number of nesting pairs in 1991 from 1990 (6.8%), is at least an index of a population equal to or slightly higher than in 1990. Substantial increases (>30%) in colony size during the 1991 nesting season, compared to 1990, were reported at Point Mugu (316%), Seal Beach NWR (85%), Huntington Beach (57%), White Beach (65%), Saltflats (50%), Saltflat Island (32%), and Mariner's Point (558%). Significant declines occurred at Santa Clara River, Ormond Beach, Terminal Island, Bolsa Chica, FAA Island, North Island NAS, Chula Vista. Some of these colonies probably declined as a result of inter-colony movement, a phenomenon observed in other years.

Fledgling Success - Between 1729 and 1839 young were fledged in 1991 (Table 1), surpassing the record-breaking year in 1990. In fact, 1991 was the most productive year on record. Assuming a middle value of 1784 ($[1729 + 1939]/2$), production of fledglings was 1.13 times higher than production in the last record year, 1990, 1.58 times higher than the previous best production year, 1988, and 2.34 times higher than the last poor production year, 1989. The ratio of fledglings:breeding pairs was 0.97, higher than 1990 (0.93) and the previous record year 1986 (0.94). This relatively high ratio value in two consecutive years, 1990 and 1991, in combination with the gross number of breeding pairs and productivity, indicate highly successful seasons.

Gross productivity by cluster (Table 2) was highest in the San Diego area (846), followed closely by the Los Angeles/Orange cluster (660). These two clusters account for 84% of the fledglings produced in 1991. The next most productive cluster was in the Contra Costa/Alameda area (141), followed by Ventura

(95) and San Luis Obispo/Santa Barbara (43). The ratio of fledglings:breeding pairs was generally good in all areas, the highest was recorded in Contra Costa/Alameda (1.26). Very high ratios were recorded in Ventura (0.95), San Diego (0.98), Los Angeles/Orange (0.93), and moderately high ratios were observed in San Luis Obispo/Santa Barbara (0.83). The high ratio in the San Luis Obispo/Santa Barbara cluster reflects the discovery of a previously unobserved roosting flock at the largest colony in the cluster, Mussel Rock Dunes. Outstanding productivity (>1.0 fledgling/pair) at individual colonies was widespread, reported from NAS Alameda, Point Mugu, Venice Beach, Seal Beach NWR, White Beach, Santa Margarita River, Batiquitos Lagoon, and Mariner's Point. Most of these colonies were listed as having high productivity in 1990.

Breeding Chronology - Least Terns arrived at most sites either during the last week of April or during the first week in May (Table 3). The first eggs were discovered at Seal Beach NWR and at least 10 other sites by the first week in May. Arrival dates were typical compared to other years, but the start of the breeding season was somewhat early, as was true in 1990. The bulk of first fledglings were reported from the third week in June and continued to the middle of July. The earliest reported fledgling was from Seal Beach NWR on June 5, 11 days before the next report of a fledgling. Departure dates were spread out from the end of July through September and probably more accurately reflect the departure date of the observer.

Clutch Size - Avoidance of potential human disturbance and logistics problems prevent many observers from collecting data on clutch size. Although the data was not collected throughout the State, clutch size appeared to be high (Table 4). Including both first and second wave clutches, mean clutch size was 1.98 eggs/clutch. This compares to 1.94 eggs/per clutch in 1990, which was higher than in 1989.

Predation - Despite the widespread productivity, mortality and nest abandonment caused by predation continued to be a problem at some colonies in the State. Although the number of individual nesting sites affected by predation is lower than in 1990, several sites had relatively heavy mortality. Unfortunately, predation took the form of sudden disappearances of eggs or chicks without unequivocal documentation of the predator involved. All of the documented predators were avian species, most diurnal, although possibly two species of mammals were implied as predators.

American Kestrels took chicks at NAS Alameda, Seal Beach NWR, and Bolsa Chica, and were suspected predators at North Island NAS and San Elijo Lagoon. Common Raven was a documented predator at Bolsa Chica and the North Beach nesting site, Santa Margarita. Courting Northern Harriers and the presence of Red Foxes probably

prevented tern nesting at Oakland Airport, a site with heavy predation in past years, and may have taken as many 25 chicks at NAS Alameda. Two family groups of American Crows were discovered taking chicks at Venice and may have been responsible for high numbers of chick deaths. This species was not a predator in 1990 and should be monitored in 1992. A Red-tailed Hawk was documented taking chicks at Bolsa Chica. An unknown owl species was documented at the Saltflats site, Santa Margarita, and was suspected at nearby White Beach. Western Gulls were suspected at 4 colonies, NAS Alameda, Delta Beach, San Elijo, and Mariner's Point and an unidentified gull species was suspected at FAA Island. Western Meadowlark was a suspected egg predator at Bolsa Chica. A Peregrine Falcon was suspected to have taken adults at Saltworks. Loggerhead Shrikes were implicated in predation events at 4 sites in 1990 and none in 1991.

Among mammals, a difficult group to identify after a predation event, none were documented predators but were suspected at three colonies. The reduced number of suspected and documented sites from 1990 (15), reflects both a reduction in the number of mammalian predators, due in part to predator removal programs, and perhaps to a lack of documentation from some sites at the time this report was prepared. The only species positively identified, was a Raccoon at San Elijo and at the Batiquitos site, where it apparently invaded the colony late in the season and missed the bulk of nesting season. An unidentified mammal species was suspected at White Beach.

Feral cats were a surprising missing element from the predator list. Again, active removal from colonies, both before and during the seasons, may have resulted in real reductions. Red Fox were noted in the general vicinity of some colonies, but were not suspected or documented predators this year. Fox control measures appear to have been largely effective in 1991, as in 1990. Continued removal of this exotic species have prevented losses at several sites (e.g., Bolsa Chica and Seal Beach NWR). Ants were not a factor in 1991, as control measures implemented in 1990 have proven successful in eliminating them from affected colonies.

Other Sources of Disturbance - Despite monitoring and posting of colonies, disturbance resulting from human intrusion into colonies remained a problem at several sites on public lands. (Table 6). Six colonies (Mussel Rock Dunes, Ormond Beach, Batiquitos Lagoon, Chula Vista, D Street, Tijuana Slough) were confirmed as having some amount of human disturbance in the form of pedestrians, vehicles and unleashed pets. Monitors at all six sites considered human disturbance an important factor contributing to a portion of failed breeding. At Ormond Beach, Spanish-speaking trespassers could not understand the posted signs written in English and walked through the colony on several occasions. The Pismo Dunes colony, while in the boundaries of an

off-road vehicle park, was not observed to be directly affected by vehicles, due largely to protective fencing. Off-road vehicles were observed as being problems at Ormond Beach and Batiquitos Lagoon. Roosting or nesting by other birds was documented as a factor in reproduction at NAS Alameda (gulls), Buena Vista (domestic geese), and FAA Island (gulls). Preventing birds from roosting is a control measure with few clear options. Two-thirds of the nesting area at the Santa Clara River mouth was washed away by an unusually large volume of river floodwater before the season began. Hypothermia was implicated as a source of mortality for 18-20 chicks at NAS Alameda. An unusually large fish provided to a chick by the adult, apparently choked the chick to death at Mussel Rock Dunes.

DISCUSSION

The remarkable increase in the breeding population and the excellent productivity during the 1991 season are not likely to be artifacts of increased survey effort or expertise, since the monitoring effort remained relatively constant. Although there was some turnover in individual monitors, number of visits remained at virtually the same level as 1990. The increase in population appears to represent a genuine surge in population size and reproductive output, matching or slightly exceeding that of 1990, another excellent year.

The widespread increase in population was probably related to at least a few factors. First, the 1991 season, as in 1990, likely benefited greatly from a relatively large cohort entering the breeding population from 1988, a highly productive year. This large cohort was joining a population that had been steadily increasing in recent years. The cohort from 1989, while relatively small at approximately 760 fledglings, probably added enough new breeders to the population to keep the numbers at or slightly above the 1990 level.

Second, the early laying and large clutch size together suggest that 1991, as in 1990, may have been a good food year, and this may have encouraged participation by adults that did not breed during the poor 1989 season. These reproductive attributes were implicated in 1990 as being partly responsible for the population increase. Contrasting to this hypothesis is the observance of a possible food shortage offshore at Terminal Island. The 2 nesting pairs were observed being inattentive to chicks and absent for long periods. It is unknown if this possible food shortage was observed elsewhere.

Third, in addition to the possible increase in food, protection of sites was directly responsible for much of the success noted the past several years. For example, ground predators and human disturbance have been controlled by fencing at many colonies, and

aggressive, pre-season predator control was of great value at the State's largest colony, Santa Margarita River, Bolsa Chica, and Seal Beach NWR.

The importance of swift predator control before and during the season was evidenced at several colonies in 1991. In some cases, where predators were documented as having great impact to reproduction, efforts to control the offending species was met with either frustrating results or, worse yet, hesitation in the wake of potentially volatile political situations. Once the season was underway, early identification and removal of documented or potentially lethal exotic species was conducted at Point Mugu (feral cats), and Seal Beach NWR and Bolsa Chica (Red Fox). Both Point Mugu and Seal Beach NWR were able to have successful seasons, while Bolsa Chica suffered a multitude of predation events and predator removal difficulties. Tijuana Slough NWR suffers from numerous predators and logistically difficult to manage disturbance from extensive human trespassing. The colony is located near an entry point for illegal aliens coming across the border.

Despite the high productivity in 1991, much room for concern remains. This leaves future productivity vulnerable to point threats such as local predators and oil spills. Localized predators can have a particularly debilitating effect on tern productivity. Although the number of nesting sites affected by predation was low in 1991, individual predators at just a few sites can have a decimating effect on the total number of fledglings produced statewide. Historically, terns were able to co-exist with native predators by having large colonies that flooded the habitat, probably always producing large cohorts of chicks, much greater than could be taken by predators. Thus, when terns were reduced to small, isolated, and densely packed colonies, their defensive strategy was diminished, and predators, whose numbers may have grown, could easily have a decimating effect.

Although the numbers of nesting pairs and fledglings is excellent and approaches a portion of the primary objective of the California Least Tern Recovery Plan (USFWS 1980), the nesting colonies are not well distributed. The recommendations listed in the Recovery Plan state that the breeding population must be distributed in "at least 20 coastal wetland ecosystems" throughout the California breeding range. De-listing can only be considered if the pairs are distributed at these ecosystems and that the ownership and management of the habitat is focused on least terns. In 1991, the number of secure ecosystems falls well short of the target number.

RECOMMENDATIONS

Colony and Nesting Sites - With the statewide population increasing, the creation of new sites and enhancement of existing sites must be considered high priorities. However, attempts to create new sites have met with mixed success throughout the State. In San Diego County, several human-created or existing "potential" sites have gone unused. Recent efforts to enhance nesting areas in Ventura and San Luis Obispo County have had encouraging results. Temporary fencing erected at a new nesting site prior to the nesting season near the Santa Clara colony protected 12 nests in 1991. Portions of nesting habitat were fenced at Ormond Beach providing some protection, but high tides and trespassing negated some of the effort. A temporary enclosure was erected for nesting terns within the boundaries of the Pismo Dunes Off-highway Park, and provided adequate protection from vehicles. In Los Angeles County, where the Least Tern population has increased greatly, new nesting sites are needed to allow continued increases. An attempt to establish a new site was undertaken at Dockweiler State Beach, near Playa del Rey, about 1 mile from the relatively dense Venice Beach colony. Erection of the fence, placement of decoys, and broadcasting recorded tern calls were attempted late in the season and may have missed the bulk of the potential nesting pairs (pers. obs.). This effort will continue in 1992 at a more intensive level to attract terns.

Continual enhancement of Least Tern sites is also an important priority, in addition to site preparation prior to nest initiation. Increased protection from human disturbance will be needed to fully develop the potential of colonies in Ventura County and parts of San Diego County.

The importance of protecting seemingly abandoned Least Tern nesting sites cannot be underestimated. This species, while generally showing very high site fidelity (Atwood and Massey 1988), has also been shown to undergo some colony turnover (Burger 1984). Colony-site dynamics are very difficult to document and result from a variety of factors including competition, predation, and physical changes in site structure (Erwin et al. 1981). Therefore, currently unoccupied sites that appear abandoned (e.g., ones in San Diego County) and apparently ideal unoccupied habitat (e.g., in Ventura County), must be considered as viable, potential nesting habitat in future seasons. These sites must be secured, enhanced, and protected for an increasing Least Tern population.

Monitoring - Monitoring must continue at all sites at at least the 1991 level. Continuing disparity in monitoring effort exists within the State (Table 7), and this translates into a disparity in colony protection and reproductive success. Although few colonies receive less than two days per week monitoring effort,

some colonies or potential colonies are simply not visited frequently enough to document nesting. Colonies with only weekly monitoring appear to be more likely to fail than those with daily monitoring and they often fail without a clear indication of the problem. Some of these areas encompass many acres of potential viable habitat but have inherently low pair numbers. Thus, extensive monitoring effort at these areas, at the expense of other established sites, is often not accomplished. Expansion of the Monitoring Program's success will require innovative development of new funding sources. Reliance on volunteer contributions—a rare exception is the sort successfully implemented by the Ventura Audubon—is inconsistent with the methods of data collection that should be conducted.

The need for increased standardization of methodology was only briefly attempted in 1991 and is currently being developed for the 1992 season. Estimates of population size and fledgling success are dependent upon the method used to make the estimates and should be tightly controlled by the regional supervisor at all colonies. An instruction packet will be made available to all monitors prior to the 1992 season that includes updated mid and final season report forms, glossary of terms, and methods for monitoring, including conducting fledgling counts.

Predator Control - Selected predator control should continue at all sites, where appropriate or feasible. Early detection and prompt exclusion or removal of tern predators is clearly linked to fledgling success. Only rare colonies seem to succeed without intervention (e.g., Upper Newport Bay). A fenced enclosure is the first step in protection of many nesting sites. Often, protecting a site to increase hatching success is the key to good productivity. At other sites, hatching success may be relatively high, but chick and fledgling success may quite low. Thus, some sites benefit greatly from simply erecting temporary fencing to enhance hatching and fledgling success and, at other sites, more complex predator control measures, such as removal or relocating problem individuals, may be necessary to increase productivity. Increased involvement by Animal Damage Control (ADC) to remove specific, documented predators and to act as consultants in identifying predators or predation risks is warranted. A stable funding base to cover such contingencies should be sought. Concurrent to virtually any predator control program should be an education campaign to stem the tide of ill-informed and negative public response, particularly in terms of exotic animal control.

Although our ability to recognize and deal with predators has evolved greatly over the past several years, many field monitors and land managers remain frustrated by the emphasis on "crisis management" (removal of predators only after damage has done). This policy impacts not only the breeding success of Least Terns but also the morale of the program participants. Currently Least Tern monitors are working with the California Department of Fish

and Game and the U.S. Fish and Wildlife Service for monitors to effect a clear set of step-by-step predator reaction procedures. The reaction procedures will be initiated by the field monitor, but they will be in contact with the regional representative and appropriate agency personnel before any actual predator removal.

While spot removal of certain predators may be time-consuming or complicated by a regimented chain of command, wholesale removal of all potential predators is not feasible nor appropriate. Extirpation of all local predators prior to the nesting season's onset, collides with the broader goals of managing coastal wetlands to retain some semblance of their natural biodiversity. This conflict is especially clear in the case of controlling native raptors which may be serious Least Tern predators but are themselves rare (Burrowing Owl, Northern Harrier) or endangered (Peregrine Falcon). Intense predator management at key sites with historically high productivity (e.g., FAA Island, Santa Margarita River, Venice, Bolsa Chica, NAS Alameda, and Seal Beach NWR), with spot removal of individual problem animals at other sites, may ultimately be the best approach. The pre-season removal of exotic or feral predators should continue. The need for explicit policies regarding predator management is now critical to ensure both the continued success of the terns and the health of the protection program.

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TABLE 1 - CALIFORNIA LEAST TERN COLONY SIZE AND FLEDGLING SUCCESS - 1991.

| COLONY\NESTING SITE | PAIRS | FLEDGLINGS |
|--------------------------|---------|------------|
| S.F. BAY AREA | | |
| P.G.E. Pittsburg | 2 | 3 |
| Port Chicago | 0 | 0 |
| NAS Alameda | 108-112 | 131-144 |
| Oakland Airport | 0 | 0 |
| Tern Isl. , Hayward | 0 | 0 |
| S.L.O./S.B. CO's | | |
| Mussel Rock Dunes | 35 | 27 |
| Pismo Dunes | 6 | 4 |
| San Antonio Creek | 0 | 0 |
| Purisma Point | 10 | 0 |
| Santa Ynez River | 0 | 0 |
| VENTURA CO. | | |
| Santa Clara River | | 24 |
| north | 2 | |
| mcgrath beach | 12 | |
| mcgrath lake | 12 | |
| Ormond Beach | | 12-14 |
| edison | 5 | |
| west | 12 | |
| Point Mugu | 50 | 55-60 |
| L.A./ORANGE CO. | | |
| Venice Beach | 198 | 200 |
| Terminal Island | 2 | 0 |
| Seal Beach NWR (Anaheim) | 189 | 276-291 |
| Bolsa Chica | | |
| north island | 0 | 0 |
| south island | 159 | 79-110 |
| Huntington Beach | 72 | 51 |
| U. Newport Bay | 90 | 31 |
| SAN DIEGO CO. | | |
| White Beach | 33 | 52 |
| Santa Margarita River | | |
| north beach | 259 | 294 |
| saltflats | 36 | 44 |
| saltflats isl. | 33 | 39 |
| Buena Vista Lagoon | 0 | 0 |
| Agua Hedionda Lagoon | 0 | 0 |
| Batiquitos Lagoon | | |
| mouth | 24 | 28-34 |
| park and ride | 11 | 4 |
| east | 0 | 0 |
| San Elijo Lagoon | | 5 |
| islands | 5 | |
| saltpan | 5-8 | |
| | | |
| | | |

TABLE 1 - CALIFORNIA LEAST TERN COLONY SIZE AND FLEDGLING SUCCESS - 1991.

| COLONY/NESTING SITE | PAIRS | FLEDGLINGS |
|---------------------|------------------|------------------|
| San Dieguito Lagoon | 0 | 0 |
| Los Penasquitos | 0 | 0 |
| F.A.A. Island | 125 | 124 |
| Mariner's Point | 125 | 130 |
| North Fiesta Island | 0 | 0 |
| Stony Point | 0 | 0 |
| South Shores | 0 | 0 |
| Cloverleaf | 0 | 0 |
| North Island, NAS | 28 | 13-37 |
| Delta Beach | 35 | 15-25 |
| Grand Caribe Island | 0 | 0 |
| D Street Fill | 45-47 | 38-42 |
| Chula Vista WR | 1 | 0 |
| Saltworks | 31 | 10 |
| Tijuana Slough NWR | | |
| north | 1 | 0 |
| south | 63 | 28 |
| TOTAL 1991 | 1825-1834 | 1729-1839 |
| 1990 | 1706 | 1487-1676 |
| 1989 | 1240 | 764 |

TABLE 2 - CALIFORNIA LEAST TERN CLUSTER SIZE AND FLEDGLING SUCCESS, 1991

| CLUSTER | PAIRS Range [mean] | FLEDGLINGS Range [mean] | MEAN RATIO fledglings:pair |
|-----------------------------------|-----------------------|----------------------------|-------------------------------|
| | | | |
| CONTRA COSTA/ ALAMEDA | 110-114 [112] | 134-147 [141] | 1.26 |
| | | | |
| SAN LUIS OBISPO/ SANTA BARBARA | 52 | 43 | 0.83 |
| | | | |
| VENTURA | 93 | 91-98 [95] | 1.02 |
| | | | |
| LOS ANGELES/ ORANGE | 710 | 637-683 [660] | 0.93 |
| | | | |
| SAN DIEGO | 860-865 [863] | 824-868 [846] | 0.98 |
| | | | |
| TOTAL | 1825-1834 [1830] | 1729-1839 [1784] | 1.00 |

TABLE 3 - CHRONOLOGY OF CALIFORNIA LEAST TERN BREEDING EFFORT - 1991

| COLONY | ACTIVITY PERIOD | | DATE OF FIRST: | | |
|-------------------------|-----------------|---------|----------------|---------|-----------|
| | START | END | EGG | CHICK | FLEDGLING |
| S.F. BAY AREA | | | | | |
| P.G.E. Pittsburg | 9 May | 18 May | 30 May | 20 June | 5 July |
| NAS Alameda | 25 April | 21 Aug | 13 May | 4 June | 23 June |
| S.L.O./S.B. CO's | | | | | |
| Mussel Rock Dunes | 27 April | 5 Aug | 18 May | 8 June | 6 July |
| Pismo Dunes | 3 May | 30 Aug | 26 May | 15 June | unknown |
| Purisma Point | 29 April | 2 Aug | 16 May | 6 June | 17 July |
| VENTURA CO. | | | | | |
| Santa Clara River | | | | | |
| north | 2 May | 21 Sept | 2 June | 22 June | 9 July |
| mcgrath beach | 2 May | 21 Sept | 31 May | 17 June | 9 July |
| mcgrath lake | 2 May | 21 Sept | 21 May | 9 June | 9 July |
| Ormond Beach | | | | | |
| edison | 13 May | 7 Aug | 8 June | 1 July | unknown |
| west | 13 May | 23 Aug | 8 June | 29 June | 21 July |
| Point Mugu | 20 May | 21 Aug | unknown | 11 July | 11 July |
| L.A./ORANGE CO. | | | | | |
| Venice Beach | 6 May | 4 Aug | 2 May | 23 May | 30 June |
| Terminal Island | 17 Apr | 19 July | 27 June | 17 May | none |
| Seal Beach NWR | 9 Apr | 26 June | 30 Apr | 22 May | 5 June |
| Bolsa Chica | 3 May | 7 Aug | 3 May | 25 May | 26 June |
| Huntington Beach | unknown | unknown | unknown | unknown | unknown |
| U. Newport Bay | 7 May | 23 July | 7 May | 24 May | 26 June |
| SAN DIEGO CO. | | | | | |
| White Beach | 28 Apr | 4 Aug | 7 May | 30 May | 27 June |
| Santa Margarita | | | | | |
| north beach | 3 Apr | 31 Aug | 4 May | 25 May | 20 June |
| saltflats | 3 Apr | 13 Aug | 8 May | 27 May | 9 July |
| saltflats isl. | 10 Apr | 8 Aug | 7 May | 30 May | 9 July |
| Batiquitos Lagoon | | | | | |
| mouth | 21 Apr | 11 Aug | 18 May | 9 June | 19 June |
| park and ride | 2 June | 11 Aug | 2 June | 23 June | 30 June |
| San Elijo Lagoon | 27 Apr | 14 Sept | 23 May | 13 June | 4 July |
| F.A.A. Island | 22 Apr | 11 Aug | 2 May | 22 May | 18 June |
| Mariner's Point | 20 Apr | 19 Aug | 3 May | 22 May | 19 June |
| North Island, NAS | 24 Apr | 4 Aug | 6 May | 29 May | 19 May |
| Delta Beach | 18 Apr | 26 Aug | 12 May | 3 June | 24 June |
| D Street Fill | 24 Apr | 25 Aug | 13 May | 1 June | 16 June |
| Chula Vista WR | 27 Apr | 28 June | 21 May | none | none |
| Saltworks | 2 May | 2 Aug | 6 May | 7 June | 28 June |
| Tijuana Slough NWR | 18 Apr | 10 Sept | 14 May | 4 June | 25 June |

TABLE 4 - CLUTCH SIZE OF CALIFORNIA LEAST TERNS, 1991.

| COLONY | NUMBER OF CLUTCHES | | | CLUTCH SIZE | |
|-------------------------|--------------------|-------------|------------|-------------|-------------|
| | 1 EGG | 2 EGGS | 3 EGGS | MEAN | S.D. |
| S.F. BAY AREA | | | | | |
| NAS Alameda | 12 | 102 | 5 | 1.94 | 0.37 |
| S.L.O./S.B. CO'S | | | | | |
| Pismo Dunes | 2 | 4 | 1 | 1.86 | 0.7 |
| Mussel Rock Dunes | 1 | 26 | 9 | 2.22 | 0.48 |
| Purisma Point | | 14 | | 2.0 | 0 |
| L.A./ORANGE CO'S | | | | | |
| Terminal Island | | 2 | | 2.0 | 0 |
| Venice | 23 | 150 | 37 | 2.07 | 0.53 |
| Bolsa Chica | 32 | 124 | 11 | 1.87 | 0.49 |
| Seal Beach NWR | 16 | 139 | 26 | 2.06 | 0.48 |
| SAN DIEGO CO. | | | | | |
| White Beach | 5 | 30 | 4 | 1.97 | 0.49 |
| North Beach | 16 | 233 | 23 | 2.03 | 0.38 |
| Saltflats | 2 | 33 | 5 | 2.08 | 0.42 |
| Saltflats Island | 4 | 30 | 2 | 1.94 | 0.41 |
| San Elijo Lagoon | 0 | 10 | 2 | 2.17 | 0.39 |
| Chula Vista | | 1 | | | |
| D Street | 8 | 48 | 3 | 1.92 | 0.43 |
| FAA Island | 3 | 114 | 18 | 2.11 | 0.38 |
| Mariner's Point | 10 | 108 | 20 | 2.07 | 0.46 |
| Delta Beach | 12 | 51 | 0 | 1.81 | 0.4 |
| NAS, North Island | 1 | 27 | 2 | 2.03 | 0.32 |
| Saltworks | 9 | 42 | 4 | 1.91 | 0.48 |
| Tijuana Slough NWR | 7 | 75 | 8 | 2.01 | 0.41 |
| TOTAL | 163 | 1363 | 180 | 2.0 | 0.45 |

TABLE 5 - PREDATORS AT CALIFORNIA LEAST TERN COLONIES, 1991.

| COLONY | DOCUMENTED PREDATOR | | SUSPECTED PREDATOR | |
|---|---------------------|-----------|--------------------|-----------|
| | Avian | Mammalian | Avian | Mammalian |
| S.F. BAY AREA | | | | |
| P.G.E. Pittsburg | | | | |
| NAS Alameda | H,K | | | |
| Oakland Airport | | | H | |
| S.L.O./S.B. CO's | | | | |
| Mussel Rock Dunes | | | | |
| Pismo Dunes | | | | |
| Purisma Point | | | | |
| VENTURA CO. | | | | |
| Santa Clara River | | | | |
| Ormond Beach | | | | |
| Point Mugu | | | | |
| L.A./ORANGE CO. | | | | |
| Venice Beach | C | | | |
| Terminal Island | | | | |
| Seal Beach NWR | K | | | |
| Bolsa Chica | K,R,Y | | M | |
| Huntington Beach | | | | |
| U. Newport Bay | | | | |
| SAN DIEGO CO. | | | | |
| White Beach | | | O | N |
| Santa Margarita | | | | |
| north beach | R | | | |
| saltflats | O | | | |
| saltflats isl. | | | | |
| Batiquitos Lagoon | | | | |
| mouth | | | | A |
| park and ride | | | | |
| San Elijo Lagoon | | | K | A |
| F.A.A. Island | | | G | |
| Mariner's Point | | | B | |
| North Island, NAS | | | K | |
| Delta Beach | | | B | |
| D Street Fill | | | | |
| Chula Vista WR | | | | |
| Saltworks | | | P | |
| Tijuana Slough NWR | | | | |
| Abbreviations: A - Raccoon, B - Western Gull, C - American Crow, G - Gull sp., H - Northern Harrier, K - American Kestrel, M - Western Meadowlark, O - Owl sp., P - Peregrine Falcon, R - Common Raven, Y - Red-tailed Hawk | | | | |

TABLE 6 - SOURCES OF DISTURBANCE AT CALIFORNIA LEAST TERN COLONIES, 1991

| COLONY | DISTURBANCE FACTOR | | |
|--|--------------------|--------|-------|
| | Human | Animal | Other |
| S.F. BAY AREA | | | |
| P.G.E. Pittsburg | | | |
| NAS Alameda | | | Q |
| Oakland Airport | | Z | |
| S.L.O./S.B. CO's | | | |
| Mussel Rock Dunes | P | | |
| Pismo Dunes | | | |
| Purisma Point | | | |
| VENTURA CO. | | | |
| Santa Clara River | | | |
| Ormond Beach | P,V | D | F |
| Point Mugu | | | F |
| L.A./ORANGE CO. | | | |
| Venice Beach | | | |
| Terminal Island | | | S |
| Seal Beach NWR | | Z* | |
| Bolsa Chica so.isl. | | Z* | |
| Huntington Beach | | Z* | |
| U. Newport Bay | | | |
| SAN DIEGO CO. | | | |
| White Beach | | | |
| Santa Margarita | | | |
| north beach | | | |
| saltflats | | | |
| saltflats isl. | | | |
| Batiquitos Lagoon | V | | |
| mouth | | | |
| park and ride | P | D | |
| Buena Vista | | B | |
| San Elijo Lagoon | | | |
| F.A.A. Island | | B | |
| Mariner's Point | | | |
| North Island, NAS | | | |
| Delta Beach | | | |
| D Street Fill | C | | |
| Chula Vista WR | P | | |
| Saltworks | | | |
| Tijuana Slough NWR | P | | |
| Abbreviations: B - roosting birds, C - construction, D - dogs, F - flooding, P - pedestrians, Q - hypothermia, S - food shortage, V - vehicles Z - Red Fox, Z* - Red Fox (control required) | | | |

TABLE 7 - MONITORING EFFORT AT CALIFORNIA LEAST TERN COLONIES, 1991.

| COLONY | PRIMARY MONITOR | NUMBER OF VISITS |
|-------------------------|-------------------|------------------|
| S.F. BAY AREA | | |
| P.G.E. Pittsburg | L. Collins | 13 |
| NAS Alameda | L. Collins | 111 |
| Oakland Airport | L. Feeney | 45 |
| S.L.O./S.B. CO's | | |
| Mussel Rock Dunes | M. Perry | 32 |
| Pismo Dunes | R. Burton | 47 |
| Purisma Point | J. Dougherty | 38 |
| VENTURA CO. | | |
| Santa Clara River | D. Davis | 25 |
| Ormond Beach | D. Schafer | 39 |
| Point Mugu | G. Smith | 18 |
| L.A./ORANGE CO. | | |
| Venice Beach | C. Caffrey | 56 |
| Terminal Island | K. Keane | 22 |
| Seal Beach NWR | M. Silbernagle | 32 |
| Bolsa Chica, so. isl. | M. Rubega | 15 |
| Huntington Beach | J. Fancher | * |
| U. Newport Bay | M. Rubega | 11 |
| SAN DIEGO CO. | | |
| White Beach | J. Tutton | * |
| Santa Margarita | | |
| north beach | L. Belluomini | * |
| saltflats | D. Stadtlander | * |
| saltflats isl. | D. Stadtlander | * |
| Batiquitos Lagoon | J. Konecny | 13 |
| San Elijo Lagoon | R. Patton | 26 |
| F.A.A. Island | J. Price | 40 |
| Mariner's Point | G. Johnson | 36 |
| North Island, NAS | L. Belluomini | 93 |
| Delta Beach | M. Evans-Layng | 109 |
| D Street Fill | B. Foster | 57 |
| Chula Vista WR | D. Parker-Chapman | 15 |
| Saltworks | J. Price | 20 |
| Tijuana Slough NWR | R. Patton | 23 |

* NUMBER OF VISITS NOT REPORTED