From: Mike Murray
To: Britta Muiznieks
Subject: Re: Least Tern Shelters
Date: 06/28/2007 04:33 PM
Attachments: BLSK Chick Shelters FL.pdf
Calif LETE 1998 annual report.pdf
LETE Shelters USNavy.doc
Interior LETE MO info.doc
Tern Chick Shelters Yorkshire GB.doc
LETE info Alameda WR.doc
LETE Mgt in GA.pdf
LETE Chick Shelters FL.pdf

Britta,

There are hundreds of references about using "shelters" for tern chicks and other CWB chicks. Many are nonspecific about what the shelter is made of. There are also a number of references about using ceramic roofing tiles for California least tern chicks. There are a few references specifically about using wooden pallets. Attached are a few representative references. Unfortunately, the issue of chick shelters is often only one or two sentences in a lengthy report. Where I could (if it was not a PDF file), I highlighted the references in blue. You will also see occasional mentions of "chick fence" in these references. There are many more about that if one searches for it. The references below were found by searching for "tern chick shelters" or similar variations.

BLSK Chick Shelters FL.pdf (See page 10, Minimizing the Effects of Weather and Flooding section)

Calif LETE 1998 annual report.pdf (Page 3, Site Preparation Section, which starts on p. 2, last paragraph; Table 1 near end of doc, Chick Shelter? column)

LETE Shelters USNavy.doc (See blue text)

Interior LETE MO info.doc (see blue text)

Tern Chick Shelters Yorkshire GB.doc (see section 8.)

LETE info Alameda WR.doc (see Project Description, paragraph 3)

LETE Mgt in GA.pdf (See p. 31,i.e., p. 5 of 8, last paragraph..."Various chick shelters..."

LETE Chick Shelters FL.pdf (see p. 5, Section 2, Shade and Shelter,. Suggests cinder blocks.)

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▼ Britta Muiznieks

Britta Muiznieks	To: Mike Murray/CAHA/NPS cc: Subject: Least Tern Shelters
06/28/2007 10:07 AM EDT	

Mike-
Can you get me a copy of the paper referencing the shelters?

Thanks,
Britta

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Management Opportunities and Techniques for Roof- and Ground-nesting Black Skimmers in Florida

FINAL PERFORMANCE REPORT

1 July 1995–30 June 1996

Lara Coburn
David Cobb
Jeff Gore

May 1997

Florida Game and Fresh Water Fish Commission
620 South Meridian Street
Tallahassee, FL 32399-1600

0019865

Management Opportunities and Techniques for Roof- and Ground-nesting Black Skimmers in Florida

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MANAGEMENT OPPORTUNITIES AND TECHNIQUES FOR ROOF- AND GROUND-NESTING BLACK SKIMMERS IN FLORIDA

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Abstract: The black skimmer is listed in Florida as a Species of Special Concern, and reproductive success is extremely important to the recovery of the species. Factors affecting reproductive success include predation, human disturbance, food availability, pollutants in the environment, habitat loss, and shifts in nesting from ground to roof colony sites. In this report, we outline pertinent aspects of black skimmer life history, summarize threats to their reproduction, and recommend management techniques to protect and enhance nesting areas. New projects to implement and test management techniques and to evaluate their impacts are also outlined. Although designed specifically for skimmer colonies, these recommendations may also benefit other beach- and roof-nesting birds in Florida.

INTRODUCTION

The black skimmer (*Rynchops niger*) is listed in Florida as a Species of Special Concern (Wood 1996), and reproductive success is extremely important to the recovery of the species. Factors affecting reproductive success include predation (Burger 1981*a*, Gochfeld 1981, Quinn 1989), human disturbance (Gochfeld 1981), food availability (Tomkins 1951; Erwin 1977*a,b*), pollutants in the environment (Hays and Risebrough 1972, Gochfeld 1975, Burger et. al. 1994), and habitat loss (Downing 1973). Skimmers have colonized alternative habitats (such as roofs) in conjunction with least terns(*Sterna antillarum*), presumably in response to disturbance by humans, predation, and a reduction in available habitat.

Cracked and crushed black skimmer eggs have been found in roof-nesting colonies in Florida, suggesting that these colonies may not be as productive as those on the ground (Greene and Kale 1976, Fisk 1978*a*, Gore 1987). Skimmers in ground and roof colonies in northwest Florida have been found to have low, but similar, reproductive rates (0.0–0.25 fledged chicks per nest). Hatching rates were higher in ground-nesting colonies, but fledging rates were higher in roof-nesting colonies (Coburn 1995).

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Although Gore (1991) suggested that black skimmer populations in northwest Florida were stable, there has been a marked shift in nesting sites (Downing 1973), which may have negatively impacted populations over time. Active management of roof colonies may help to increase low overall reproduction rates and positively impact state and regional breeding populations.

In this report, we outline pertinent aspects of black skimmer life history, summarize threats to their reproduction, and recommend management techniques to protect and enhance nesting areas. New projects to implement and test management techniques and to evaluate their impacts are also outlined. Although designed specifically for black skimmer colonies, these recommendations may also benefit other beach- and roof-nesting birds in Florida.

BIOLOGY AND NESTING ECOLOGY

Skimmers winter on the southern shores of the Gulf of Mexico (including Florida) and from western Mexico to Argentina and Chile (Clapp et al. 1983, Spendelow and Patton 1988, Stevenson and Anderson 1994). Their breeding range extends from Massachusetts to southern Florida on the Atlantic coast, from southern Florida to the Yucatan Peninsula on the Gulf coast, and from southern California to Ecuador on the Pacific coast (Loftin and Smith 1996). They also breed locally near San Diego, California, and inland at the Salton Sea (American Ornithologists Union 1983, Clapp et al. 1983, Spendelow and Patton 1988).

Skimmers typically arrive at their colony sites during April and May. In Florida, they arrive during mid- to late April, whereas in Texas they begin breeding during mid-March (Oberholser 1974, Stevenson and Anderson 1994). The time of arrival at the colony site affects their ability to produce multiple clutches (Bent 1921). Generally, skimmers nest near major ocean inlets or shallow estuaries (Portnoy 1977, 1978; Therres et al. 1978; Buckley and Buckley 1980) on bare or sparsely vegetated sand beaches, natural barrier islands, sand shoals, sandbars, and dredged material sites (Erwin 1977*b*, Barbour 1978, Buckley and McCaffrey 1978, Chaney et al. 1978, Gochfeld 1978, Parnell et al. 1978, Blus and Stafford 1980, Loftin and Smith 1996). They have also been found nesting at inland marsh sites, but these colonies tend to be smaller than those on sandy sites (Portnoy 1977, 1978; Erwin 1980; Erwin et al. 1981). In Florida, skimmers usually nest on open sand beaches, dredged material islands, and berms along highways and causeways (Schreiber and Schreiber 1978). They were first reported on roofs in south Florida in the 1970s (Greene and Kale 1976) and in northwest Florida in 1986 (Gore 1987). They have also been found nesting at inland sites (Langridge and Hunter 1986) and near lakes and rivers in the central and southern regions of the state (Sprunt 1954, Barbour 1978).

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Although skimmers prefer to nest in open unvegetated sites, they have been found in, and appear to tolerate, a wide range of habitats, usually nesting is the presence of terns (*Sterna* spp.) (Gochfeld 1978). This association may be due to the greater aggressiveness of the terns towards intruders (Gochfeld 1978, Erwin 1979). Skimmers nest in association with common terns (*S. hirundo*) and gull-billed terns (*S. nilotica*) on the Atlantic coast (Soots and Parnell 1975; Gochfeld 1976, 1978; Erwin 1977*b*, 1979; Buckley and McCaffrey 1978; Blus and Stafford 1980; Buckley and Buckley 1980) and with gull-billed terns, least terns, and Forster's terns (*S. forsteri*) in Florida (Fisk 1978*a,b*). Skimmers may also nest in colonies adjacent to those of laughing gulls (*Larus atricilla*), sandwich terns (*S. sandivicensis*), and royal terns (*S. maxima*), but there is usually no overlap between subcolonies (Blus and Stafford 1980). In some cases, the presence of royal and sandwich terns may cause black skimmers to desert a colony site.

Skimmer colony size is highly variable and can range from <10 pairs (Coburn 1995) up to 1,000 pairs (Spendelow and Patton 1988). There is a positive relationship between the number of terns and the number of skimmers found at a colony site. Large black skimmer colonies are more likely to be found in conjunction with large tern colonies (Gochfield 1978).

Skimmers are highly specialized tactile hunters and feed mainly on fish and aquatic invertebrates (Erwin 1977*a*). They have a laterally flattened, scissor-like bill, that is distinctive in that the lower mandible is longer than the upper. Skimmers feed by flying in a straight line over the water with the lower mandible below the surface. On contact with food, they snap their head down and close their bill (Tomkins 1951). Skimmers feed mainly at night, but they have also been seen wading into shallow pools during the day to pick up small fish (Zusi 1962, Barbour 1978).

There is distinct sexual dimorphism, with males being approximately one-fourth larger than females (Burger and Gochfeld 1990). Juveniles and non-breeding adults are separable by the presence of a white band across the nape of the neck. There is little known about the age at which they first breed, but it is probably around 3 years. The oldest known black skimmer was 12 years old (Kennard 1975), however, this is probably a underestimate because many other larids live >20 years (Terres 1991).

Skimmers begin courtship (feeding, aerial chases, and displays) and copulation soon after they arrive on the breeding grounds. Courtship and copulation continue during nest creation, egg laying, and incubation. Eggs are laid above the high water mark in an unlined scrape approximately 3.5 cm deep and 10–15 cm in diameter (Terres 1991, Coburn 1995). Nests are generally

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widely spaced within the colony, with a nearest neighbor space of 198 ± 187 cm (Burger and Gochfeld 1990). Mean inter-nest distance is greater in colonies that contain few nests (542 ± 520 cm; 6 nests) than in colonies which are larger and contain more nests (121 ± 65 cm; 35 nests) (Burger and Gochfeld 1990).

Egg laying begins in May and continues through July (Erwin 1977*b*). If the first nest is destroyed early in the season, a second clutch will often be laid at a new site within the colony. In comparison with other seabirds, skimmers have an unusually large clutch of eggs (1–5). Clutches of more than 5 eggs may result from 2 females laying in 1 nest (Erwin 1977*b*). The egg laying period lasts from 4 to 8 days. Eggs are laid either on successive or alternate days, but rarely on the same day. The length of the incubation period is 21–26 days, but there is disagreement as to which sex incubates (Burger 1981*b*, Burger and Gochfeld 1990, Terres 1991).

Skimmers attend and guard their chicks until they fledge. Adult aggression increases at hatching because small chicks are easily killed by conspecifics and predators. Skimmers may kill small tern and black skimmer chicks that wander into their territories (Safina and Burger 1983). Until they fledge, chicks are fed partially digested and whole fish, primarily by the male parent (Burger and Gochfeld 1990). Chicks can leave the nest after a few days, but do not fledge until they are approximately 21–23 days old.

When an intruder approaches, young chicks crouch in the sand or near vegetation. They create their own scrapes using the same sand-kicking behavior used by adults to create nest scrapes (Bent 1921, Hays and Donaldson 1970). In the event of a human intruder, adult skimmers may lead their chicks several hundred meters away from the nest (Burger and Gochfeld 1990). For chicks, consequences of running from the nest can include being eaten by predators or conspecifics, being subjected to aggression from neighboring territorial adults, being separated from their parents for a time sufficient to cause debilitation or starvation, and/or being exposed to the effects of sun or rain (Gochfeld 1981).

Erwin (1977*b*) saw strong expressions of hatching asynchrony and sibling dominance and found that 10 of 11 chicks fledged were first-hatched chicks. This may be due to food limitations. Dorward (1962) suggested that sibling aggression found in boobies and gannets (Sulidae) is related to severe food limitation. Male chicks begin to grow more rapidly than females after about 11 days. Male chicks fledge at an average of 295 grams, while female chicks fledge at 264 grams. Fledged chicks remain near the colony site until late August or September (Erwin 1977*b*).

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THREATS TO COLONIES AND REPRODUCTION

Habitat Loss

The most critical requirement of black skimmers is undisturbed nesting sites because eggs, nestlings, and adults are highly vulnerable to disturbance (Loftin and Smith 1996). However, beach-nesting habitat suitable for skimmers is being lost at an alarming rate. Erosion has reduced the amount of sand remaining above the high tide line (Downing 1973) and beach and dune areas have been developed for residential purposes. Most of the remainder has been developed into recreational areas with roads, parking lots, public beaches, restaurants, and marinas. Due to the increased development of beach habitats and the associated recreational use of undeveloped beaches, especially during the breeding season (Barbour 1978), skimmers have begun nesting on alternative substrates and in alternative habitats, including gravel covered roofs, salt marshes, dredge material deposits, and causeways (Frohling 1965; Downing 1973; Greene and Kale 1976; Fisk 1978*a,b*; Gore 1987; Burger and Gochfeld 1990; Coburn 1995). In Florida, however, dredge material deposits are often sandy areas frequently used for recreation, and causeways typically support high levels of automobile traffic.

This extremely heavy competition from humans for beach and dune habitat has left most colonial seabirds access to only a few fragments of their former nesting range. There are relatively few colonies of skimmers and terns found on natural sites along the Atlantic coast (Gochfeld 1978). Perhaps <20% of all least tern and black skimmers east of the Mississippi River nest on natural sites (Downing 1973). Gore (1991) found a majority of black skimmer colonies in northwest Florida on roofs.

Direct Human Disturbance

Human disturbance has been implicated as a cause of colony abandonment and lowered reproductive success in several species of colonial nesting waterbirds (Buckley and Buckley 1972, Nisbet and Drury 1972, Conover and Miller 1978, Manuwal 1978), including black skimmers (Safina and Burger 1983, Potter 1992, Coburn 1995).

Recreational uses of beaches adjacent to black skimmer colonies pose a major threat to colony success. Humans directly disturb colonies by approaching, standing, or walking along the periphery; entering, walking, or driving through the colony; and exploring and remaining in the colony for recreational activities. The major impact of these activities on breeding

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skimmers is the interruption of incubation, brooding, and feeding. This is most detrimental during the hot portion of the day, as unattended eggs and chicks can quickly overheat (Burger and Gochfeld 1990).

In addition to humans walking in or near colonies, other activities can have a detrimental impact on the success of black skimmer colonies, including the use of jet skis, boats, cars, and off-road vehicles near or in colonies (Burger and Gochfeld 1990, Coburn 1995). Potter (1992) noted that 8 out of 11 dead adult skimmers found on the JFK Causeway in Laguna Madre, Texas, were killed by collisions with automobiles.

Deliberate attempts to harm adults, eggs, or chicks have been noted in Massachusetts (Austin 1933, 1946), New Jersey (Burger and Gochfeld 1990), and New York (Gochfeld 1974, Post and Gochfeld 1979), however, few incidents of vandalism have been noted in black skimmer colonies in Florida. Signs posted around colonies and the vigilance of beach residents probably help to keep these incidents to a minimum.

Environmental Contamination

Eggshell thinning due to environmental contaminants has been associated with nesting failure (Ratcliffe 1967). Thinning was not noticed in black skimmer eggs in New York, New Jersey, South Carolina, or northwest Florida (Blus and Stafford 1980, Burger and Gochfeld 1990, Coburn 1995), but has been observed in Texas (White et al. 1984). From 1978 to 1981, White et al. (1984) found DDE residues up to 51 ppm, with 35% of all eggs tested containing ≥10 ppm. Eggshells were 4–12% thinner than normal, but residue levels were not significantly correlated with shell thickness (White et al. 1984). These levels of contamination were, however, within the range of values known to negatively affect reproduction in other avian species (L. Stickel 1973, W. Stickel 1975).

Shell-less eggs can also be a result of contamination. Burger and Gochfeld (1990) found a few shell-less eggs each year (0.5% of all eggs laid), usually scattered around the colony rather than in nests. Tejning (1967) showed that organomercurial contamination in hens produced an increase in the number of shell-less eggs laid outside the nests.

Custer et al. (1983) and Nisbet and Reynolds (1984) provided evidence that local variation in organochlorine levels in tern eggs and young were related to local variation in residues in their food. King (1989) found DDE and PCB in fish eaten by black skimmers in Galveston Bay, Texas.

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Data on metals in estuarine sediments in New York revealed ample opportunity for them to enter the black skimmer food chain (Greig and McGrath 1977). Mercury, cadmium, lead, and selenium have been found in skimmers from Galveston Bay, Texas (King and Cromartin 1986). All indications suggest that skimmers become contaminated through fish, their primary food item.

An inconsequential number of oiling events have been reported for black skimmers (Burger and Gochfeld 1990).

Food Availability

Lack (1954) hypothesized that food is the major limiting factor in bird populations in general, and low black skimmer fledging success in Virginia has been attributed to limited prey availability (Erwin 1977*a*). Custer and Mitchell (1987) found evidence of contamination in dead young, but attributed the majority of deaths to starvation. Large fish kills, due to high levels of organochlorine contaminants, reduced the availability of food for chicks.

Accidents and Entanglements

Black skimmers have been observed entangled in fishing gear (Nickell 1964; L. Coburn, pers. obs.), kite strings, and plastic six-pack rings (Gochfeld 1973*a,b*). Skimmers have also been known to be entangled in natural vegetation (Burger and Gochfeld 1990). Metal wire fences enclosing sites have also caused injury to young that fly or run into them (Potter 1992).

Weather and Flooding

Direct impacts of storms—particularly hurricanes—to birds include the geographical displacement of individuals and increased mortality due to high winds, heavy rains, storm surges, and flooding (Wiley and Wunderle 1993). Bare sand washes and blows readily during storms and can force adults to leave nests unattended (Downing 1973). Eggs can tolerate short periods of inundation, but the major threat is the lethal chilling of embryos. Young chicks are most vulnerable to overheating, but older chicks are more susceptible to chilling from rain (Burger and Gochfeld 1990). Potter (1992) reported that storm events were the primary cause of black skimmer nest failure on the JFK Causeway over the Laguna Madre, Texas.

Indirect impacts include the loss of food supplies, nests, and nesting sites (Wiley and Wunderle 1993). Weather and flooding have been implicated as major reasons for black skimmer nest failure (Burger 1982, Morgan 1982,

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White et al. 1984, Potter 1992, Coburn 1995), and Florida is particularly susceptible to severe storms and hurricanes during the summer. Colonies on low-lying areas are easily inundated by storm surges and high tides associated with these weather events.

Predation

Predation is a major threat to colonies and has been identified as a primary factor in black skimmer colony abandonment (Burger 1982) and loss of eggs and young in some colonies (DePue 1974, Morgan 1982, Coste and Skoruppa 1989, Burger and Gochfeld 1990, Coburn 1995). Typical mammalian predators include foxes (*Vulpes vulpes*, *Urocyon cinereoargenteus*), coyotes (*Canis latrans*), raccoons (*Procyon lotor*), and feral dogs and cats. Avian predators impacting black skimmer colonies include owls (Strigidae), laughing gulls, ruddy turnstones (*Arenaria interpres*), fish crows (*Corvus ossifragus*), grackles *(Quiscalus* spp.), and great blue herons (*Ardea herodias*) (Parkes et al. 1971, DePue 1974, Morgan 1982, Greene and Kale 1976, Potter 1992, Coburn 1995).

Cracking of Eggs on Roofs

In northwest Florida, Coburn (1995) found that roof-nesting black skimmers had a lower hatching rate (8%) than those nesting on the ground (68%). Roof nesting generally fails because the eggs develop cracks, caused in part by the incubating adults. Black skimmer nests on roofs are significantly shallower than those on the ground (1.7–2.0 cm and 3.4–4.9 cm, respectively). The problem may be a lack of sides on the nest needed to distribute the incubating bird's weight, or that the gravel or hard roof concentrates the bird's weight onto a single point on the egg, causing it to crack. Cracks can be monitored as they become larger, and eventually the egg becomes crushed or the contents leak out (Coburn 1995). Cracked eggs have not been seen in ground colonies, however, they have been documented in roof colonies in various areas of Florida (Greene and Kale 1976, Gore 1991, Coburn 1995), suggesting that it is not a localized problem.

MANAGEMENT AND PROTECTION OF GROUND COLONIES

The main threats to black skimmer ground colonies in Florida include disturbance, predation, flooding and weather, vegetative succession, food availability, and lack of suitable nesting habitat. The following actions can be taken to minimize these threats, protect black skimmer ground colonies, and maintain nesting sites.

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Limit Human Disturbance

Human disturbance of black skimmer ground colonies can be deterred somewhat by posting signs around the periphery of the colony. Signs nailed to wooden posts spaced 6–30 m apart (O'Meara and Gore 1988) should be placed 100–200 m from the edge of the colony (Erwin 1989). Rope can be strung between the signs as a further deterrent. Fencing provides added protection by providing a physical barrier to humans and vehicles. Plastic fencing attached to heavy metal rods can be placed 100–200 m around the edge of the colony; wire fencing is not recommended as it may result in injury to young birds (Potter 1992).

Signs, rope, and/or fencing should be in place at traditional nesting sites prior to 1 April (i.e., before migrating terns and skimmers arrive at the site). All protection activities should be completed either in the early morning or late afternoon to minimize heat stress.

Fences, rope, signs, and posts should be maintained throughout the season, as strong storms and high winds can damage them. All items should be removed from the sites at the end of the breeding season, usually in late August. Signs are available from the regional nongame wildlife biologist in each regional office of the Florida Game and Fresh Water Fish Commission (see Appendix A).

Sites should be monitored for human intrusion periodically during the breeding season. If human disturbance becomes and remains a problem, enforcement of state and federal laws protecting black skimmers and their nesting sites may be necessary. Educating beachgoers, both residents and tourists, is also effective in deterring humans from entering or otherwise disturbing colonies. People seem to be less likely to disturb colonies once they learn why it is important to minimize disturbance of the birds (L. Coburn, pers. obs.).

Another important consideration is limiting disturbance by bird watchers, nature photographers, bird banders, and biologists. If it is necessary for biologists or other investigators to monitor colonies, visits should be made in the early morning or late afternoon in order to limit exposure of eggs and chicks to the weather. Visits should be limited in duration (<30 minutes if possible) to minimize the amount of time each bird is kept off its nest. Investigators should also wear drab colored clothing, avoid looking directly at the birds, and approach the colony in an oblique manner (Burger and Gochfeld 1981).

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Exclude and Control Predators

Black skimmers rely heavily on aggressive terns to thwart potential predators, however, predation from mammals and birds continues to be a problem in ground colonies (Coburn 1995). Fencing may be used to partially excluded mammalian predators from colonies. This may deter some large predators such as dogs, foxes, and coyotes. Electric fencing has been suggested to control smaller mammalian predators and those that can climb plastic fences (O'Meara and Gore 1988), however, this may injure or kill young skimmers or terns that accidentally run or fly into it.

Domestic animals, such as dogs and cats, should be kept off the beaches as they will chase adults and eat eggs and chicks. State and federal regulations should be consulted before initiating any program to trap or kill feral cats or dogs and other wild animals responsible for the destruction of nests or colonies.

Most avian predation occurs after an initial human disturbance, when adults leave the nest to attack the intruder. This behavioral response leaves nests, chicks, and eggs unattended (Austin 1929). The key to limiting avian predation is limiting human disturbance to the colony. Some avian predators (e.g., laughing gulls) can be partially controlled by limiting vegetative succession and decreasing the amount of available nesting habitat for species other than skimmers and terns. Burger and Gochfield (1990) suggested that when gulls first begin to nest at or near a black skimmer or tern colony, it is important to eliminate the nest, thereby discouraging further nesting by gulls. If the nest is left intact and is successful, 1 pair can serve as a nucleus, attracting dozens or even hundreds of pairs within 2 or 3 years (Burger and Gochfeld 1990). Again, state and federal regulations should be consulted before any action is taken.

Minimize the Effects of Weather and Flooding

Little can be done to prevent storms or flooding from damaging colony sites and destroying chicks and embryos. However, the extent of the damage can be mitigated somewhat by limiting human disturbance so adults do not leave nests unattended. Also, wooden pallets or boards can be placed on the site to provide shelter for chicks. These shelters can also provide shade for chicks during the hottest portion of the day.

Platforms can be built on low-lying sites that are frequently over washed by storm surges and high tides. This would entail placing wooden pallets end to end over the colony site and covering the pallets with clean dredge material. Sand could also be placed on the site without pallets, but the pallets may help anchor

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the sand. Elevated platforms can also be used. Decoys may help to insure that terns and skimmers nest on the elevated site. Any work should be completed and decoys should be in place prior to 1 April in order to attract returning birds.

Control Vegetation

Skimmers prefer to nest in open, unvegetated sites (Spendelow and Patton 1988) but will nest in a wide range of habitats in order to nest with terns (Gochfeld 1978). Vegetation should, therefore, be managed to accommodate the species of tern that skimmers nest with, primarily least terns. Least terns prefer to nest on sites that have approximately 4% vegetative cover (Burger 1984) found in dispersed clumps (Thompson and Slack 1982).

Removing vegetation is preferable to killing it without removal. Vegetation can be removed manually or with roto-tillers, bulldozers, tractors, or plows (O'Meara and Gore 1988). Vegetation can also be covered with dredge material. Methods of killing vegetation include spraying with salt water or with Ureabore, a highly concentrated salt compound (Kotliar and Burger 1984). Herbicides can also be used, but their use should be limited because of the threat of environmental contamination. Any efforts to control, remove, or kill vegetation should be completed at traditional nesting sites prior to 1 April in order to minimize disturbance to returning terns and skimmers.

Protect and Maintain Feeding Sites

Most black skimmer ground colonies are within close proximity to estuaries, bays, the Gulf of Mexico, or the Atlantic Ocean. Food is probably not a limiting factor in these cases, however, environmental contamination may result in fish kills or sublethal contamination of fish. These situations have not been noted in Florida to date, but close monitoring of the food supply is necessary. Due to the size of the water bodies used as feeding sites by black skimmers, measures to protect these areas may not be feasible. Periodic monitoring of fish and black skimmer egg contents may, however, help to identify trends and elucidate possible reasons for reproductive failures if they occur.

Provide Additional Habitat

Nesting habitat can be created for least terns and black skimmers (Loftin and Smith 1996). Dredged material can be deposited on existing beaches or barrier islands when vegetative succession has occurred. This may be ideal if the site has been used previously, is relatively free of mammalian predators, and has low levels of human disturbance. Dredge material can also be deposited offshore to create islands of new habitat. The sand should be clean

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and can be a mixture of sand and shell; clay and silt should be avoided as eggs can become glued to the finer particles in wet weather (Thompson and Slack 1982). Small amounts of shell debris may serve to increase the site's attractiveness to terns (O'Meara and Gore 1988) and skimmers. Dredge spoil islands should be built high enough to avoid being washed over by high tides and should also be large enough to provide some temporal stability, as they will erode over time due to wave action and storms. The islands should have a slight slope to allow for drainage, but if the slope is too great, heavy rains and high winds will erode the sand quickly, possibly covering nests and eggs and burying chicks. Shade for chicks can be provided with wooden pallets. Created sites should be posted to deter human disturbance and the islands should be monitored for mammalian predators and to control vegetative succession.

Decoys have been used successfully to attract terns and skimmers to suitable nesting habitat, both new or unused (Slaydon 1981, Kress 1983, Kotliar and Burger 1984). Decoys can be made from styrofoam or wood, with a dowel placed in the underside of the model for mounting in the sand. Decoys representing both species should be used on the site and placed in pairs or singly about 1.5 m apart (O'Meara and Gore 1988). All decoys should be in place prior to 1 April and can be removed once birds colonize the site. Nonaggressive sounds of nesting terns and skimmers can be played to further attract birds to the site (Kress 1983). Although decoys have been used successfully in the first year at 2 sites in northwest Florida (Florida Game and Fresh Water Fish Commission, unpubl. data), decoys and recordings may have to be used for several years before terns and black skimmers colonize a site (Kotliar and Burger 1984).

MANAGEMENT AND PROTECTION OF ROOF COLONIES

The primary cause of reproductive failure of black skimmers on roofs is the cracking of eggs (Greene and Kale 1976, Gore 1987, Coburn 1995). Other factors impacting roof colonies include human disturbance, predators, weather and flooding, and food availability. Several actions can be taken to limit the effects of these factors and to increase the reproductive success of skimmers on roofs.

Limit Disturbance

Due to the nature of their location, roof colonies are not subject to the amount of intense disturbance ground colonies endure. Maintenance workers and biologists are typically the only humans present in roof colonies. Unnecessary visits should be avoided throughout the breeding season, and, if

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necessary, visits should be made early in the morning and limited in duration. Eggs on roofs are well camouflaged and difficult to see, thus, care should be used to avoid stepping on eggs or young chicks. Mobile chicks will run from the nests when a human enters the colony, and will often inadvertently run off the side of the roof. Therefore, if walking on the roof, care should be used to avoid running chicks. Chicks that fall off roofs are generally able to survive and should be returned to the colony.

Exclude Predators

Roofs are generally inaccessible to mammalian predators, but cats and raccoons may be able to climb onto them. Maintenance workers should be consulted, and if mammalian predators are found on roofs they should be trapped and destroyed. Preventive measures should then be taken to preclude access to roofs by other mammalian predators that may locate the colony. Avian predators that can impact roof colonies are usually chased away by terns, but wooden pallets can be placed in the colony to provide cover for chicks. Human disturbance should be minimized to prevent providing predators with the opportunity to attack unattended eggs and chicks.

Minimize the Effects of Weather and Flooding

Heavy rains can flood nests, leaving eggs and young chicks in standing water. Eggs can float away in high water or can be blown out of nests by high winds. A slight pitch (i.e., $\leq 5^\circ$) in the roof may help provide drainage and decrease the amount of standing water. Roofs on new buildings should have a slight pitch and sufficient drainage routes incorporated into their design.

Roofs provide chicks with some protection from storms. During severe weather or during the hot portion of the day, chicks that are able to leave the nest can crouch in the corner of the parapets or by the side of roof structures to avoid wind, rain, and the sun. Wooden pallets can also be added in the middle of roofs to provide shade.

Maintain Feeding Sites

Black skimmer roof nesting sites are found at varying distances from large bodies of water, and skimmers may be feeding at smaller sites closer to the roof. It is possible to watch birds leaving the colony and follow them to find their feeding sites. Smaller water bodies usually have lower numbers of fish and may be more susceptible to contamination. However, these smaller bodies of water are easier to monitor and manage than larger sites. Checking fish and eggs for contaminants may be worthwhile, and protection of feeding sites may be necessary.

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Increase Hatching Success

Increasing Nest Depth.—Eggshell cracking, the primary cause of reduced hatching success in roof-nesting skimmers, is probably a result of 2 factors: attributes of the gravel and the shallowness of nests. Experiments to increase nest depth on roofs has shown some evidence of increased hatching success (Coburn 1995). Nest depth has been shown to have a significant positive relationship with hatching success, and a uniform thicker layer of gravel may provide the needed support for the brooding adults' body weight. An increase of 2.5 cm of gravel, creating an average depth of at least 4.0 cm on the roof, may help improve hatching. Construction gravel is not expensive and the main cost would be in transporting gravel to the site and placing it on the roof.

Building owners and managers should be consulted about augmenting the gravel cover on their roofs. Several owners in northwest Florida have been cooperative. The gravel should be added prior to 1 April to insure that when the birds arrive no humans or equipment will be on the roof, causing the birds to colonize elsewhere. The gravel should be of the same type and color as is already in place.

Decrease Gravel Size.—The most significant problem related to the gravel substrate is individual particles becoming embedded in the underlying tar and protruding up into the nest. Very shallow nests with loose gravel under the eggs also characteristically produce cracked eggs. The effect of the larger gravel is somewhat mitigated in deeper nests in which a depression can be made for the eggs and the edges of the nest can support the body weight of the adult (Coburn 1995). Although it does not appear that gravel size is the most important factor in the cracking of the eggs, this attribute is probably important. Gravel typically found on roofs varies in size from 4.9 mm to 16 mm in diameter (Coburn 1995). When adding gravel to roofs to increase nest depth, it may be prudent to use a smaller size (i.e., <4.9 mm).

Prevent Flooding.—In order to improve drainage, a slight pitch or slope can be added to a new roof during construction. However, this will not help those birds nesting on preexisting roofs. If roofs on which skimmers and terns nest are renovated, adding a slight pitch (i.e., $\leq 5^{\circ}$) could significantly improve nesting conditions. Well-constructed roofs do not collect standing water; roof designs or repairs that prevent roof leaking will also reduce the chance of flooding of skimmer nests.

Investigate the Possibility of Environmental Contamination.—Eggshell thinning should be investigated as a possible cause for cracking eggs at each location where cracks have been noticed. Cracked eggs from

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roofs can be compared with uncracked eggs from other sites and to historical data on black skimmer shell thickness. If a significant thinning has occurred, every effort should be made to protect feeding sites and reduce contamination. Site protection is often difficult, however, so initial efforts should be to alleviate substrate problems

Increase Fledging Success

Fence Roof Edges, Drain Pipes, and Vents.—Young chicks often fall off the sides of roofs, causing injury or death from the fall or from starvation. Fencing ≥15 cm in height made from plastic screen, plastic coated wire, or galvanized hardware cloth can be placed around roof edges that are not protected by a gutter. Although chicks may be injured by running into the wire, net survival should increase. Chicks can also fall into drain pipes and air conditioning vents unless these openings are fully screened.

Provide Protection for Chicks.—Wooden pallets can be placed on roofs to provide shade for young chicks during the hot portion of the day, shelter during severe weather, and protection from predators.

POPULATION ESTIMATION AND METHODS OF COLONY CENSUS

Censusing black skimmer colonies is necessary to monitor population and nesting habitat trends. Colony size can be estimated in several ways. Total numbers of adults can be estimated from the colony periphery by counting birds loafing at the colony site and adding the number of birds flying overhead. Nest numbers can be estimated by counting the numbers of unattended nests and the numbers of adults sitting on nests. These counts can be made from outside the colony using binoculars or a spotting scope. If the colony is very large, a portion of the colony can be counted and extrapolated to the entire colony. Estimates of roof colonies can be performed by counting the maximum number of adults observed in flight over the building (O'Meara and Gore 1988), although this method may greatly underestimate colony size (Gore 1991). Aerial photography is also effective in assessing total colony size, as the dark color of the skimmers contrasts with the light colored sand and roof gravel.

In order to assess nesting success, a survey within the colony is required. Only an experienced observer possessing the appropriate permits and permission from property owners should enter a colony. Serious studies of nesting success should involve periodic visits to each colony. Surveys should be performed either early in the morning or late in the afternoon in order to minimize disturbance. Visits should be limited to <30 minutes to minimize the

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amount of time each bird is kept off the nest. Nests on the ground can be marked with wooden tongue depressors and roof nests can be marked with metal washers or wooden blocks painted white and numbered. During each visit, nests, eggs, and chicks should be counted, and each egg checked for cracks.

In intensive studies of reproductive success, visits should be made once a week. For less comprehensive studies, visits and counts should be made ≤3 times during the nesting season in order to minimize disturbance to the colony. Generally, counts should be performed in late May to early June (egg laying and incubation period), mid- to late June (hatching), and July (fledging) (O'Meara and Gore 1988), but actual dates should be based on observations of nesting behavior at individual colonies.

Any information gathered from colonies regarding size, location, habitat, chicks produced, etc., can be mailed to the Section Leader, Survey and Population Monitoring, Nongame Wildlife Program, Florida Game and Fresh Water Fish Commission, Rt. 7, Box 3055, Quincy, FL, 32351.

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APPENDIX A

Regional offices of the Florida Game and Fresh Water Fish Commission. To obtain Nesting Area signs or other technical assistance in protecting black skimmer colonies, please contact the nongame biologist in the nearest regional office.

Northwest Region:	Nongame Biologist Florida Game and Fresh Water Fish Commission 3911 Highway 2321 Panama City, FL 32409 904-265-3677
Northeast Region:	Nongame Biologist Florida Game and Fresh Water Fish Commission Route 7, Box 440 Lake City, FL 32055 904-758-0525
Central Region:	Nongame Biologist Florida Game and Fresh Water Fish Commission 1239 SW 10th Street Ocala, FL 32674 904-732-1225
South Region:	Nongame Biologist Florida Game and Fresh Water Fish Commission 3900 Drane Field Road Lakeland, FL 33803 941-648-3205
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State of California
The Resources Agency
Department of Fish and Game
Habitat Conservation and Planning Branch

CALIFORNIA LEAST TERN BREEDING SURVEY

1998 SEASON

by
Kathy Keane

Habitat Conservation and Planning Branch Report, 2000-01

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FINAL REPORT TO

California Department of Fish and Game
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Sacramento, CA 95814

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CALIFORNIA LEAST TERN BREEDING SURVEY

1998 SEASON

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State of California
The Resources Agency
Department of Fish and Game

CALIFORNIA LEAST TERN BREEDING SURVEY, 1998 SEASON [1]

by

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ABSTRACT

An estimated 4,141 to 4,182 pairs of California least terns nested at 39 nesting sites in 1998 and produced an estimated 2,686 to 2,810 fledglings. Statewide pair estimates increased 3.9%, but fledgling estimates decreased by 14.6% from 1997 estimates, likely due to high chick mortality at many sites. Seven sites (NAS Alameda, NAWS Point Mugu, Venice Beach, Huntington Beach, Santa Margarita River North Beach, Mariner's Point, and Delta Beach North) supported a combined total of 65% of statewide pairs and produced 66% of the state's fledglings in 1998. Fledglings per pair were 0.64 to 0.68, lower than 1997 (0.80).

One of the more interesting findings of 1998 was a report of a nesting pair on evaporation pond dikes near Kettleman City in the San Joaquin Valley. Both eggs hatched and one chick apparently fledged.

It is likely that monitors continue to underestimate renesting, as reported pair estimates are only 378 lower than statewide nest numbers of 4,541, despite 64 eggs lost to flooding, 900 observed dead chicks and minimum losses to predators of 147 eggs and 165 chicks. Another method of estimating pairs was requested and attempted by some monitors in 1998, based upon the number of renesters that a given site may generate, rather than the number of renesting pairs at that site. This estimate was 3,483 pairs, or 84% of estimates derived by the traditional method. Statewide mean clutch size was 1.66 eggs per nest, lower than for the previous three years, suggesting limitations in prey availability, as reported by several monitors. However, statewide mean hatching success was 0.80, similar to the previous two years.

After a 54% increase in pairs and a 200% increase in fledglings between 1995 and 1997, pair numbers increased only 3.8% and fledgling numbers decreased by 14% from 1997. This is likely related to limitations in prey availability during 1998, as evidenced by high chick mortality, poor nest attendance, abnormal chick feeding and kleptoparasitism.

[1] Keane, K. 2000. California least tern breeding survey, 1998 season. Calif. Dep. Fish and Game, Habitat Conservation and Planning Branch Report, 2000-01. Sacramento, CA 43 pp.

INTRODUCTION

The California least tern *(Sterna antillarum browni)* is one of three subspecies of least tern that breed in North America. A migratory species, it nests from April through August along the western coast of North America from the San Francisco Bay area, California, to Baja California Sur, Mexico. Least terns presumably winter in Central America or northern South America, although the specific locations of their wintering sites remain unknown. The subspecies was listed as endangered under the federal Endangered Species Act on October 13, 1970 and by the California Endangered Species Act on June 27, 1971. The interior race of the least tern *(Sterna antillarum athalassos),* also federally listed as endangered, primarily occupies the Mississippi River valley and its tributaries. The eastern coast race *(Sterna antillarum antillarum)* nests from Massachusetts to Florida (Massey 1974).

California least terns historically nested in several small, scattered aggregations on sandy beaches and salt flats along the coast (Chambers 1908). The progressive loss during the early part of this century of undisturbed sandy beaches resulted in a severe reduction in both nesting sites and numbers of nesting pairs (Chambers 1908). By the 1940's, terns were gone from most beaches of Orange and Los Angeles counties and were considered sparse elsewhere (Grinnell and Miller 1944).

The current breeding range of the least tern in California extends along the coast from the Tijuana River estuary, just north of the U.S.-Mexico border, to San Francisco Bay (Small 1994). Following listing under the federal and state endangered species acts, the number of least tern nesting sites gradually increased from 23 in 1976, when statewide censuses were initiated, to 38 in 1997. Estimated numbers of nesting pairs have also escalated from 664 in 1976 to over 4,000 in 1997. Protection of nesting sites with fencing and signing has effectively limited human disturbance at most nesting sites. However, both native and non-native predators have been implicated in major losses of eggs, chicks and occasionally adults (see the Site Summary Appendix, Tijuana River) at several sites and over several years. Although many native animals are currently, and have likely historically been, least tern predators (e.g., American kestrel, common raven, gray fox, coyote), the proximity of nesting sites to human-modified habitats has resulted in increased threats of predation. For example, feral cats and dogs, free-roaming house cats, introduced red foxes, and animals whose populations benefit from human presence (e.g., American crow) have exerted strong predation pressures at many nesting sites. In addition, many predators appear to benefit from the localized and abundant prey source provided by the few remaining nesting areas[2]. In addition, occasional summer storm systems (as in 1995), recurrent or continual human disturbance (e.g., Tijuana River), and occasional deliberate human-induced mortality affect reproductive success. Finally, El Niño systems, or other winter storms that influence water temperature or salinity, may in turn affect least tern prey availability, which can result in chick mortality due to starvation (Caffrey 1997). Thus, although the least tern population has increased substantially from its pre-listing status, continued monitoring and predator management at nesting sites will be required to ensure its long-term survival.

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[2] According to A. I. McCormick, quoted in Bent (1921), the beaches of Los Angeles County in the 1890s “from Santa Monica southward, afford excellent breeding grounds for numberless birds of this species.” By 1943, “breeding stations [are] few and sparsely populated, owing to almost complete human use of suitable beaches” (Grinnell and Miller 1944). In 1997, Los Angeles County supported only two least tern nesting sites.

Least tern monitoring studies throughout the state of California have been conducted annually since 1973 to estimate numbers of nesting pairs and reproductive success. Experienced monitors conduct nesting site surveys per protocol established in monitoring packets provided annually. Monitors that conduct surveys within nesting sites, marking and checking nests during each visit, are authorized to do so through 10(a)(l)(A) permits issued by the United States Fish and Wildlife Service (USFWS) as well as a Memorandum of Understanding issued by the California Department of Fish and Game (CDFG). Results of monitoring studies conducted annually from 1973 through 1997 are summarized in annual reports compiled by the CDFG.

METHODS

Monitor Selection and Instruction

Site monitors were selected based on past least tern monitoring experience and on knowledge of particular nesting sites. Names of primary site monitors and their assistants are provided in Table 1, which also includes a summary of the type of monitoring conducted at that site (Type 1 or Type 2 site; see Monitoring Methods below), and site preparation methods, further discussed below under Site Preparation. Monitoring methods were detailed in monitoring packets provided to all monitors in spring 1998.

Along with the monitoring packet, monitors also received a diskette with seven spreadsheets for entering final report data, and a mailer (addressed to Kathy Keane) for the diskette. Spreadsheets requested data on site preparation, nest numbers and estimated pairs, productivity, mortality due to factors other than predators, and predator losses. The diskette also included a Master Nest Log spreadsheet for monitors wishing to maintain digital information on each nest, such as initiation date, type and date of outcome (e.g., hatched, lost to predators, abandoned). Finally, all monitors were provided a list of names, phone numbers and e-mail addresses of all monitors by nesting site. They were encouraged to communicate with monitors in their region regarding the potential for movement of renesting birds among sites (to assist in estimating pairs) and to coordinate simultaneous fledgling counts.

Site Preparation and Protection

Site preparation methods are summarized in Table 1, such as the type of fence (see legend on Table 1); whether or not interpretive signs, chick shelters or decoys were provided at the site; and whether vegetation management was conducted prior to least tern nesting in 1998. Fencing types vary from site to site, depending upon the potential for human and predator access, on the consistency of nesting areas used from year to year, and on the jurisdiction in which the site is located. For example, at Ormond Beach, nesting is concentrated nearly every year in different locations of the beach, so permanent fencing is not practical. At the other end of the spectrum, sites on recreational beaches such as Huntington and Venice, or sites with active military training nearby (e.g., Santa Margarita River) are protected with permanent fencing and chick fence, which must be frequently maintained during the season to ensure that chick losses do not occur.

Fences, depending upon type and maintenance, can minimize access by humans as well as by potential mammalian predators. In addition to fence placement, other methods of active and proactive predator management are used prior to and during least tern nesting at many sites. In 1997, Wildlife Services (formerly Animal Damage Control), a division of the United States Department of Agriculture, provided predator management services at these sites: Naval Air Station (NAS) Alameda; Naval Air Weapons Station (NAWS) Point Mugu; Batiquitos Lagoon; San Diego County sites administered by the US. Navy (White Beach, Santa Margarita River sites, Naval Training Center, North Island NAS, Delta Beach North and South, and Naval Amphibious Base [NAB]- Ocean), by the City of San Diego (Mariner's Point, North Fiesta Island), the Port of San Diego (Lindbergh Field, D Street Fill) and USFWS Refuges (Tijuana Wildlife Refuge and Chula Vista Wildlife Refuge). Other sites (e.g., Huntington Beach, Seal Beach, Venice Beach, Bolsa Chica, and Vandenberg AFB) contract with other experienced predator managers on a scheduled or as-needed basis. Still other sites (Saltworks, McGrath State Beach, Ormond Beach, Pismo [Oceano]Dunes) may not receive any predator management. All predator managers operate under 10(a)(l)(A) permits that authorize access within least tern nesting sites, and possess depredation permits that authorize the trapping or other removal of animals protected under the Migratory Bird Treaty Act or other environmental laws.

Vegetation management also varies among nesting sites. Minsky (1987) and Erickson (1985) reported mean percent cover values of less than 5% for nesting areas they sampled. However, the proximity of many nesting sites to populations of invasive weeds often results in vegetation cover too dense to support least tern nesting. Vegetation management it is not necessary for some nesting sites, while at other sites intensive management in the form of herbicides or mechanical removal is conducted (see Table 1). Chick shelters, often in the form of ceramic roof tiles, are sometimes used at sites with little to no vegetation growth, but chick use of such shelters has also been observed at sites where sufficient vegetation appears to be present (e.g., L.A. Harbor Terminal Island). Interpretive signs are used at several nesting sites (see Table 1), particularly at those with frequent human visitation. Site-specific information, when provided by monitors, on other preparation techniques is summarized in Table 1.

Monitoring Methods

Site Types

Type 1 sites are those in which monitors enter the nesting site and temporarily disturb nesting terns while marking and checking nests; most nesting sites in 1998 were considered Type 1 sites. This type of monitoring allows for the collection of more detailed data than for Type 2 sites, which are monitored from the outside only, with monitors counting birds observed in incubating posture to estimate nest numbers. Monitors at Type 1 nesting sites walk through the site (occasionally using portable blinds), looking for unmarked (new) nests, marking them, and checking and recording the contents of previously marked nests. Nests are typically marked with numbered tongue depressors or other wooden stakes; at some nesting sites where egg predation is a problem, less conspicuous marking may be used. Thus, monitoring at Type 1 sites provides more quantitative data (e.g., clutch size, incubation periods, hatching success) and generally more accurate data for nest numbers than at Type 2 sites. In addition, evidence of predation (e.g., mammal tracks, remains of chicks or eggs) can also be noted during monitoring at Type 1 sites and subsequently addressed if warranted. On the other hand, monitor disturbance is minimized at Type 2 sites, and behavioral observations and some predation events may be more easily observed. Monitors at Type 1 sites typically cannot evaluate nest attendance, census chicks (see discussion of fledgling counts) or observe chick feeding (sometimes important in terms of prey availability). In addition, monitors at Type 1 sites may occasionally miss predation events while monitoring (it may be difficult to hear the specific least tern alarm calls used in the presence of a predator in the din of those used in response to monitor presence). Thus, distinct advantages and disadvantages exist for the two types of monitoring.

Nest and Pair Counts

In addition to numbers of nests, monitors also calculate the number of pairs, which is used to derive a statewide population estimate. Although less accurate than the number of nests, this value is generally a better indicator of population status. For example, during years when egg predation is high, nest numbers will also be high because many pairs may initiate new nests (renest) when their first and possibly subsequent nests are lost (Massey and Atwood 1981). Thus, the numbers of nests cannot be compared from year to year to reliably evaluate population trends. Monitors calculate the number of pairs using the total number of nests, minus the estimated number of nests initiated by renesting pairs (renests) from the same or another nesting site. However, the number of pairs is actually impossible to determine accurately without observations of uniquely banded birds at each nest.

In the 1998 monitoring packet, monitors were also asked to estimate total pairs using a new method discussed in the recommendations section of the 1997 report (Keane 1998). This method uses the number of renesting pairs that a given site may generate, rather the number of pairs renesting at that site. For example, monitors subtract all losses of entire clutches and broods (the latter, of course, being more difficult to estimate) that occur prior to a certain date (beyond which renests would not be expected) from the total number of nests for the season. Thus, pairs are only counted when they renest. This method for pair estimation may not be more accurate for a given site (since unsuccessful pairs may renest elsewhere) but may yield a more accurate estimate of pairs statewide. This method also avoids estimating “first wave” and “second wave” pairs (see below).

Nesting Waves

Findings by Massey and Atwood (1981) and assessments of recaptures of numerous banded birds of known age at the Santa Margarita River nesting sites indicate that pairs nesting early in the season are generally experienced breeders (3 years old and older). Later nests are generally those of renesting pairs and of first breeders (2-year old birds) that may arrive after older birds. Generally, nests early in the season during what has been called the “first wave” are assumed to be those of pairs nesting for the first time that year, so the number of “first wave” pairs is simlar to the number of “first wave” nests. The number of late-season (“second wave”) nests, minus the estimated number of renesters, provides an estimation of “second wave” pairs. During years when recruitment is expected to be high (e.g., high productivity two years prior) and losses to predators are low early in the season, renesters typically contribute minimally to “second wave” nest numbers. Alternatively, “second wave” nests have a higher probability of being renests when low recruitment is anticipated and/or major egg and chick losses are apparent early in the season. Estimating pairs for the “second wave,” however, can be problematic, as it may be difficult to determine when the “second wave” begins. At some sites, two peaks in nesting are apparent, with the number of newly initiated nests declining through early June and a smaller, second peak (and sometimes two peaks) or "second wave" of nesting from mid-June into early July (e.g., Caffrey 1997, Figure 1 - State and South, Caffrey 1998 Figure 3 - Venice Beach, White Beach). At such sites, the date that numbers of new nests start to climb once again is used as the beginning of the "second wave." However, at many sites, and at some sites during some years, only one peak of nesting is apparent, with the number of new nests gradually declining from early June through the end of the season (e.g., Caffrey 1997, Figure 3 - Bolsa Chica). For this reason, "first wave" and "second wave" have been referred to in quotes (Caffrey 1997 and 1998). June 15 has historically been used for sites with no second peak of nesting to denote the beginning of the "second wave," so that similar methods to estimate pairs can used at all sites.

Fledgling Counts

Monitors must also estimate the fledgling numbers for their site. An accurate estimate may be obtained by conducting frequent "chick round-ups" at fenced sites and recording band numbers of chicks recaptured just prior to fledging. Banding is not conducted at most sites, however, as many monitors are not permitted banders. Also, the expansiveness of many sites and availability of sufficient vegetation for chick refuge may diminish the probability of chick recapture. Thus, at most nesting sites, censuses are conducted to estimate fledglings. Because fledglings may be away from the site learning foraging skills during the day, the recommended timing for censusing is just prior to dusk, when they may return with their parents to the nesting site. At some sites, terns leave to roost for the night at other locations, particularly when nocturnal predation or other disturbances are occurring at the nesting site. Monitors at some sites have not succeeded in locating the roosting area for their site; instead, they conduct daytime censuses, which may result in underestimates[3].

Studies of color-banded chicks indicate that fledglings may remain at the site for up to three weeks post-fledging (Massey 1989); of course, this will vary with predation pressures, human disturbance, prey availability and other factors. Based on this information, however, and lacking a better method, monitors are asked to census fledglings during an evening visit to the nesting (or roosting) site every three weeks until a month after the last chick has hatched. The results of such counts are added for an overall estimate of fledglings for the season. However, monitors are cautioned that fledglings may roost at sites other than their natal nesting site, particularly after departing from nesting areas, (e.g., terns banded at Santa Margarita River seen at Batiquitos Lagoon W-2; NAWS Point Mugu and Ormond Beach terns fly between sites). Thus, monitors were encouraged to communicate with monitors of nearby sites to coordinate simultaneous fledgling counts on or near June 16, July 7, July 28, and August 18 to minimize double-counting.

In 1998, monitors were also requested to use a new method for estimating fledglings, based upon the ratio of fledglings to adults during each count. Adults as well as fledglings would be counted during dusk censuses[4], and the ratio of fledglings to adults for each is averaged for the season and used with the estimate of total pairs, multiplied by 2 (to get total adult individuals), to derive an estimate of total fledglings for the season. For example, if fledgling

[3] For example, during one count in Los Angeles Harbor, fledglings increased from 35 prior to dusk to 79 at dusk.

[4] Dusk counts are also recommended for this method, as ratios derived during daylight hours, when some parents may be foraging away from the site, may be inaccurate. However, this assumes that birds that have not yet produced fledglings are roosting with their mates rather than among the flocks of censused fledglings.

numbers averaged approximately half that of adults (ratio 0.5) during counts, and the estimated number of pairs for the season was 100 (200 adults), then the fledgling estimate would be 200 times 0.5, or 100. However, because most monitors did not attempt to use this method, fledgling estimates derived from this method are not provided in this report.

Monitoring Hatching Success and Losses

In addition to calculating pair and fledgling numbers, monitors record losses to predators of eggs, chicks, fledglings and adults. Monitors were asked to distinguish between "suspected" or "documented" predation events. Documented predators are those actually observed preying on least tern eggs, chicks or adults or for which absolutely unequivocal sign is observed (e.g., mammal tracks at a nest, a raptor pellet with tern remains, a chick or adult carcass or remains that suggest a specific type of predator, or tracks or feathers of an avian predator within the nesting site). Suspected predators are those seen near the nesting site or flying over the site but not observed taking prey or leaving depredation evidence as described above. Monitors at Type 1 sites also record factors affecting hatching success not directly related to predators (egg infertility or abandonment, eggs lost to flooding or human intrusion, eggs incubated beyond expected hatching date [generally infertile]), and observed mortality of chicks, fledglings or adults not directly related to predators.

Data Analysis and Report Compilation

Information from mid-season report forms submitted to Kathy Keane by monitors was summarized in table format, listing numbers of nests initiated as of June 13 and potential threats to reproductive success observed by that date. The mid-season report table was submitted in early July to CDFG and to all monitors by mail or e-mail. Monitors from most sites, except those administered by the U.S. Navy, also submitted final spreadsheet reports on the provided diskettes to Kathy Keane. Spreadsheet information from each site was copied into a master spreadsheet, which was used to prepare the tables in this report. Reproductive success for each site was calculated by dividing the estimated number of fledglings for the season by the number of pairs at that site. Mean clutch size was calculated by dividing the total number of eggs by the total number of nests. No statistical analyses or additional calculations were conducted.

Changes in Nesting Site Names or Use

The terms "nesting sites" and "colonies" have been unclear in monitoring reports of past years. Caffrey (1997) defined a nesting site as the location for a discrete and contiguous group of nesting birds, and a colony as the general location of a breeding area, which birds from separate nesting sites may use for roosting and foraging. According to this definition, colonies may include more than one nesting site, and if all pairs within a colony nest within a single, contiguous nesting site, the colony name and site name are the same (Caffrey 1997 and 1998). Erickson (1985) referred similarly to nesting sites as "colonies" and "sub-colonies." However, in ornithological literature, the term "colony" typically refers to a colonially-nesting group of birds on a breeding site, rather than to a geographical location. Thus, in this report, the term "nesting site" is used unless the discussion refers to a group of nesting terns, although site names remain the same as those used for "colonies" in monitoring reports prior to the 1998 season.

Monitors generally report data separately for non-contiguous nesting sites. At the following sites, however, monitors combined data and reported it as for one nesting site in 1998:

- Tijuana River includes data for sites north and south of the river, reported separately in previous years but combined in 1997 & 1998;
- Ormond Beach includes data for Perkins and Edison sites, combined in 1997 and 1998.

Nesting sites used in 1998 but not in 1997 include:

- The dike of an evaporation pond near Kettleman City in California's Central Valley;
- A new nesting island created at Point Mugu;
- South Shores in Mission Bay, not used previously;
- Chula Vista Wildlife Refuge, which has not been used since 1993.

Nesting sites used in previous years but not used in 1998 include:

- Vandenberg Beach 2;
- Port of Los Angeles Pier 300, no longer available for nesting per an interagency agreement;
- Hollywood Beach in Ventura, where the first known least tern use was reported in 1997;
- Naval Training Center, not used since the 1995 nesting season.

RESULTS AND DISCUSSION

Distribution and Productivity by Region

An estimated 4,141 to 4,182 pairs of California least terns nested at 39 nesting sites (Figure 1 on page 23) along the coast of California in 1998 and produced an estimated 2,686 to 2,810 fledglings fledglings (Table 2A). Statewide pair estimates increased 3.9% from 1997 estimates, but fledgling estimates decreased by 14.6% over 1997 fledgling estimates (Table 2A), likely due to high predator pressure and high chick mortality at many sites. Seven sites (NAS Alameda, NAWS Point Mugu, Venice Beach, Huntington Beach, Santa Margarita River [shortened in report tables to SM River] North Beach, Mariner's Point, and Delta Beach North) were the only sites with over 5% each of the total statewide nesting population. Combined, these sites supported 65% of statewide pairs and produced 66% of the state's fledglings in 1998. Fledglings per pair (0.64 to 0.68) were lower than 1997 (0.80) (Keane 1998). Summaries that discuss nest site preparation, reproductive success and/or predator information during 1998 were provided by some monitors for their nesting sites and are included in the Appendix (page 15).

A most interesting finding of the 1998 least tern nesting season was the report of a nesting pair near Kettleman City in California's Central Valley, over 50 miles from the coast. This is in the Tulare Lake Bed, former location of the largest freshwater wetland in California. According to Jeff Seay of H.T. Harvey Associates in Fresno, the nest was located on the dike of an evaporation pond and successfully fledged one young. He also reported sightings of foraging least terns at Lemoore Naval Air Station in both 1997 and 1998 but no nesting.

The two nesting sites in the San Francisco Bay region, primarily NAS Alameda, supported 6% of statewide pairs and produced approximately 4% of statewide fledglings. Pair estimates in the San Francisco Bay region changed little (a 2.4% decrease) from 1997 numbers, although fledgling estimates in 1998 were 69% lower than in 1997 (Table 2B), largely due to an apparent shortage of least tern prey (see the Site Summary Appendix).

The San Luis Obispo/Santa Barbara region (four nesting sites in 1997 but only three in 1998) supported only 1% of the state's nesting pairs and fledglings in 1998, although estimates increased for both pairs (9.4%) and fledglings (44%) from 1997 numbers (Table 2B). The three Ventura County sites supported only 5% in 1997 but 10% in 1998 of the statewide nesting population. A substantial increase in pair estimates at NAWS Point Mugu and a small increase at Ormond Beach resulted in a 112.8% increase for the region over 1997 pair estimates. Fledgling estimates at NAWS Point Mugu increased over 1997 estimates by over 900%, resulting in a 133% increase for the region over 1997 fledgling estimates (Table 2B).

The seven Los Angeles/Orange County nesting sites supported 29% of both pairs and fledglings for the state, slight decreases (2.1% in pairs and 11% in fledglings) from 1997 estimates. Fledgling estimates decreased from 1997 estimates for all Los Angeles/Orange County nesting sites except Los Angeles Harbor and Bolsa Chica (Table 2A and 2B).

The 23 nesting sites in San Diego County (59% of the state's 39 sites) harbored 54% of statewide least tern pairs and generated approximately 59% of statewide fledglings in 1998. Pair estimates in San Diego decreased only slightly (by 1.8%) from 1997, although fledgling estimates in 1998 reflected a 16% decrease from 1997 values (Table 2B).

Chronology; Pair and Nest Numbers

The earliest nests for the 1998 season were reported at NAWS Point Mugu, Delta Beach North, NAB Ocean and SM River North Beach, and the latest nests were located at Mission Bay Mariner's Point and Venice Beach (Table 3A).

Data on "first wave" and "second wave" nests and pairs were not provided for many sites (Table 3A). However, whether or not monitors derived nesting pair numbers by estimating first wave and second wave nests and subtracting renesters (Table3A) or by other methods, it is apparent, as in previous years, that monitors are substantially underestimating renesting pairs and thus overestimating pairs for their site. Statewide nesting pair estimates of 4,163 (Table 3A) are only 378 lower than statewide nest numbers of 4,541, despite reports of 64 eggs lost to flooding, 900 observed dead chicks, among other mortality or losses (Table 5) and minimum losses of 147 eggs and 165 to predators (Table 6).

In an attempt to minimize the problem of overestimating pairs, a new method was requested of monitors in 1998, using the number of renesting pairs that a given site may generate, rather the number of pairs renesting at that site. For sites with no data reported for this new method, pair estimates were derived using the average ratio of pair numbers estimated via the new method (Table 3B) to pair numbers via the old method (Table 3A), calculated from provided data; this ratio was 0.84:1. Statewide pair estimates using the new method are 3,483 (Table 3B), or 84% of those using the old method (4,163; Table 3A), although it is likely this is still an overestimate, given the reported mortality in Tables 5 and 6.

Clutch Size and Hatching Success

Table 4 summarizes productivity statewide and for each nesting site. A total of 4,541 nests were reported statewide, and 6,980 eggs were found in nests with sites reporting clutch sizes. Mean clutch size for the season was 1.66 eggs per nest, lower than 1997 (1.86), 1996 (1.89) and 1995 (1.71) (Keane 1998; Caffrey 1997 and 1998). White Beach and NAWS Point Mugu reported the lowest clutch sizes in 1998; and aside from sites with very small nest numbers, the highest clutch sizes were reported for NAS Alameda, Vandenberg AFB, LA Harbor TC2, and Batiquitos Lagoon W-l and E-2 (Table 4).

Statewide mean hatching success (number of eggs hatched divided by the total number of eggs) was 0.80, similar to 1997 (0.798) and 1996 (0.81), but higher than 1995 (0.76) (Keane 1998; Caffrey 1997 and 1998). Venice Beach, L.A. Harbor Pier 400 and Delta Beach North had the highest hatching success in 1998, while the lowest hatching success, due to predation (see Table 6), was reported for Batiquitos Lagoon W-l and Saltworks. Mussel Rock (Guadalupe) Dunes had no hatching success (Table 4). Table 4 also summarizes data from fledgling counts, although because some monitors used a range, statewide fledgling values (2,686 to 2,810) are presented in Table 2A.

Causes of Reproductive Failure

Table 5 summarizes reported causes of reproductive failure other than predators. A total of six to eight eggs statewide were reported lost to vandalism or trespassing by humans. Indirect effects of human disturbance (i.e., egg or chick abandonment) are not included in this total. A total of 64 eggs from seven sites were reported lost to flooding (Table 5).

Total abandoned or infertile eggs (including those that never hatched and were incubated beyond expected hatching dates) reported for the state were 731, or approximately 10 percent of all eggs statewide. Mission Bay sites (FAA, North Fiesta and South Shores) had, by far, the highest percentages of abandoned/infertile eggs, likely due to high levels of predation (Table 5).

A total of 900 non-predator-related chick deaths were recorded statewide in 1998 (Table 5). Quantitative statewide data on chick mortalities are unavailable for 1995 and 1996 (Caffrey 1997 and 1998), but only 361 chick mortalities were reported for 1997. Several monitors reported evidence of food shortages[5] in 1998, as further described in the Appendix. Dead chick numbers

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[5] Assumptions about least tern food shortages are based upon indirect evidence, as least tern prey, often ephemeral and localized, is difficult to sample. Factors suggesting a potential prey shortage include low mean clutch sizes, poor nest attendance, kleptoparasitism among least tern adults, high numbers of abandoned nests, dropped fish too large for chick consumption on the nesting site, and high chick mortality (Caffrey 1997). Some least tern monitors claim these factors are equivocal as they can also be attributed to high levels of predation. However, others questioned about this assertion stated that some of these observations would not be apparent unless terns were nearly continually defending the nesting site from potential predators. For example, (1) Dr. Charles Collins found normal chick weights and low chick mortality (other than to predation) even when the Huntington Beach nesting site experienced very high levels of kestrel predation; (2) Seal Beach reported egg abandonment of 12% but low chick mortality (Table 5) despite repeated visits by a peregrine in 1997. Anecdotal information from local bait barges on populations of small anchovies may also be used when prey shortages are suspected.

represented approximately 16% of the 5,617 eggs hatched for the season; fledgling losses (23 individuals) represent less than 1% of total eggs hatched. Twenty-three adult deaths were also reported statewide in 1998 (Table 5). Presumed causes of mortality were not requested in 1998; however, when site summaries (Appendix) were provided, some monitors reported signs of prey shortages.

Table 6 summarizes reported losses to predation by documented and suspected predators (see Methods). Total reported statewide losses to predators in 1998 included 179 eggs, 141 chicks, 20 fledglings and 43 adults. Many more losses not possible to estimate were reported by monitors as "unknown." Data on losses to predators provided for U.S. Navy sites in San Diego did not include predator types; these are summarized on the last page of Table 6 under "Losses Not Reported by Predator Type." In addition, no data on predator losses were received from several monitors. The highest egg losses in 1998 were attributed to gull species, and unreported predators. Chick losses to American kestrels were higher than for other reported predators. More adults were lost at Santa Margarita River North Beach in 1998 by unreported predators than any other site (Table 6). Reported predation losses are likely minimum numbers, as predation that results in no evidence (e.g., raptors catching prey at the site and consuming it elsewhere) undoubtedly occurs during hours when monitors or predator management specialists are not present to document its occurrence. Reported losses in 1998 are lower than in 1997, when an minimum of 334 eggs, 245 chicks, 41 fledglings and 100 adults were reported lost to predators (Keane 1998).

Comparisons with Previous Years

Figure 2 (page 24) summarizes increases and decreases in least tern pairs and fledglings since 1976. After a 54% increase in least tern pairs and a 200% increase in fledglings between 1995 and 1997, pair numbers only increased 3.8% and fledgling numbers decreased by 14% from 1997. The minimal increase in pairs and the decrease in fledglings is likely related to limitations in prey availability, as evidenced by high chick mortality and abnormal chick feeding (see the Appendix).

RECOMMENDATIONS

Funding

Funding for least tern monitoring and predator management has always been an issue of concern. Although the least tern population appears to be continuing to increase, this success story would certainly reverse itself if funding for monitoring and management is discontinued or significantly reduced. The proximity of most nesting sites to potentially high levels of human disturbance and predation compels a need for sometimes very intensive monitoring and predator management. As human populations near least tern nesting areas continue to increase, these threats will only be exacerbated. These facts must be successfully communicated to those individuals, far removed from day-to-day least tern management, who make funding decisions.

Currently, most monitors with only CDFG funding are provided sufficient reimbursement to visit their sites only several hours per week and thus may not be observing many instances of predation or human disturbance that may otherwise have been prevented. Increased funding would allow monitors to spend more time at nesting sites and thereby enhance tern reproductive success. Although all sites would benefit from increased monitoring, the Tijuana River sites need at least one full-time monitor and predator manager to observe and attempt to prevent instances of human disturbance and predation. Egg or chick losses to equestrians and other trespassers should be well documented and immediately reported to USFWS Law Enforcement, who should be ready to issue citations.

Funding for predator management would also enhance the reproductive success of sites with only CDFG funding. As stated in the acknowledgements below, predator management provided by the U.S. Navy, City of San Diego and other entities has been essential in enhancing the least tern reproductive success. However, at sites with only CDFG funding, predator management funds are sparse. For example, Wally Ross and Ron Brown volunteered numerous hours in 1997 for as-needed predator management at Venice Beach and Bolsa Chica, and several sites, particularly those in Ventura and San Luis Obispo counties, have no predator management at all.

Nesting Sites

Site managers are appreciated, as stated below, for their ambitious efforts in site preparation and maintenance. However, several CDFG sites would benefit from better site preparation, and the Venice Beach site is at the top of the list. Monitors volunteered innumerable hours during 1997 to install and maintain the Venice chick fence. Thousands of beach goers observe this site each year, and the neglected condition of the fence does little to enhance their impression of endangered species and wildlife management. USFWS and CDFG must meet with Venice Beach site management (Los Angeles County Harbors and Beaches) and the site owner (California State Parks) to discuss and designate responsibilities for future site maintenance. Many other sites (e.g., Ormond Beach) could benefit from temporary or permanent fencing and/or better enforcement to effectively exclude human intrusion. Others are in need of additional fencing to effectively deter mammalian predators. Still others could benefit from interpretive signs, both in English and Spanish. If funding in future years can be increased, a portion should be dedicated toward such much-needed enhancement efforts at existing nesting sites.

In addition, creation of new nesting sites is always a priority. For example, Los Angeles County still supports only two nesting areas - Venice Beach and Los Angeles Harbor. The attempt several years ago at creating an additional site south of Venice Beach failed; however, Malibu Lagoon may be an option for a new nesting location. Creation of additional sites in Ventura County and areas to the north should also be considered in future years.

Monitoring

The monitoring recommendations included in the 1997 report (Keane 1998) are reiterated here. The development of methods to improve the accuracy of estimating pairs and fledglings is a high priority. Monitors now estimate total pairs for a site by subtracting the assumed number of renesters, which is generally pure speculation, from the total number of nests. Monitors were requested this year to use a new method based upon the number of renesting pairs a given site may generate, rather than the number of renesters that may nest at a given site. However, it was apparent that monitors may still be underestimating renesters, as discussed previously.

Monitors not conducting dusk counts should be using chick recapture data or reliable chick census data to estimate fledglings; otherwise, they must expend more effort in attempting to locate the roosting site and conduct dusk fledgling counts. Daytime fledgling counts must be considered underestimates (see footnote 3) and should be adjusted accordingly. Finally, monitors must make an effort to coordinate simultaneous fledgling counts with monitors of nearby sites (e.g., Batiquitos and Santa Margarita River sites) to minimize double-counting.

Monitors were requested in 1998 to try another fledgling estimation method that may account for birds departing earlier than three weeks, using the ratio of adults to fledglings during each count. This is further described in the Methods section of this report, although most monitors did not make use of this method. Preliminary results of population viability analyses conducted by Dr. Jonathan Atwood suggest that monitors are substantially underestimating fledglings, as the estimated current least tern population size is not possible to obtain with the reported fledgling numbers by his calculations. However, many monitors are still not conducting dusk fledgling counts, and, as discussed above, day counts can result in substantial underestimates.

Although it may not be practical for some large sites, the use of a portable blind is highly recommended when at all possible. Nests can be more easily located, information on nest attendance and other behaviors can be observed, and a census of chicks close to fledging can be maintained to corroborate (or to supplement or replace) data obtained from fledgling counts.

Predator Management

In her 1996 report (Caffrey 1998), Carolee Caffrey stated that “Wiping out all potential predators prior to the onset of nesting would clearly benefit terns, but it is unnatural, unacceptable, and not possible anyway.” She adds, “Some sort of ecologically- and ethically-sound predator management program must be worked out, and soon.” These opinions are shared by a majority of least tern monitors and resources agency personnel, and the development of a least tern predator management plan should be considered a top priority.

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I will also try to recognize here the many individuals that have contributed to least tern nesting success during this and previous years. It is unlikely that terns would be doing even half as well as they are without the financial contributions and many hours of effort expended by site managers in site preparation and maintenance. These dedicated site managers include NAS Alameda, Vandenberg AFB, Ventura Audubon Society, NAWS Point Mugu, Port of Los Angeles, USFWS Refuges (Seal Beach and Tijuana River), California State Parks (Pismo [Oceano] Dunes and Huntington Beach), U.S. Navy SOUTHWEST DIV (for all San Diego

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County Navy sites), City of San Diego and San Diego Audubon Society (for Mission Bay sites), County of San Diego (San Elijo Lagoon) and Port of San Diego (Lindbergh Field, D Street Fill and Chula Vista Wildlife Refuge). Thank you all very much, and keep up the wonderful work.

Many of the site managers mentioned above are also appreciated for providing generous funding for monitoring, as state funding for monitoring is never abundant. I sincerely thank the following for funding least tern monitoring and/or predator management on sites within their jurisdictions: NAS Alameda, PGE Power Plant in Pittsburgh, California State Parks (monitoring at Pismo [Oceano] Dunes State Park and predator management at Huntington Beach State Park), Vandenberg Air Force Base, NAWS Point Mugu, Port of Los Angeles, USFWS Refuges (Seal Beach and Tijuana River), U.S. Navy SOUTHWESTDIV (for White Beach, Santa Margarita River sites, Naval Training Center, North Island NAS, Delta Beach North and South, and NAB Ocean), Port of San Diego (Lindbergh Field, D Street Fill, and Chula Vista Wildlife Refuge, and City of San Diego (predator management at North Fiesta and Mariner's Point).

I will not take the time to list all field monitors by name, as names of assistant monitors were not provided for some sites (see Table 1), so I would undoubtedly miss some. But I extend my heartfelt thanks to each and every site monitor, whether you spent only a few or several hundred hours monitoring nesting sites in 1998.

Similarly, I do not know by name many of the personnel of U.S.D.A. Wildlife Services, but these dedicated individuals are also acknowledged for their commitment toward enhancing least tern productivity. Although we may differ in our some of our opinions about predator management, the least tern population could not have reached 4,000 pairs so quickly without your many years of effort. Brian Walton and all his assistants are also much appreciated for their tireless predator management efforts in 1998. Wally Ross is acknowledged for his contributions toward tern productivity at Huntington Beach, Bolsa Chica, Seal Beach, Los Angeles Harbor and Venice Beach. Don Reierson and Elaine Paine of the University of California, Riverside are also greatly appreciated for promptly and successfully addressing the problems of ant predation at several nesting sites.

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APPENDIX - SITE SUMMARIES

The monitors reported the following:

PGE, Pittsburgh: The breeding population at this colony grew from four pairs in 1997 to eleven pairs in 1998. This colony had not appeared to host more than four breeding pairs in any year in any year since it was first monitored in 1984. The 1998 breeding population also exceeded the estimated seven to nine breeding pairs observed in 1984. Food availability for terns at Alameda NAS may have been particularly reduced in 1998. This may have facilitated an increase in the PGE population.

Alameda NAS: Several lines of evidence suggesting a shortage of prey were noted, including: a lag in the initiation of first nests compared with first nest dates for previous years (although this may have been related to predator presence early in the season); poor nest attendance beginning in late June; a high percentage (21 to 26 percent) of nests with incubation periods over 24 days; abnormal chick feeding; a high percentage (47 to 58%) of dead chicks; and kleptoparasitism among adults.

Oceano Dunes SVRA: This year we had the most nests ever, 40! Last year was the second highest number at 21. We also had a very productive year.

Guadalupe/Mussel Rock Dunes: At the time when the two nests were found, a flock of approximately 10 adults and about 18 fledglings had moved to the area (suspected from the Pismo Dunes Vehicular Area). The nests were found within 20 feet of each other and approximately 30-40 feet from the day roosting area of adults and fledglings. The two nests were lost within 5 days of having found them.

Vandenberg AFB - Purisima Point: Notes regarding provided information in tables:

- Table 1, Site Type: Purisima Point is a "Modified Type 2" colony that allows for entrances when predation or other disturbances that may have affected breeding success may have occurred;
- Total eggs: 37, calculated by multiplying the number of known nests by 1.86; the mean clutch size for 14 nests with known contents.
- total fledglings: fledglings do not appear to stay at Purisima Point more than a few days after fledging. This was noted in all 4 years we have been monitoring the site. The fledgling counts are based primarily on day/evening regular monitoring rather than specifiec fledgling counts.

Site preparation at the Purisima Point site involved activating electric fences. As in '96 and '97, no decoys or chick shelters were used at VAFB. There was no least tern breeding activity at the Beach 2 site, or at any historic or potential site other than Purisima Point. Monitoring at Purisima was conducted 3 days per week, as usual. The "modified Type 2" approach initiated in 1996 was continued, with a minimal number of entries made into the colony to identity and monitor nests and document predation. Bi-weekly coordination meetings between the least tern monitor, USDA-APHIS Animal Damage Control (now Wildlife Services, or WS), U.S. Fish and

Wildlife Service (USFWS), Santa Cruz Predatory Bird Research Group (SCPBRG), and VAFB ensured that monitoring and predator control were conducted with minimum intrusion into the colony. The highest breeding adult tern population observed at the Purisima colony was 44 on June 16. A higher count of 55 adults and 2 fledglings observed on July 12 was presumed to include some migrating birds. Overall, an estimated nesting population of 19 pairs produced 14 fledglings at Purisima Point. This contrasts sharply with 1997, when an estimated 25 least tern pairs produced only 2 fledglings. This significant increase in fledging success was due to a new predator monitoring and control project initiated this year. This pilot study and control project, conducted by the SCPBRG, focused on avian predators, particularly great horned owls that caused significant losses in 1997. The project included radio-tracking of 4 great horned owls that were live-trapped and later released near Purisima Point in '97; live-trapping of additional owls before and during nesting season; live-trapping and later (post-tern nesting) release of 2 barn owls and 3 kestrels; and ongoing avian predator observations in the least tern colony vicinity. In August '98, with the permission of the California Department of Fish and Game and USFWS, a total of 5 banded and radio-tagged great horned owls were relocated to the Livermore area and released. As of 18 Nov 98, 3 owls remain alive at least 150 miles from Vandenberg, one has no signal, and the fate of the last is unknown (possible mortality). There is no indication that any of the great horned owls have returned to VAFB. WS also conducted predator monitoring and control as in prior years. Measures used in prior years that continue to be successful included placement of gull and crow carcasses to deter predation by these species. The electric fence proved an effective deterrent for most coyotes. WS removed and destroyed 13 coyotes and 2 bobcats. One great horned owl that eluded live capture was also lethally taken by WS, and WS also incidentally pole-trapped one kestrel that had to be euthanized due to injury. The electric fence does not appear to deter bobcats. Great horned owls may have taken 2 chicks, and a peregrine falcon was suspected of taking 1 adult and 2 fledglings. No mammalian predation was documented in 1998, and avian predation was dramatically reduced (in '97, great horned owls took as many as 13 adult terns). Other significant events included a 17 May Delta II launch near the tern colony. The launch occurred early in the season, when many birds were still migrating, and no overall change in least tern numbers was noted. There were also a few unauthorized human entries into the colony; no impact on reproductive success was observed. Breeding was late (first nests 13 June), and there were several observations of oversized fish being brought to chicks. 4 chicks and 1 adult were found dead of unknown causes. However, fledging success suggests that El Niño effects were, if present, not pronounced. Future planned activities include continuation of the SCPBRG avian predator project and initiation of a mammalian predator study aimed at developing methods of non-lethal deterrents and control. Indications of a possible food shortage included a 44-day lag in first nests after the arrival of terns.

Ormond Beach: The monitor reported the following: I surveyed at this site from 4/20/98 through 8/21/98. During this time I made 44 monitoring visits to the site. The time spent at the site per visit ranged between 1 and 8.5 hours, with an average time per visit of about 4.5 to 5 hours. I was rather consistent about monitoring 3 days per week (typically Wednesday, Friday, Sunday), except during the inactive periods earlier and later in the season.

The first adult terns were seen on 5/3. The first nest was seen on 5/24. The last nest began on 7/10. New nest initiation was steady from 5/24 until 6/19. Starting 6/19 and until 7/10 (last found nest) there were only 9 new nests, separated by lag-time periods within that time of 5 days (6/19-6/24), 8 days (6/24-7/2) and.....5 days (7/5-7/10). Birds started to depart the site.....by late July and it was *very quiet* by mid-August. On 8/21 (my last visit), there were about 10 terns in the evening at the estuary. These 10 were a mix of adults and fledglings, with some limited feeding of fledglings by adults still occurring. By this time there were no longer any birds in the nesting area and all were loafing by the estuary.

Unlike previous years, the estuary mouth remained open to the ocean for nearly the entire season. The mouth finally closed completely on 8/5, and after that was intermittently either completely closed or open narrowly. During the season, the foredunes and hard pack shifted greatly, and there was much flooding into the foredune and middle dune area.

People and dogs off-leash walking through the dunes were a problem. Of particular disruption to the colony was a group of surfers and similar individuals who spent time (day and throughout the night) at a hut they had built from woody debris at the rack line just into the foredune nesting area. They often foraged for wood through the colony area, walked through the dunes to access the hut, and tossed bottles and trash into the surrounding foredunes. There was also undoubtedly noise disturbance resulting from beach parties at night with fires. There were occasionally off-road vehicles but this was not serious problem.

Throughout the season, the food source was of great curiosity. The terns flew in and out from all directions (with and without fish). There appeared to be some feeding at Mugu Lagoon, in the canal ways between Mugu and Ormond, in the wetland area behind the Ormond dunes (until it dried up), in the J Street Canal, in the Ormond Beach Estuary, in the area of the Port Hueneme Pier and beyond to the northwest, as well as out over the ocean. Unlike previous years, there was apparently much less foraging in the estuary and J Street canal area, perhaps because the estuary mouth was open most of the summer. Although I did observe much flying in and out from the opposite directions of Mugu and Port Hueneme, most of the actual foraging I personally observed took place out over the ocean.

Regarding a possible food shortage: I observed much feeding of mates and young early in the season, but as the season progressed, I more often observed:

- Less feeding of mates and young.
- Adult birds sitting on the nest for hours on end with no relief (no food flown in to them and no partner replacing them on the nest). At least one bird appeared to be on the nest for about 10 days with no relief, or so it appeared to me.
- Nests with eggs left unattended for much longer periods of time.
- Less feeding of fledglings than I'd expected.
- Adults flying in with fish, being chased by other adults and fledglings, and ultimately eating the fish themselves.

Potential predators were western meadowlark, western gull, domestic dog (these three most likely); also gull spp., white-tailed kite, coyote, great blue heron, Caspian tern, kestrel, raven, opossum, black-crowned night heron, feral cat, and northern harrier.

Los Angeles Harbor: Least terns in the L.A. Harbor nested exclusively on Pier 400 in 1998, after the formerly-used Pier 300 site was decommissioned in accordance with guidelines in the 1997 Interagency Nesting Site Agreement. The nesting site constructed in the southern portion of Pier 400 in 1997 (Central Nesting Site) was available for nesting once again in 1998. An additional site, the Southeastern Nesting Site, was also provided in 1998 but was not protected with fencing, as no construction activities were anticipated in the area during the nesting season. The first nests were noted on May 8 at Pier 400 and May 18 at the Pier 400 Access Corridor (TC2), an unprepared site also used for nesting in 1997. Most nesting (89%) on Pier 400 occurred in areas outside the provided nesting sites described above. Nest totals were 178 at Pier 400 and 40 at TC2. The estimated total for least tern pairs (172) exceeded pair numbers since least tern breeding in Los Angeles Harbor has been monitored. This may be related to the fact that least tern prey availability has increased in the Los Angeles Harbor, as suggested by a comparison of foraging data collected since 1994. The Pier 400 and Corridor sites produced an estimated 148 fledglings, more than any year at Los Angeles Harbor nesting sites. However, reproductive success values of 0.68 fledglings per nest and 0.86 fledglings per pair were reduced from 1997 values (1.00 fledglings per nest and 1.31 fledglings per pair).

Reasons for the moderately low reproductive success are unclear. Common ravens removed eggs from eight nests at the Corridor; however, hatching success in 1998 (0.89 eggs hatched per eggs laid) was higher than 1997 (0.76) because more eggs were lost to predators, primarily gulls, in 1997. Although recorded chick and fledgling mortality was higher in 1998 (13 individuals) than 1997 (four individuals), losses do not explain the fact that only 148 fledglings were observed of the 350 eggs that hatched. It is possible that an American kestrel or peregrine falcon was taking chicks when monitors were not present, although no evidence to this effect was observed. Another possibility is that parents departed from nesting sites with their young soon after fledging, so they were not observed during fledgling censuses conducted every three weeks per California Department of Fish and Game (CDFG) protocol.

Bolsa Chica: The monitor reported the following: I believe that the impact of the pair of kestrels was devastating to this colony. There is a large discrepancy between the number of chicks hatched and the number of fledglings. Only 15% of the chicks were found dead total (from predation, starvation, or other causes).

Huntington Beach: An American kestrel was documented at the site on June 19 and was trapped June 20. Two more kestrels were observed at the site July 14, and Wally Ross trapped a total of four kestrels from the site the same day. While some predation most certainly occurred, it is believed that these events had minor effects to reproductive success, based upon the continued high activity level at the colony subsequent to these events and the number of fledglings. Wally Ross' immediate response and trapping success is believed to have minimized the predation level. One nest was lost early in the nesting season as a result of being buried as a ground squirrel mounded material on the nest.

San Elijo Lagoon: California least terns were observed throughout the lagoon from 22 April through 26 August. Late spring storms, closure of the lagoon mouth to the ocean, an unstream sewage spill and a flood gate valve broken in the closedposition on the east basin flood control dike resulted in the primary nesting area of the east basin saltpanne being submerged by up to two feet of water throughout May. One pair of terns established a two-egg nest on the east island. No clear tracks were visible around the eggshell fragments found in the scrape on the next monitoring visit, but raccoons were suspected of being responsible due to tracks elsewhere on the island. Water had receded enough in early June that one nest was established at the northeastern edge of the inundated saltpanne, on a ridge of old dredge spoil on the edge of the saltmarsh. The single egg hatched and the chick appeared to have fledged. The east basin area did not dry out as usual during the nesting season, with water retained in low areas forming channels through the saltpanne. The breeding pair and fledgling were joined in mid-July by migrants roosting and foraging in the east basin. Up to 22 adult and 12 fledgling least terns were observed on 22 July. One depredated adult and one fledgling were found. Again, no clear tracks were associated with the carcasses, but coyotes were suspected due to tracks in the area. By late July most least tern activity had shifted to the central basin. Over 100 CLTs were observed on 29 July, including at least 46 adults and 37 fledglings.

Mission Bay Mariner's Point: Poor nest attendance and abnormal chick feeding was noted here in 1998. Mariner's Point was well prepared but was not large enough to accommodate all terns in Mission Bay. This site needs periodic pest control, at least 3 times during the season: May l, June 1 and July 1.

Mission Bay FAA Island: Gulls are a problem each year. Gulls are impossible to manage as there are hundreds roosting each night and any predator control risks disturbance to the terns. An effective method of deterring gull roosting during the winter is recommended. Also, this site needs improvements in vegetation removal prior to the nesting season.

Mission Bay South Shores: Poor nest attendance and abnormal chick feeding was noted at this site, and low productivity was also a result of a peregrine falcon taking adults. The selection of South Shores as a new nesting site was due to poorly prepared sites designated for Least Terns in East Mission Bay. Both Fiesta and FAA islands were overgrown due to heavy rain that was not compensated for in site preparation. To avoid future use at South Shores, which is not fenced and has heavy human disturbance, both FAA and Fiesta islands need improved vegetation removal.

Chula Vista WR: Following the 1997 nesting season, San Diego Unified Port District capped the southwestern 150 m of the site with sand-shell dredge spoil. Prior to the terns' arrival this season, Zoological Society of San Diego (ZSSD) staff applied herbicide and coordinated mechanical disking and harrowing of the site. ZSSD staff and volunteers pruned back vegetation, surveyed the grid system, and placed decoys and ceramic tiles for chick shelters. Monitoring was conducted April through August one to three days per week. Predator management was conducted by personnel from USDA Wildlife Services. Funding was provided by the San Diego Unified Port District through the Zoological Society of San Diego. California least terns were observed from 21 April to 11 September. Two to three pairs established three nests with six eggs (average clutch size 2.00 eggs per nest). Three chicks from two of the nests hatched successfully and are estimated to have fledged from the site (50 percent of total eggs, 100 percent of eggs hatched). The two eggs from the first nest and one of the two eggs from the second nest were depredated. Gray fox, striped skunk, and/or rats were suspected due to tracks, scats, and subsequent trapping on-site. They were also documented preying on eggs and chicks at Forster's tern nests on adjacent dikes. Eggshell fragments indicated hatching of a snowy plover nest on the site, but chicks were never observed. The presence of kestrel, harrier, barn owl, raven, gull and/or the above species may account for their losses. Predator management and site preparation (and its lack at adjacent sites early in the season) resulted in the recolonization of this site in 1998. Least terns last nested at this site in 1993 and snowy plover nesting was last recorded in 1984. Forster's terns nested at this site for the first time and established 46 nests. Success was severely limited by losses to high tides and predators, but 15 to 20 young are estimated to have fledged. Additional disturbances may have come from illegal boat landings. Tracks of at least one trespasser with a large dog were found along the shoreline. Snowy plovers, Forster's terns, and Belding's Savannah sparrows may also have been impacted by the notable invasion this season of the aggressive Mexican swimming arched crabs.

Lindbergh Field: Prior to the terns' arrival, San Diego Unified Port District personnel applied herbicide, manually removed vegetation, constructed plastic mesh covers over storm drains, and erected 8-10" tall plastic mesh chick barriers to enclose ovals between operational roadways and taxiways of the southeast airfield. Port District and Zoological Society of San Diego personnel established a 30 m grid system in the two ovals used last year by terns for nesting. ZSSD and SDUPD personnel completed extensive repairs to chick barriers following storm events in late April and early May. Monitoring was conducted April through August one to three days per week. Predator management was conducted by personnel from USDA Wildlife Services. Funding was provided by the San Diego Unified Port District through the Zoological Society of San Diego. California least terns were observed at the airfield from 21 April through 30 July, and at the adjacent bayfront through 18 August. Seventeen to eighteen pairs of terns established 18 nests with 33 eggs (average clutch size 1.83 eggs per nest). A single-egg nest was abandoned, and the fate of one egg from a two-egg clutch was uncertain; but lack of chick sightings and predator presence make depredation likely. At least 31 chicks successfully hatched (93.9 percent). From 18 to 23 young are estimated to have fledged from the colony this season (54-70 percent of total eggs, 58-74 percent of eggs hatched). One adult least tern was found dead on the site with no apparent signs of trauma. The disappearance of one egg from a two-egg clutch and two chicks within five days from hatching coincided with visits to the site by feral cats and western gulls. Gulls and cats were removed from the area, but management efforts were hampered by repeated tampering with traps, the inability to use lethal means, and nesting of gulls on nearby rooftops with difficult access. The disappearance of a third chick and from four to nine large chicks and/or fledglings coincided with hunting on the site by kestrels and peregrine falcons. An additional fledgling was observed being taken by a peregrine. Concern was raised in early May due to spilling of jet fuel from a transport vehicle on a nearby roadway and discharge of some fuel from a storm drain into the adjacent bay and foraging areas. The majority of the spill was contained on land and that in the bay was contained along a relatively limited strip of shoreline. Though terns were observed foraging in the area, no direct impacts were documented; hatching success and chick growth measurements did not indicate any problems and survival appeared to be limited only by predation. There was an 82 percent reduction in nest numbers from 1997 to 1998 which may have been influenced by predator presence this season, but is most likely attributable to the significant depredation experienced by the colony last year. Fledgling success increased 55 to 61 percent from last season, due to increased predator management efforts.

D Street Fill: Prior to the terns' arrival, Zoological Society of San Diego staff coordinated mechanical discing and harrowing of the site. ZSSD and USFWS staff and volunteers moved rocks from the site, pruned back vegetation, surveyed the grid system, and placed decoys and ceramic tiles for chick shelters. San Diego Unified Port District personnel removed derelict boats and debris from the perimeter of the site. Ant control bait experiments were conducted by personnel of the U.C. Riverside Entomology Department and predator management by USDA Wildlife Services staff. Monitoring was conducted April to early September one to three days per week. Funding was provided by the San Diego Unified Port District through the Zoological Society of San Diego. California least terns were observed at the site from 20 April through 21 August. Six to seven pairs established seven nests with 13 eggs (average clutch size 1.86 eggs per nest). Eleven eggs hatched (85 percent). The two eggs of the first nest were depredated by ravens, and one chick from a three-egg clutch was found dead with no visible trauma. Eight to ten young are estimated to have fledged from the colony this season (61-77 percent of total eggs; 73-91 percent of those that hatched). While up to ten of this season's young were observed to fly, actual reproductive success of the colony is not completely clear due to the presence of predators capable of preying on fledglings, including American kestrels, peregrine falcons, and northern harriers. A helicopter landed adjacent to the nests in late June, but apparently did no direct damage. There was an 83 percent reduction in nest numbers from 1997 to 1998 which is most likely attributable to the significant depredation and low reproductive success experienced by the colony last year (41 nests produced only six to eight fledglings). Nest initiation and colony size may also have been hindered early this season by the presence of predators, late spring rains and resulting vegetation, and by the presence of derelict boats on the shoreline of the site, and disturbance by the boats' occupants and their dogs. Numbers of pairs and nests of western snowy plovers were also significantly decreased at the D Street Fill this season. However, least tern reproductive success rates (number of fledglings per nest) increased this season by 87 to 88 percent over that of 1997.

Tijuana River: U.S. Fish and Wildlife Service refuge staffrepaired fencing and posted signs with assistance from California Department of Parks and Recreation and Department of Forestry staff and correctional camp crews prior to the terns' arrival at the Tijuana Estuary. Additional signs were posted as needed once nesting was underway. Monitoring was conducted April through mid-September, one to three days per week.

California least terns were observed from 23 April through 10 September. At least 85 pairs established 124 nests. Forty-four nests were established south of the Tijuana River, including three approximately 100 m north of the U.S.-Mexico border, 12 adjacent to a berm on the beach midway between the border and 4river, and 29 in the "south site" on the beach southeast of the mouth of the river. Eight nests were established north of the river, including 25 on the beach north of the river mouth, 49 amid dunes approximately 200 m north of the river and 6 at the "north site" south of Seacoast Drive. Average clutch size was 1.69 eggs per nest, with a total of 210 eggs.

An estimated 43 to 60 percent of the eggs hatched (91 to 126 eggs from 55 to 75 nests) at least 32 eggs from 24 nests were abandoned or failed to hatch, 11 eggs from eight nests were depredated, two eggs from one nest were found with damage attributable to either predators or human activity, a two-egg clutch was destroyed by human activity, and a two-egg clutch was lost to high tides. The fates of 34 eggs from 23 nests were uncertain, but age of nests and lack of hatching or chick presence make predation most likely. Additional eggs from at least five nests were destroyed following their abandonment, another was stepped on, and another depredated.

One chick and three adults were found dead with no apparent signs of trauma, and one chick died while hatching. Predation was documented for two chicks and three adults, but an additional 28 to 79 young are estimated to have been preyed upon. From 45 to 61 young are estimated to have fledged from the colony this season.

At least one egg was apparently preyed on by a rodent, one by a ground squirrel, four by cats, two by a coyote, and two by a gull, An American kestrel was observed preying on a tern chick. A peregrine falcon preyed on at least one adult least tern, and feathers indicated at least two more had been depredated. One depredated egg and one chick were found, but the responsible species could not be ascertained. Each of the above-mentioned species documented as responsible for predation this season is also suspected of additional predation. Opossums, gull-billed terns, northern harriers, barn owls, a short-eared owl, a burrowing owl, and loggerhead shrikes were observed within the nesting areas and are suspected of taking chicks and/or eggs. Snakes, feral dogs, striped skunk, great blue heron, black-crowned night heron; Cooper's hawk, white-tailed kite, common raven, American crow, and western meadowlark were also recorded in the area. Black-bellied plovers apparently opportunistically preyed on eggs of a previously-abandoned nest.

There was a 58 percent reduction in nest numbers from 1997 to 1997 which may have been influenced by predator presence this season, but is most likely attributable to the significant depredation and low reproductive success experienced by this colony last year. Nest initiation and colony size may have been hindered this season by late spring storms. However, reproductive success improved this season, with a 46 to 77 percent increase in hatching success and an 82 to 97 percent increase in numbers of fledglings.

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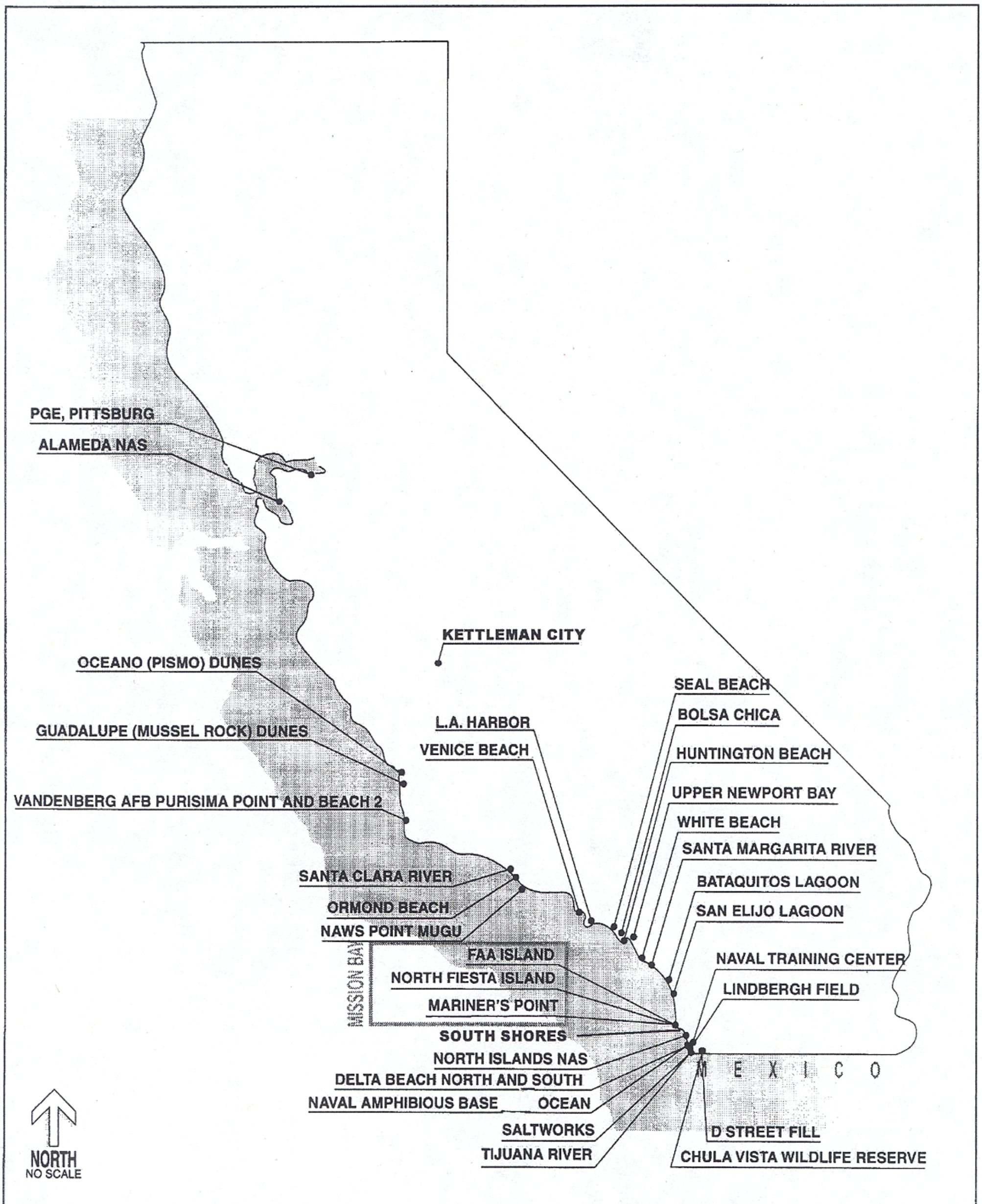

Figure 1. Location of California Least Tern Nesting Sites, 1998

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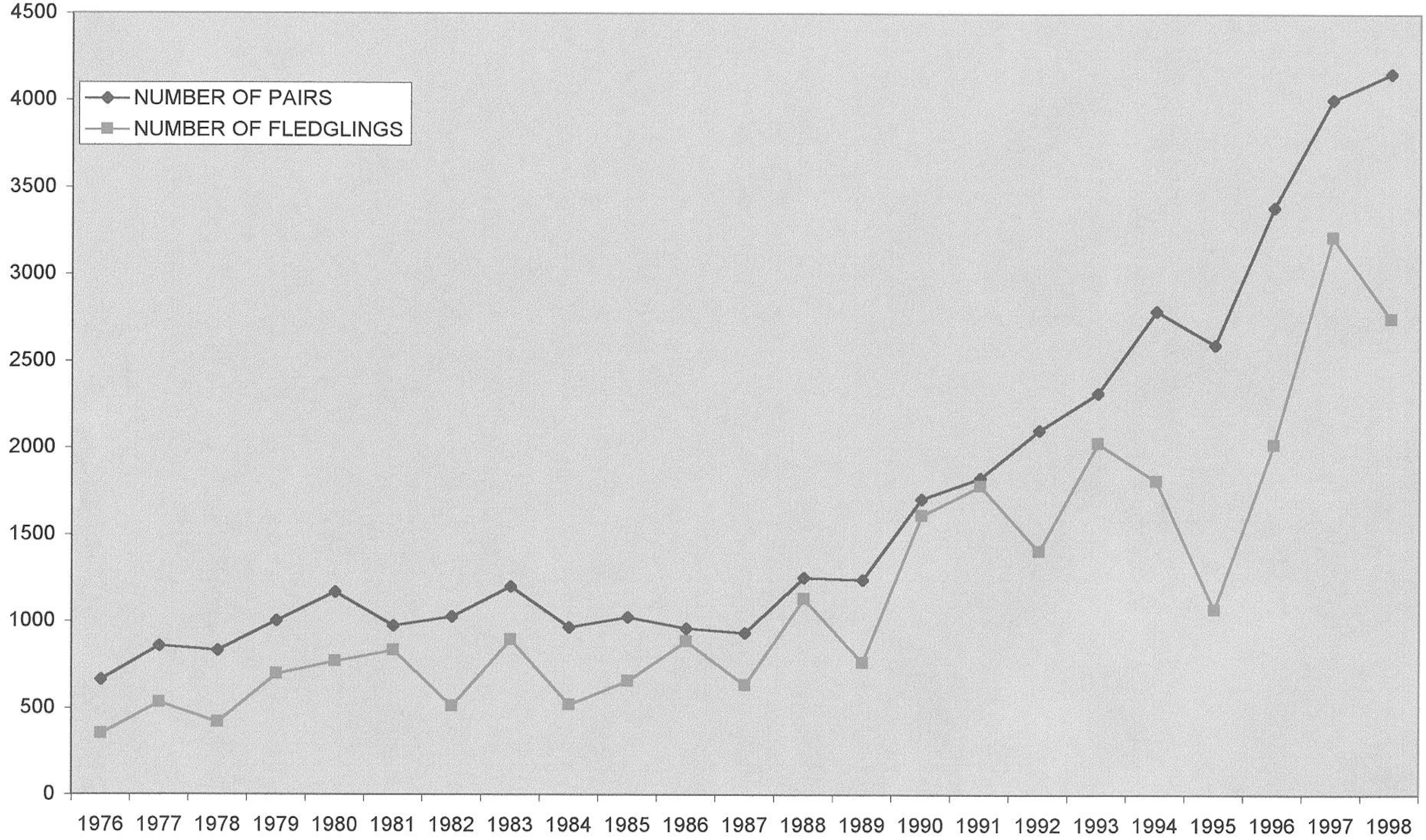

Figure 2. California Least Tern Pairs and Fledglings, 1976 to 1998

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Table 1. California Least Tern Site Preparation and Monitor Information, 1998

Site Name	Site Type[a]	Fence Type[b]	Name of Primary Monitor	Names of Other Monitors	Inter-pretive signs at site?	Chick shelters?	Decoys?	Grid System?	Vege-tation Manage-ment[c]?	Other Site Preparation?	By Whom?
PGE, Pittsburgh	1	2	Laura Collins	N/A	YES	40	NO	NO	3	fill holes	PG&E
NAS Alameda	1	1	Laura Collins	Leory Feeney	YES	170 minimum	NO	YES	4	cover holes; clean shelters; add 26 tons gravel	Navy
Oceano Dunes SVRA	1	large	Ann Marie Tipton	Gary Palkovic	YES	NO	NO	NO		large seasonal ex.	NA
Mussel Rock/Guad. Dn	1	N/A	M. Paloma Nieto	N/A	NO	NO	NO	NO	NO	none	N/A
Vandenberg AFB: Purisima	2	1	Sandra J. Schultz	Thomas E. Applegate	NO	NO	NO	NO	NO	NO	NA
Kettleman City	1	4	Luke Cole		NO	NO	NO	NO	NO	none	
Santa Clara River	1	Temp	Don Davis	Art Marshall, Jan Lewison, Linda O'Neil, Terry O'Neil, Jane Davis	YES	NO	NO	NO	Yes (Arundo Removal Only)		Ventura Audubon
Ormond Beach	2	3 (&4)	Cynthia Plummer	Walter Wehtje	YES	NO	NO	NO	7	-	-
NAWS Point Mugu	1		Tom Keeney	Daniel Gautier,	NO	?	?	?	?	?	
NAWS Pt Mugu Nesting Isl	2		Tom Keeney	Lyn Perry	NO	?	YES	?	?	?	
Venice Beach	1	2	Rodd Kelsey	Mike Taylor	YES	NO	NO	YES	7	Fence maintenance	Rodd Kelsey
LA Harbor Pier 400	1	1	K. Keane	N. Mudry; W. Ross, N. Liberato	NO	YES	YES	YES	6	YES; flagging and contractor employee education programs	Port of Los Angeles (POLA)

0019921

Table 1. California Least Tern Site Preparation and Monitor Information, 1998

Site Name	Site Type[a]	Fence Type[b]	Name of Primary Monitor	Names of Other Monitors	Inter-pretive signs at site?	Chick shelters?	Decoys?	Grid System?	Vege-tation Manage-ment[c]?	Other Site Preparation?	By Whom?
LA Harbor TC2	1	4	K. Keane	N. Mudry; W. Ross, N.	NO	NO	NO	NO	6	YES, same as above	POLA
Seal Beach	1	1	John Bradley	Charlie Collins, Pat Collins, Jeff Johnson, Wally Ross	NO	168	NO	YES	4	Electric fence maintenance and preseason predator management	USFWS personnel and contracted predator control specialist - Wally Ross
Bolsa Chica	1	4	Gary Gillis	Jill Frayne	NO	20	NO	YES	1	No	Gary Gilis, volunteers
Huntington Beach	1	2	Doreen Stadtlander	Wally Ross	YES	YES	NO	YES	1	?	State Parks, David Pryor, Wally Ross
Upper Newport Bay	1	4		none	NO	15	NO	NO	NO	NO	
White Beach	1	no data	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
SM River North Beach	1	no data	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
SM River Salt Flats	1	no data	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
SM River Salt Flats Is.			NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
Batiquitos Lagoon W-1	1	1	Kathy Keane	John Konecny, Nathan Mudry, Carol Hertzog, Jennifer Price, Seth Shulberg	YES	YES	YES	YES	NONE	some chick fence repair at W-2	N/A
Batiquitos Lagoon W-2	1	1	Kathy Keane		YES	YES	YES	YES	6		CDFG
Batiquitos Lagoon E-1	1	1	Kathy Keane		YES	YES	NO	YES	6		CDFG
Batiquitos Lagoon E-2	1	1	Kathy Keane		YES	YES	YES	YES	1		CDFG
Batiquitos Lagoon E-3	1	1	Kathy Keane		YES	YES	YES	YES	2, minimal		CDFG

0019922

Table 1. California Least Tern Site Preparation and Monitor Information, 1998

Site Name	Site Type[a]	Fence Type[b]	Name of Primary Monitor	Names of Other Monitors	Inter-pretive signs at site?	Chick shelters?	Decoys?	Grid System?	Vege-tation Manage-ment[c]?	Other Site Preparation?	By Whom?
San Elijo Lagoon	1	3	Robert Patton	NA	yes	no	no	yes, but only on island (30 m grid with ceramic tiles at intersecti ons)	6 (veg clearing needed on islands; no veg management other than water level manage-ment to flood the east basin in winter)	a double-strand, smooth wire on T-post fence is maintained, signs posted, and attempts made a water level management	San Diego County Parks Department and San Elijo Lagoon Conservancy staff and volunteers
Mission Bay FAA Island	1	1	Jennifer Price	none	YES	YES	NO	YES	2	New grid	FAA, USFWS
Mis. Bay Mariner's Pt	1	1	Jennifer Price	Ginger Johnson	YES	YES	NO	YES	4	Keep-out signs visible from water	City of San Diego
Mis. Bay N. Fiesta Isl.	1	1	Jennifer Price	none	NO	NO	NO	NO	4	NO	City of San Diego, Audubon Soc.
Mission Bay South Shores	1	3	Jennifer Price	R. Collins	NO	NO	NO	NO	7	NO	

0019923

Table 1. California Least Tern Site Preparation and Monitor Information, 1998

Site Name	Site Type[a]	Fence Type[b]	Name of Primary Monitor	Names of Other Monitors	Inter-pretive signs at site?	Chick shelters?	Decoys?	Grid System?	Vege-tation Manage-ment[c]?	Other Site Preparation?	By Whom?
Lindbergh Field	1	3	Robert Patton	Brian Foster, Elizabeth Copper, Shauna Wolf, Chris Hutcherson, Susan Euing	yes	no	no	yes (30 m grid squares marked by rock cairns and spray-painted coordinates at intersections)	4	8-10" tall plastic mesh chick barrier installed, stormdrains covered with plastic mesh fabric, grid system surveyed and coordinates spray-painted on the asphalt and chick barrier	San Diego Unified Port District and Zoological Society of San Diego personnel
North Island NAS	1	no data	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
Delta Beach North	1	no data	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
Delta Beach South	1	no data	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
NAB Ocean	1	no data	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
Chula Vista Wildlife Reserve	1	3	Robert Patton	Brian Foster, Elizabeth Copper, Shauna Wolf, Susan Euing,	yes	yes	yes	yes, (30 m squares marked by tiles at intersections)	4	San Diego Unified Port District had sand-shell dredge spoil cap	Zoological Society of San Diego staff, volunteers, and contractors

0019924

Table 1. California Least Tern Site Preparation and Monitor Information, 1998

Site Name	Site Type[a]	Fence Type[b]	Name of Primary Monitor	Names of Other Monitors	Inter-pretive signs at site?	Chick shelters?	Decoys?	Grid System?	Vege-tation Manage-ment[c]?	Other Site Preparation?	By Whom?
D Street Fill	1	3	Robert Patton	Shauna Wolf, Susan Euing,	yes	yes	yes	yes, (30 m squares marked by tiles at intersecti ons)	4	grid system established; tiles & decoys placed; rocks, debris, & trash removed; derelict boats on shoreline removed.	Zoological Society of San Diego staff, volunteers, and contractors, San Diego Univied Port District and USFWS refuge staff
Saltworks	1	4	Elizabeth Copper	Mark Pavelka	NO	few tiles	NO	NO	NO	barricade of one dike	Saltworks
Tijuana Estuary	1	3	Robert Patton	Brian Collins, Shannon Smith, Nick George, Shauna Wolf	YES	NO	NO	NO	7	signs erected & fence repairs made prior to season; additional signs & twine barricades placed around nesting areas & maintained through season.	USFWS refuge personnel assisted by State Parks staff and CDF correction camp crew

a Type 1 sites: monitors walk through the site, marking and checking nest contents. Type 2 sites: monitors conduct observations from outside the nesting site.

b 1) fence excludes most mammalian predators (e.g., chain link or other fence that fully encloses the site)
2) site fence as for 1 but also cantilevered &/or with barbed wire at the top to exclude cats and other climbing mammals
3) fencing does not exclude most mammalian predators (e.g., not fully fenced on all sites, or fenced only with posted signs and twine).
4) No enclosure whatsoever

c 1) site is mechanically graded or dragged; 2) vegetation is manually removed; 3) herbicide (Roundup or Rodeo) is used;
4) a combination of 1,2, or 3 is used; 5) vegetation is removed by other means; 6) vegetation management is not necessary.

0019925

Table 2A.
Reported California Least Tern Pairs and Fledglings by Nesting Site, 1998

SITE NAME	1998 Pairs - low	1998 Pairs - high	1997 Pairs	% + or - from 1997	1998 Nests	1998 Fledglings low	1998 Fledglings high	1997 Fledglings	% + or - from 1997	1998 Fledglings per Pair low	1998 Fledglings per Pair high
SAN FRANCISCO BAY											
PGE, Pittsburgh	11	11	4	175%	13	8	8	2	300.0%	0.73	0.73
NAS Alameda	243	243	244	0%	248	90	90	316	-71.5%	0.37	0.37
SAN LUIS OBISPO/SANTA BARBARA COUNTIES:											
Oceano (Pismo) Dunes	37	37	6	517%	40	25	25	4	525.0%	0.68	0.68
Guadalupe/Mussel Rock	2	2	30	-93%	2	0	0	23	-100.0%	0.00	0.00
Vandenberg AFB - Beach 2	0	0	3	N/A	0	0	0	0	N/A	0.00	0.00
Vandenberg AFB - Purisima Pt	19	19	25	-24%	20	14	14	0	N/A	0.74	0.74
KINGS COUNTY:											
Kettleman City	1	1	0	100%	1	1	1	0	100.00%	1.00	1.00
VENTURA COUNTY:											
Santa Clara River	38	38	43	-12%	38	22	22	37	-40.5%	0.58	0.58
Ormond Beach	86	86	63	37%	86	50	62	51	-2.0%	0.58	0.72
NAWS Point Mugu	274	274	74	270%	274	165	165	16	931.3%	0.60	0.60
L.A./ORANGE COUNTIES:											
Venice Beach	383	383	375	2%	387	200	200	263	-24.0%	0.52	0.52
L.A. Harbor Pier 400	143	143	73	96%	178	148	148	105	41.0%	1.03	1.03
L.A. Harbor TC2	29	29	3	867%	40					0.00	0.00
Seal Beach	167	167	178	-6%	180	94	104	113	-16.8%	0.56	0.62
Bolsa Chica	136	136	141	-4%	154	74	74	61	21.3%	0.54	0.54
Huntington Beach	319	319	373	-14%	320	249	249	325	-23.4%	0.78	0.78
Upper Newport Bay	26	26	82	-68%	31	20	20	25	-20.0%	0.77	0.77
SAN DIEGO COUNTY:											
White Beach	33	33	17	94%	34	15	20	18	-16.7%	0.45	0.61
SM River - North Beach	644	644	728	-12%	665	265	265	930	-71.5%	0.41	0.41
SM River - Salt Flats	43	43	41	5%	43	10	15	30	-66.7%	0.23	0.35
SM River - Salt Flats Is.	40	40	39	3%	40	10	15	15	-33.3%	0.25	0.38
Batiquitos Lagoon W-1	12	12	83	-86%	15	16	40	254	-88.9%	0.08	0.22
Batiquitos Lagoon W-2	81	81	59	37%	86						
Batiquitos Lagoon E-1	2	2	25	-92%	6						
Batiquitos Lagoon E-2	9	9	0	n/a	16						
Batiquitos Lagoon E-3	75	75	104	-28%	88						
San Elijo Lagoon	1	2	9	-89%	2	1	1	7	-85.7%	0.50	1.00
Mission Bay FAA Island	31	31	20	55%	48	25	25	10	150.0%	0.81	0.81
Mission Bay Mariner's Point	528	528	268	97%	584	596	596	165	261.2%	1.13	1.13
Mission Bay North Fiesta Isl.	21	21	76	-72%	23	13	13	20	-35.0%	0.62	0.62
Mission Bay South Shores	9	9	0	N/A	9	1	1	0	N/A	0.11	0.11
Lindbergh Field	17	18	102	-83%	18	18	23	50	-64.0%	1.00	1.35
North Island NAS	59	59	22	168%	77	62	87	13	376.9%	1.05	1.47
Delta Beach North	284	284	310	-8%	337	200	200	300	-33.3%	0.70	0.70
Delta Beach South	60	60	15	N/A	81	60	75	10	500.0%	1.00	1.25
NAB Ocean	151	151	85	78%	184	175	175	45	288.9%	1.16	1.16
Chula Vista Wildlife Refuge	2	3	0	n/a	3	3	3	0	0.00%	1.00	1.50
D Street Fill	5	7	38	-87%	7	8	10	0	N/A	1.14	2.00
Saltworks	39	39	36	8%	39	3	3	7	-57.1%	0.08	0.08
Tijuana River	81	117	211	-62%	124	45	61	3	1400.0%	0.38	0.75
TOTALS	4141	4182	4005	3.9%	4541	2686	2810	3218	-14.6%	0.64	0.68

[a] see text and Table 3B. For sites where no data were provided for this method, the same number as for traditional pair calculation was used.

Table 2B. California Least Tern Pairs and Fledglings by Region, 1998

REGION	1998 Pairs[a]	% of 1998 Statewide Population	1997 Pairs	% + or - from 1997	1998 Fledglings low	1998 Fledglings high	% of 1998 Statewide Fledglings	1997 Fledg-lings	% + or - from 1997
San Francisco Bay	254	6%	248	2.4%	98	98	4%	318	-69%
San Luis Obispo & Santa Barbara Counties	58	1%	64	-9.4%	39	39	1%	27	44%
Kings County	1	0%	0	n/a	1	1	0%	0	n/a
Ventura County	400	10%	188	112.8%	237	249	9%	104	133%
Los Angeles & Orange Counties	1203	29%	1229	-2.1%	785	795	29%	892	-11%
San Diego County	2247	54%	2288	-1.8%	1526	1628	59%	1877	-16%

[a] average of low and high values, Table 2A

0019927

Table 3A. California Least Tern Pair and Nest Data, 1998

Site Name	Date of First Nest	Date of "Second Wave" Start[a]	Total NESTS "First Wave"[a]	Minus Estimated Renesters "First Wave"	TOTAL PAIRS "First Wave"	Total NESTS "Second Wave"	Minus Estimated Renesters "Second Wave"	TOTAL PAIRS "Second Wave"	TOTAL NESTS 1998	TOTAL PAIRS 1998	Date of Last New Nest
PGE, Pittsburgh	19-May	23-Jun	7	1	6	6	1	5	13	11	6-Jul
NAS Alameda	15-May	25-Jun	244	5	239	4	0	4	248	243	7-Jul
Oceano (Pismo) Dunes	08-Jun	19-Jul	38	3	35	2	0	2	40	37	19-Jul
Mussel Rock/Guad. Dn	26-Jul	N/A	0		0	2		2	2	2	26-Jul
Vandenberg AFB: Purisima	13-Jun	N/A	4	0	4	16	1	15	20	19	28-Jun
Kettleman City	?	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	1	?
Santa Clara River	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	38	38	No Data
Ormond Beach	24-May	N/A	86	0	86	0	0	0	86	86	10-Jul
NAWS Point Mugu	5-7 May	No Data	No Data	No Data	No Data	No Data	No Data	No Data	266	266	27-Jul
NAWS Pt Mugu Nesting Isl	08-Jun	No Data	No Data	No Data	No Data	No Data	No Data	No Data	8	8	?
Venice Beach	10-May	None	365	2	363	22	2	20	387	383	01-Aug
L.A. Harbor Pier 400	08-May	none	140	20	120	38	15	23	178	143	20-Jul
L.A. Harbor TC2	18-May	01-Jun	20	3	17	20	8	12	40	29	01-Jul
Seal Beach	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	180	167	No Data
Bolsa Chica	07-May	None	143	10	133	11	8	3	154	136	07-Jul
Huntington Beach	08-May	No Data	No Data	No Data	No Data	No Data	No Data	No Data	320	319	?
Upper Newport Bay	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	31	No Data	No Data
White Beach	09-May	No Data	No Data	No Data	No Data	No Data	No Data	No Data	34	33	3-Jul
SM River North Beach	07-May	No Data	No Data	No Data	No Data	No Data	No Data	No Data	665	644	9-Jul
SM River Salt Flats	09-May	No Data	No Data	No Data	No Data	No Data	No Data	No Data	43	43	16-Jun
SM River Salt Flats Is.	09-May	No Data	No Data	No Data	No Data	No Data	No Data	No Data	40	40	26-Jun
Batiquitos Lagoon W-1	20-May	6-Jun	12	0	12	3	3	0	15	12	29-Jun
Batiquitos Lagoon W-2	17-May	6-Jun	64	0	64	22	5	17	86	81	20-Jul
Batiquitos Lagoon E-1	20-May	6-Jun	2	0	2	4	4	0	6	2	21-Jul
Batiquitos Lagoon E-2	21-May	6-Jun	5	0	5	11	7	4	16	9	7-Jul
Batiquitos Lagoon E-3	14-May	6-Jun	48	0	48	40	13	27	88	75	27-Jun
San Elijo Lagoon	27-May	none	2	0-1	1-2	0	0	0	2	1-2	9-Jun
Mission Bay FAA Island	20-May	18-Jun	14	0	14	34	17	17	48	31	14-Jul
Mis. Bay Mariner's Pt	13-May	19-Jun	524	0	524	60	56	4	584	528	10-Aug
Mis. Bay N. Fiesta Isl.	19-May	28-Jun	19	0	19	4	2	2	23	21	8-Jul
Mis. Bay South Shores	17-May	None	9	0	9	0	0	0	9	9	31-May

Table 3A. California Least Tern Pair and Nest Data, 1998

Site Name	Date of First Nest	Date of "Second Wave" Start[a]	Total NESTS "First Wave"[a]	Minus Estimated Renesters "First Wave"	TOTAL PAIRS "First Wave"	Total NESTS "Second Wave"	Minus Estimated Renesters "Second Wave"	TOTAL PAIRS "Second Wave"	TOTAL NESTS 1998	TOTAL PAIRS 1998	Date of Last New Nest
Lindbergh Field	12-May	23-Jun	17	0	17	1	0-1	0-1	18	17-18	23-Jun
North Island NAS	13-May	No Data	No Data	No Data	No Data	No Data	No Data	No Data	77	59	1-Jul
Delta Beach North	06-May	No Data	No Data	No Data	No Data	No Data	No Data	No Data	337	284	13-Jul
Delta Beach South	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	81	60	No Data
NAB Ocean	06-May	No Data	No Data	No Data	No Data	No Data	No Data	No Data	184	151	27-Jul
Chula Vista WR	20-May	3-Jul	2	0-1	1-2	1	0-1	1	3	2-3	3-Jul
D Street Fill	12-May	18-Jun	6	0-1	5-6	1	0-1	1	7	5-7	18-Jun
Saltworks	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	39	39	No Data
Tijuana Estuary	8-May	23-Jun	85	1-4	81-84	39	6-39	0-33	124	81-117	30-Jul
TOTALS[b]									**4541**	**4163**	

a See text for discussion of "first wave" and "second wave"

b Totals are not provided for nests and pairs first and second wave as data were not provided for many sites

NOTE: when monitors provided a range, the mean for that range was used and rounded up when necessary

0019929

Table 3B. California Least Tern Pair Data Using New Pair Calculation, 1998

Site Name	Total Nests	Number of Unsuccessful Nests before June 20	Estimated Broods Lost before June 20	Total Pairs Not Renesting[a]
PGE, Pittsburgh	13	2	0	11
NAS Alameda	248	7	0	241
Oceano (Pismo) Dunes	40	1	0	39
Mussel Rock/Guad. Dn	2	none	none	2
Vandenberg AFB: Purisima	20	1	0	19
Kettleman City	1	0	0	1
Santa Clara River	NO DATA	NO DATA	NO DATA	*32*
Ormond Beach	86	11	0	75
NAWS Point Mugu	266	NO DATA	NO DATA	*232*
NAWS Pt Mugu Nesting Isl	8	NO DATA	NO DATA	
Venice Beach	387	100	65	222
L.A. Harbor Pier 400	178	5	20	153
L.A. Harbor TC2	40	7	4	29
Seal Beach	NO DATA	NO DATA	NO DATA	*140*
Bolsa Chica	154	5	15	134
Huntington Beach	320	NO DATA	NO DATA	*268*
Upper Newport Bay	NO DATA	NO DATA	NO DATA	*22*
White Beach	NO DATA	NO DATA	NO DATA	*28*
SM River North Beach	NO DATA	NO DATA	NO DATA	*541*
SM River Salt Flats	NO DATA	NO DATA	NO DATA	*36*
SM River Salt Flats Is.	NO DATA	NO DATA	NO DATA	*34*
Batiquitos Lagoon W-1	15	7	5	3
Batiquitos Lagoon W-2	86	12	60	14
Batiquitos Lagoon E-1	6	1	4	1
Batiquitos Lagoon E-2	16	2	8	6
Batiquitos Lagoon E-3	88	3	75	10
San Elijo Lagoon	2	1	0	1
Mission Bay FAA Island	48	6	2	40
Mis. Bay Mariner's Pt	584	56	48	480
Mis. Bay N. Fiesta Isl.	23	2	1	20
Mis. Bay South Shores	9	1	2	9
Lindbergh Field	18	1	0	17
North Island NAS	NO DATA	NO DATA	NO DATA	*50*
Delta Beach North	NO DATA	NO DATA	NO DATA	*239*
Delta Beach South	NO DATA	NO DATA	NO DATA	*50*
NAB Ocean	NO DATA	NO DATA	NO DATA	*127*
Chula Vista WR	3	1	0	2
D Street Fill	7	1	0	6
Saltworks	NO DATA	NO DATA	NO DATA	*33*
Tijuana Estuary	124	5	0-4	116
TOTALS	**2792**	**238**	**309**	**3483**

a for sites with data provided for this table, pair estimates from Table 3 were compared with those derived by the new method, and the average ratio for new method:old method estimates (0.84:1) was used to estimate pair numbers via the new method for sites with no data for this table; these extrapolated estimates are shown in parentheses.

0019930

Table 4. California Least Tern Productivity Data, 1998

Site Name	Total Nests	Total Eggs	Mean Clutch Size[a]	# Eggs Hatched[b]	% Hatching[c]	Fledgling estimate method[d]	Total Fledglings
PGE, Pittsburgh	13	23	1.77	16	0.65 - 0.74	day counts	8
NAS Alameda	248	456	1.84	390	0.83 - 0.89	early a.m. counts	90
Oceano (Pismo) Dunes	40	60	1.50	40	0.7	single count	25
Mussel Rock/Guad. Dn	2	3	1.50	0	0.00	N/A	0
Vandenberg AFB: Purisima	20	37	1.85	23	0.6	3W DUSK, & day counts	14
Kettleman City	1	2	2.00	2	1.0	N/A	1
Santa Clara River	38	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	22
Ormond Beach	86	172	2.00	107	0.33 to 0.62	3W DUSK	unknown
NAWS Point Mugu	266	380	1.43	227	0.60	3W DUSK	41
NAWS Pt Mugu Nesting Isl	8	NO DATA	NO DATA	NO DATA	NO DATA	3W DUSK	?
Venice Beach	387	625	1.61	575	0.92	3W DAY	200
L.A. Harbor Pier 400	178	319	1.79	295	0.92	3W DUSK	132
L.A. Harbor TC2	40	74	1.85	55	0.74	3W DUSK	16
Seal Beach	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	3W DUSK	94 - 104
Bolsa Chica	154	277	1.80	227	0.80	3W DUSK	74
Huntington Beach	320	498	1.56	428	0.86	3W DUSK	249
Upper Newport Bay	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	20
White Beach	34	48	1.41	35	0.73	NO DATA	15
SM River North Beach	665	1002	1.51	808	0.81	NO DATA	265
SM River Salt Flats	43	69	1.60	52	0.75	NO DATA	10
SM River Salt Flats Is.	40	64	1.60	50	0.78	NO DATA	10
Batiquitos Lagoon W-1	15	28	1.87	6	0.21	3W DAY	16
Batiquitos Lagoon W-2	86	136	1.58	112	0.82	3W DAY	
Batiquitos Lagoon E-1	6	10	1.67	5	0.50	3W DAY	
Batiquitos Lagoon E-2	16	30	1.88	24	0.80	3W DAY	
Batiquitos Lagoon E-3	88	151	1.72	95	0.63	3W DAY	
San Elijo Lagoon	2	3	1.50	1	0.33	C	1
Mission Bay FAA Island	48	74	1.54	45	0.61	3W DAY	25
Mis. Bay Mariner's Pt	584	1014	1.74	885	0.87	Mortality	596
Mis. Bay N. Fiesta Isl.	23	41	1.78	33	0.80	3W DAY	13
Mis. Bay South Shore	9	18	2.00	14	0.78	3W DAY	1
Lindbergh Field	18	33	1.83	31	0.94	C	18-23
North Island NAS	77	136	1.77	118	0.87	NO DATA	62 - 87
Delta Beach North	337	586	1.74	535	0.91	NO DATA	200
Delta Beach South	81	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	60
NAB Ocean	184	312	1.70	256	0.82	NO DATA	175
Chula Vista WR	3	6	2.00	3	0.50	C	3
D Street Fill	7	13	1.86	11	0.85	C	8-10
Saltworks	39	70	1.79	5	0.13	3W DUSK	3
Tijuana Estuary	124	210	1.69	108	0.43 to 0.60	C	45-61
TOTALS	**4330**	**6980**	**1.66[e]**	**5617**	**0.80**		**see Table 2**

a Mean clutch size (number of eggs per nest) is calculated by dividing the number of eggs by the number of nests
b When monitors provided a range, the average was calculated and is presented in this column
c Hatching success is calculated by dividing the number of eggs hatched by the total number of eggs
d 3W = fledgling numbers estimated by adding total counts from censuses every three weeks;
C = combination of 3W and recapture data (see text)
e calculated only for sites with reported egg numbers

0019931

Table 5. California Least Tern Non-Predator Mortality, 1998

Site Name	Total Eggs	Number of Human-damaged Eggs	Number of Eggs Lost to Flooding	Number of Infertile or Abandoned Eggs	Percent Infertile & Abandoned Eggs[a]	Number of Eggs of Unknown Outcome	Number of Dead Chicks	Number of Dead Fledglings	Number of Dead Adults
PGE, Pittsburgh	23	0	0	3	0.13	2	1	0	1
NAS Alameda	456	2 to 4	0	48	0.11	78	216	1	1
Oceano (Pismo) Dunes	60	0	0	2	0.03	9	3	0	0
Mussel Rock/Guad. Dn	3	0	0	0	0.00	3	0	0	0
Vandenberg AFB: Purisima	37	0	0	3	0.08	11	4	0	1
Kettleman City	2	0	0	0	0.00	0	0	0	0
Santa Clara River	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
Ormond Beach	172	2	14	22	0.13	22	0	0	0
NAWS Point Mugu	380	0	32	21	0.06	0	10	6	3
NAWS Pt Mugu Nesting Isl	?	0	0	0	0.00	0	2	0	0
Venice Beach	625	0	0	40	0.06	50-60	198	3	3
L.A. Harbor Pier 400	178	0	0	18	0.10	0	5	2	0
L.A. Harbor TC2	40	0	0	8	0.20	0	0	1	1
Seal Beach	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
Bolsa Chica	277	0	4	13	0.05	35	28	3	3
Huntington Beach	498	0	0	63	0.13	3	?	?	?
Upper Newport Bay	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
White Beach	48	0	0	8	0.17	0	5	1	0
SM River North Beach	1002	0	9	148	0.15	0	177	4	2
SM River Salt Flats	69	0	1	11	0.16	0	3	0	1
SM River Salt Flats Is.	64	0	0	11	0.17	0	13	0	0
Batiquitos Lagoon W-1	28	0	0	1	0.04	8	0	0	0
Batiquitos Lagoon W-2	136	0	0	10	0.07	14	1	0	1
Batiquitos Lagoon E-1	10	0	0	2	0.20	3	0	0	0
Batiquitos Lagoon E-2	30	0	0	6	0.20	0	0	0	0
Batiquitos Lagoon E-3	151	0	0	20	0.13	34	0	0	0
San Elijo Lagoon	3	0	0	0	0.00	0	0	0	0
Mission Bay FAA Island	48	0	0	25	0.52	0	6	0	0
Mis. Bay Mariner's Pt	584	0	0	118	0.20	0	159	0	0
Mis. Bay N. Fiesta Isl.	23	0	0	8	0.35	0	1	0	1
Mis. Bay South Shores	9	0	0	4	0.44	1	4	0	0

0019932

Table 5. California Least Tern Non-Predator Mortality, 1998

Site Name	Total Eggs	Number of Human-damaged Eggs	Number of Eggs Lost to Flooding	Number of Infertile or Abandoned Eggs	Percent Infertile & Abandoned Eggs[a]	Number of Eggs of Unknown Outcome	Number of Dead Chicks	Number of Dead Fledglings	Number of Dead Adults
Lindbergh Field	33	0	0	1	0.00	1	0	0	1
North Island NAS	136	0	0	17	0.13	0	2	1	0
Delta Beach North	586	0	2	37	0.06	0	51	1	0
Delta Beach South	NO DATA	0	NO DATA	NO DATA	NO DATA	0	NO DATA	NO DATA	NO DATA
NAB Ocean	312	0	0	41	0.13	0	9	0	1
Chula Vista WR	6	0	0	0	0.00	0	0	0	0
D Street Fill	13	0	0	0	0.00	0	1	0	0
Saltworks	70	NO DATA	NO DATA	NO DATA	NO DATA	5	NO DATA	NO DATA	NO DATA
Tijuana Estuary	210	2	2	22	0.10	34	1	0	3
TOTALS	**6980**	**6 - 8**	**64**	**731**	**0.10**	**263**	**900[b]**	**23**	**23**

a Total eggs abandoned or infertile divided by the total number of eggs laid (see Table 4)

b This represents 16% of the 5,617 estimated hatched eggs (see Table 4)

NOTE: when monitors provided a range, the mean for that range was used and rounded up when necessary

0019933

Table 6. California Least Tern Losses to Predators, 1998

Predator	Site Name	Suspected or Documented?[a]	Number of Eggs Lost	Number of Chicks Lost	Number of Fledglings Lost	Number of Adults Lost	Predator Management for this Species?	Was it Effective?	If not, why?
AMERICAN CROW	Venice Beach	D	2 to 5				yes	Yes	
	PGE, Pittsburgh	S	3 minimum	?			yes	no	none caught
AMERICAN KESTREL	NAS Alameda	D		1 min.			yes	yes	
	LA Harbor Pier 400	S		30	unknown		no	N/A	not observed until end of season; could have preyed upon chicks before
	LA Harbor TC2	S		unknown			no	N/A	observed & never seen near site but low fledgling count indicates some predation possible
	Bolsa Chica	S		30	6	0-10	Yes	?	appeared towards the end of the season; all of the last 15 nests were destroyed by the
	Huntington Beach	S		unknown			yes	yes	One at site June 19 & trapped June 20. Four at site July 14 & trapped same day.
	Batiquitos Lagoon W-1	S		unknown			no	N/A	pred mngt claims never saw kestrels
	Batiquitos Lagoon W-2	S		unknown			no	N/A	
	Lindbergh Field	S		unknown	unknown		yes	yes	NA
	Tijuana Estuary	D		1			yes	yes	NA

0019934

Table 6. California Least Tern Losses to Predators, 1998

Predator	Site Name	Suspected or Documented?[a]	Number of Eggs Lost	Number of Chicks Lost	Number of Fledglings Lost	Number of Adults Lost	Predator Management for this Species?	Was it Effective?	If not, why?
ANTS	Mis. Bay Mariner's Point	D	8	16			yes	no	reinfestation after 30 days
	Mis. Bay FAA Island	D	3	4			no		no proactive ant control as site was not used by the terns until late in the season
BARN OWL	Alameda NAS	S		5 min.	?	?	yes	yes	
	Tijuana Estuary	S	unknown	unknown	unknown		yes	yes,	NA
BURROWING OWL	Tijuana Estuary	S	unknown	unknown	unknown		yes	yes	NA
COMMON RAVEN	NAS Alameda	S	1				no	not needed	
	LA Harbor TC2	D	13	20			yes	yes	yes, effective
	Batiquitos Lagoon E-1	S	unknown	unknown			yes	no	mngt early in the season; not
	Batiquitos Lagoon E-3	S	unknown	unknown			yes	no	
	D Street Fill	D	2				yes, as-needed	individuals removed and additional losses	NA
COYOTE	Oceano Dunes SVRA	3S, 5D	8				yes	no	coyotes jumped
	San Elijo	S			1	1	no	no	no predator management available
	Tijuana Estuary	D	2	unknown			yes, as-needed	individuals removed and additional	by Border patrol personnel, depredated eggs,

0019935

Table 6. California Least Tern Losses to Predators, 1998

Predator	Site Name	Suspected or Documented?[a]	Number of Eggs Lost	Number of Chicks Lost	Number of Fledglings Lost	Number of Adults Lost	Predator Management for this Species?	Was it Effective?	If not, why?
FERAL OR DOMESTIC DOG OR CAT	NAS Alameda	S		3 to 5	1	1	yes	no	too late
	Lindbergh Field	S	0-1	unknown			needed	yes	NA
	Tijuana Estuary	D	4	unknown			yes, as-needed	yes	owner retrieved and re-released in area
	Tijuana Estuary	S	4	unknown			yes, as-needed	individuals removed and additional	owner retrieved and re-released in area
GRAY FOX	Chula Vista WR	S	3				yes; as-	yes,	NA
GREAT BLUE HERON	PGE, Pittsburgh	S	?	4 minimum			no		
	LA Harbor TC2	S		4?			no	N/A	not seen in area
GREAT HORNED OWL	Vandenberg AFB-Purisima	S		0-2			yes	yes	
GULL SPECIES	Venice Beach	S	unknown	unknown			No	N/A	
	L.A. Harbor Pier 400	D	5				no	N/A	too many gulls
	Guadalupe/Mussel Rock	S	3				No	N/A	N/A
	Lindbergh Field	S	0-1	unknown			yes	individuals	NA
	Mis. Bay Mariner's Point	D	4				yes	yes	
	Mis. Bay FAA Island	D	11	2			yes	yes	see summary
	Tijuana Estuary	D	2	unknown			yes	yes	NA
LOGGERHEAD SHRIKE	Oceano Dunes SVRA	2S, 1D	2	1			no		
	Tijuana Estuary	S		?					

0019936

Table 6. California Least Tern Losses to Predators, 1998

Predator	Site Name	Suspected or Documented?[a]	Number of Eggs Lost	Number of Chicks Lost	Number of Fledglings Lost	Number of Adults Lost	Predator Management for this Species?	Was it Effective?	If not, why?
NORTHERN HARRIER	NAS Alameda	D	?	4 to 6 min			yes	yes	
	Tijuana Estuary	S	unknown	unknown	unknown		only as-needed	no, none removed and losses not reduced	sensitive status of species
PEREGRINE FALCON	LA Harbor TC2	S		unknown	unknown	unknown	no; only	N/A	sensitive status of
	Vandenberg AFB-Purisima				2	1	no	NA	inconsistent observed presence
	Mis. Bay South Shores	S				2 - 4	no		
	Lindbergh Field	S		unknown	2+	unknown	no	no, none removed and losses not reduced	sensitive status of species
	Tijuana Estuary	D		unknown	unknown	1	no	no, none	sensitive status of
	Tijuana Estuary	S				?			

Table 6. California Least Tern Losses to Predators, 1998

Predator	Site Name	Suspected or Documented?[a]	Number of Eggs Lost	Number of Chicks Lost	Number of Fledglings Lost	Number of Adults Lost	Predator Management for this Species?	Was it Effective?	If not, why?
RED-TAILED HAWK	Seal Beach	S		2			YES	YES	
	Bolsa Chica	S	?	?	?	?	No		Red tailed Hawk was found dead hanging from an electrical wire around the same time the Kestrels were caught and may have contributed to some of the damage on this colony.
	Batiquitos Lagoon all sites	S		unknown	unknown		limited	no	implicated individuals were not effectively targeted
OTHER SPECIES:									
Black-bellied Plover	Venice Beach	S	unknown				No	N/A	
Calif. ground squirrel	Batiquitos Lagoon W-1	S	12				no		pred mngt did not conduct control on this sp.
Calif. ground squirrel	Tijuana Estuary	D	1	unknown			yes, as-needed	yes, individuals removed and additional losses limited	additional individuals in area possibly inflicted additional losses
Gull-billed tern	Tijuana Estuary	S	unknown	unknown			needed for this	removed and losses not	sensitive status of species

Table 6. California Least Tern Losses to Predators, 1998

Predator	Site Name	Suspected or Documented?[a]	Number of Eggs Lost	Number of Chicks Lost	Number of Fledglings Lost	Number of Adults Lost	Predator Management for this Species?	Was it Effective?	If not, why?
OTHER SPECIES (continued):									
Opossum	Tijuana Estuary	S	unknown	unknown			yes, as-needed	yes, individuals removed and additional losses limited	additional individuals in area possibly inflicted additional undocumented losses
Raccoon	San Elijo Lagoon	S	2				not available	no	
Short-eared Owl	Tijuana Estuary	S		unknown	unknown		yes	yes	NA
Striped Skunk	Chula Vista WR	S	3				yes	yes	NA
rats	Chula Vista WR	S	3				yes	yes	NA
unidentified rodent	Alameda NAS	S			1		no	NA	NA
unidentified avian	PGE, Pittsburgh	S		2			no	NA	NA
unidentified owl	Batiquitos Lagoon E-3	S	2				no	NA	NA
unidentified avian	Mis. Bay Mariner's Point	S			6	1	yes	yes	
unidentified avian	Tijuana Estuary	D	1	unknown			yes	yes	NA
unidentified avian	Ormond Beach	S	1						broken eggshell
unidentified avian	LA Harbor Pier 400	S	1	unknown			no	N/A	cracked egg
OTHER LOSSES NOT REPORTED BY PREDATOR TYPE	White Beach	D	3	1			NO DATA	NO DATA	NO DATA
	SM River North Beach	D	7	14		18	NO DATA	NO DATA	NO DATA
	SM River Salt Flats	D	3				NO DATA	NO DATA	NO DATA
	SM River Salt Flats Is.	D	3	5			NO DATA	NO DATA	NO DATA
	North Island NAS	D		7 to 8	3 to 5	5 to 6	NO DATA	NO DATA	NO DATA
	Delta Beach North	D	6	2	1	2	NO DATA	NO DATA	NO DATA
	Delta Beach South	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
	NAB Ocean	D	14		1		NO DATA	NO DATA	NO DATA
			eggs	chicks	fledglings	adults			
TOTAL MINIMUM LOSSES[b]			147	165	26	45			

a See text for a description of "suspected" and "documented" predators.
b When a range is provided, the upper end of the range was used to calculate these totals, as reported losses are likely minimal

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Endangered Species Guidesheet

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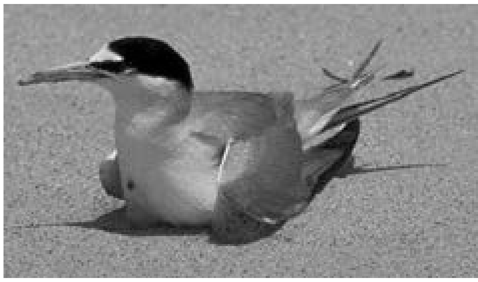
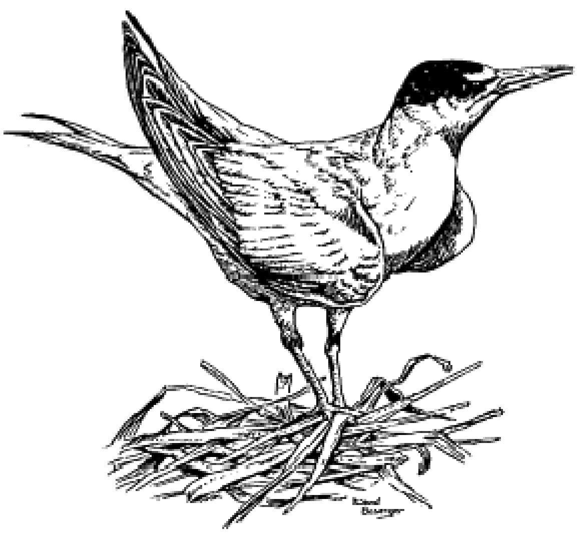


INTERIOR LEAST TERN

Sterna antillarum athalassos

The Interior least tern is a bird that forages over large rivers and nests on open expanses of sand or gravel on islands in the river. Reservoir construction along the Mississippi and Missouri rivers has reduced, and sometimes eliminated, habitat essential for reproduction. Nesting colonies are threatened by human disturbance. The Interior least tern is listed **ENDANGERED** by the Missouri Department of Conservation and **ENDANGERED** by the U.S. Fish and Wildlife Service.

Identification



Least terns are the smallest of American terns, averaging 8 1/2 to 9 1/2 inches long, with a wingspan of about 20 inches. Like all terns, they are slender with long, narrow wings, a forked tail, and a pointed bill. Interior least terns are black-capped with a white forehead, a black-tipped bill, gray and black wings, a pale gray back and tail, and a white belly.

Males have brighter feet and bills (bright orange or yellow) than females (pale or dull yellow). Juveniles tend to have darker plumage and bills than adults and often have a dark eye stripe on their white forehead.

There are two other races of the least tern in the United States: the Eastern (or Coastal) least tern (var. antillarum) and the California least tern (var. browni). Neither of these subspecies are found inland.

For a technical description of this animal, refer to:

Robbins, C.S., B. Bruun, and H.S. Zim. 1983. A Guide to Field Identification: Birds of North America. Western Publishing Company. New York, NY. 360 pp.

Life History

Females begin laying eggs in late May and produce one to four pale to olive-buff eggs. Eggs are speckled or streaked with dark, purplish-brown to blue-gray markings. Incubation generally lasts 20 to 25 days.

Hatchlings reach the fledgling stage in three to four weeks but remain with their parents until migration. Pre-fledgling mortality rates are high, but adults may live 10 years or more.

They feed almost entirely upon small fish and require shallow water areas near their nesting sites that provide abundant small fish populations. Sites for breeding and nesting are generally bare or sparsely vegetated.

Nests within the colony, or ternery, are scattered, and only the area directly around the nest is defended. Terns choose sites that are well-drained and away from the water line. Nests, or "scrapes," are made by scraping a depression in the sand or gravel. The scrape may be lined with pebbles or small shell fragments.

Interior least terns migrate in small loose flocks, arriving in Missouri from late April to mid-May. They leave for their wintering areas in August and September. It is unknown where the terns go during the winter. However, unidentified terns have been found during the winter in Central and South America.

Habitat and Distribution

Natural habitat for terns includes islands, beaches, and sandbars, but as these areas have become rare, terns have been forced to use dredge islands, dikefields, fly-ash lagoons, sandpits, and gravel roads on top of levees.

Interior least terns are generally restricted to larger meandering rivers with a broad floodplain, slow currents and greater sedimentation rates, which allow for the formation of suitable habitat. Interior least terns experience the greatest nesting success on sand or gravel bar islands because predation by terrestrial predators is reduced.

In Missouri, Interior least terns used to nest along the Missouri River and southern half of the Mississippi River, especially where the two rivers joined. They are presently found only in the southeast portion of the state along the Mississippi River in Pemiscot, New Madrid, Scott, and Mississippi counties.

Cause of Historic Decline

Channelization, irrigation, and the construction of dams, levees, reservoirs, and dikes have eliminated most of the sandbars suitable for tern nesting. Unpredictable and poorly timed water discharge from dams have flooded terns' nests and nesting sites, and allowed woody vegetation to encroach on remaining sandbars.

Current Threats to Interior Least Terns

- **Loss of breeding and nesting habitat** Damage to nests and destruction of nesting sites by dam water discharge, vegetative encroachment, and loss of nesting islands are the primary concerns for long-term survival of the least tern.
- **Human disturbance** Recreational activities on sandbars and sand and gravel pits disrupt tern breeding. ATV's, hiking, picnicking, boating, and swimming on or near sandbars with tern colonies or artificial nesting sites can result in nest failure and high mortality of young terns.

- **Predation** Predation on tern eggs and young by feral cats and dogs, coyotes, crows, laughing gulls, and foxes can be a serious problem. Unattended pets and garbage left behind on sandbars can encourage the problem.

Protection and Management: Steps Toward Recovery

There are fewer than 10 nesting colonies in Missouri. All are on sand islands in the lower Mississippi River of the bootheel region. Three of these islands are managed by the Department of Conservation, the rest are on private land. Since these areas have little use other than recreation and wildlife most landowners are pleased to assist with tern recovery efforts.

All of these sites are affected by river management that reduces water levels to expose the nesting sites during the summer months. Participation from the U.S. Army Corp of Engineers is essential to tern restoration in the Mississippi River.

Compatible river management is essential for the full recovery of the least tern. Unfortunately, there is little a private landowner can do to influence how a river flows or when a dam releases water. Wise timing of discharge from dams is needed to prevent nest flooding and to promote "scouring" of sandbars to remove woody vegetation. Private landowners who own sandy islands used by terns can help by implementing the following suggestions.

- **Waterway management** In areas where sandbars have been overwhelmed by woody vegetation, removing the vegetation may benefit the tern by providing nesting habitat. Removing vegetation by hand or by using chemicals may be necessary each year and should be done instead of mowing. Notched wing dikes that cause sand to deposit downstream can create new nesting islands.
- **Human disturbance** Avoid disturbing nesting terns or their young. People should avoid sand islands where least terns are nesting from mid-May through mid-August. In Missouri, tern nesting sites are posted as seasonal refuges. Control pets near nest sites. Hiking, boating, swimming, picnicking, and camping should be done away from tern colonies to avoid impact. If necessary, fences can be erected around terneries during the breeding season, particularly to regulate the use of ATV's.
- **Predator control** Garbage and litter should be removed from sandbars so predators are not attracted to them. The Missouri Department of Conservation can build predator exclosures around terneries to control predation of chicks and eggs, and shelters can be constructed for tern chicks using snow fence slats.

Missouri and federal law prohibits the importation, transportation, sale, purchase, taking or possession of birds on the State or Federal lists, as well as their eggs and nests.

For more information on the Interior least tern, or to report sightings of this species, contact:

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Endangered Species Coordinator or Wildlife Ecologist Missouri Department of Conservation Natural History Division P.O. Box 180 Jefferson City, MO 65102 (573) 751-4115

Working on Roofs (Least terns and Black skimmers)

Least Tern

The Least Tern (Sterna antillarum) is listed as a threatened species by both the USFWS and the FGFWFC. The interior Least Tern is the smallest member of the gull and tern family, measuring 8-9 inches (20-23 cm) long and having a 20-inch (51-cm) wingspread. Males and females appear identical with a black crown, white forehead, gray back, gray wings above with white below, orange legs and a black-tipped yellow bill. Immature birds have darker feathers, a dark bill and dark eye stripes on white heads.

The interior Least Tern arrives in Florida from their South American wintering grounds each year from mid-March through April. It nests in small, loosely defined groups on barren beaches of sand, gravel or shells, on dry mudflats and salt-encrusted soils (salt flats) and at sand and gravel pits along rivers. Nesting success depends on the presence of bare or nearly barren sandbars, favorable water levels during nesting, and abundant food.

The nest is an inconspicuous, unlined scrape usually containing 2 to 3 brown, spotted eggs. Egg laying and incubation occur from late May through early August. Eggs hatch in about 20 days and chicks are fledged in about another 20 days. The interior Least Tern feeds on small fish and crustaceans taken by diving from the air into shallow water. During the breeding season, these birds usually feed within a few hundred meters of the nesting colony.

Least Terns utilize their colony sites year after year; however, colony sites are occasionally abandoned by terns due to a variety of factors. Although some vegetation is beneficial as cover for mobile chicks, colonies will abandon sites that become too vegetated. Other factors that are correlated with abandonment are human disturbance, presence of mammalian predators, and flooding. Of these, human disturbance is probably the factor most responsible for recent declines. Human-caused disturbances can exacerbate many of these problems, which increases the rate of turnover and decreases the reproductive success of colonies. The same areas that these birds value for nesting habitat are unfortunately the same areas humans value for recreational activities. Human intrusion along beaches, lakes, and streams reduces the available nesting area for these birds. For this reason, the Least Tern has adapted their nesting habits to colonizing flat, graveled rooftops, which are generally free from humans and other predators.

Black Skimmers

The Black Skimmer (Rynchops niger) is listed as a species of special concern in Florida by the FGFWFC. The Black Skimmer measures up to 18 inches long and has a 40-inch wingspread. Males and females appear identical with black upper parts, white cheeks and neck, red feet, and a red, black-tipped bill. The bill is unique in that the lower half of the bill is longer than the upper. Immature birds are browner and more mottled above.

The Black Skimmer resides year round along Florida's coastlines, however these numbers may increase in winter due to an influx from northern portions of the bird's breeding range. The Black Skimmer generally breeds from May through September nesting in large colonies, often with other tern species. Like the Least Tern, it nests on barren beaches of sand, gravel or shells, on dry mudflats and salt-encrusted soils (salt flats) and at sand and gravel pits along rivers.

The nest is an inconspicuous, unlined scrape usually containing four to five eggs. Egg laying and incubation occur from late May through early August. Incubation lasts about three weeks with both sexes participating. The chicks can fly about one month after hatching. The Black Skimmer feeds on small fish and shrimp taken by skimming along the surface of the water and snatching their prey with a quick downward snap of their bill. During the breeding season, these birds will travel up to 5 km from the colony site in search food.

Roof-nesting

With the loss and degradation of natural colony sites, the Least Tern has adapted to nesting on gravel rooftops. Nesting on rooftops was first reported in Pensacola, Florida, and has since become widespread throughout the state. By l975, 2l%of the colonies along Florida's Atlantic coast occurred on roofs. Several studies have shown that roof colonies have higher reproductive success than do nearby beach colonies; this may reflect superiority of the roof environment or the degradation of existing ground colonies. Roof colonies have been reported typically to be larger than ground colonies, and colony size is correlated with reproductive success. There is some evidence that populations have stabilized recently, perhaps due to increased roof nesting offsetting losses at ground colonies.

Likewise, the Black Skimmer has also adapted to nesting on rooftops. Although they are primarily beach nesters, small numbers of Black Skimmers attempt to nest on roofs in a few locations in Florida each year. Roof nesting Black Skimmer colonies are usually small and have low nesting success when compared with beach colonies.

There are many hazards to eggs and young of roof nesting birds. High winds can blow eggs out of scrapes where they may be abandoned by parents, or blow eggs completely off roofs. Parents attempting to return them to their nests may also damage eggs blown out of nests. Heavy rains can flood nests and wash eggs and chicks off roofs. Chicks can become trapped in gutters or washed down drain spouts. Chicks may also stick to exposed tar and die of exposure. Chicks that fall off roofs and survive face the threat of ground predators or being crushed by vehicles if adequate shelter is lacking.

Humans entering rooftop colonies can cause chicks to run off the edges and parents to fly off scrapes leaving nests exposed; repeated intrusion may cause the colony to be abandoned. Roof repairs during or just prior to nesting season disrupt colonies and may cause them to be abandoned. Human disturbance at colonies increases stress on parents, increases intraspecific aggression rates, and exposes chicks to aggression from adults when they wander into adjacent territories. Recently, many tar and gravel roofs are being resurfaced with smooth plastic material that is unsuitable for tern nesting. This results in a further decrease in available nesting habitat.

Several factors make roof nesting more difficult for Black Skimmers than for Least Terns. These include:

1. Black Skimmers are more sensitive to human disturbance than are Least Terns. When disturbed, they typically take longer to return to nests. This exposes their nests to predators for long periods of time and may contribute to the low reproductive success on roofs. They may also be more likely to abandon colony sites than are Least Terns.

2. Black Skimmers make deeper scrapes than Least Terns. This may expose the eggs of roof nesting Black Skimmers to tar. It may also be that the adults cannot dig an adequate scrape on roofs and that they crush their eggs beneath their bodies while incubating. The shallower scrape combined with a larger egg size make the Black Skimmer's eggs more susceptible to being blown out of the nest.

Requirements

Least Terns and Black Skimmers nest on roofs surfaced with tar and gravel (pea-rock or shell) with roof slope varying from none to slightly pitched. The buildings utilized by these birds range in height from one to six stories high and range in roof area from tens of square meters to a few hectares. Any nesting activity at a building should result in the rooftop becoming immediately off-limits, except for safety or maintenance emergencies. Disturbance to the colony is the factor most likely to cause colony failure and abandonment; it is also the easiest to eliminate.

Humans entering rooftop colonies can cause chicks to run off the edges and parents to fly off scrapes leaving nests exposed; repeated intrusion may cause the colony to be abandoned. Roof repairs during or just prior to nesting season (March-July) disrupt colonies and may cause them to be abandoned. Human disturbance at colonies increases stress on parents, increases interspecific aggression rates, and exposes chicks to aggression from adults when they wander into adjacent territories. It is recommended that no persons access the rooftop during colony-site selection and nesting season (between mid March and late July).

If it is necessary to access a roof with an active nesting colony, it is important that disturbance to the birds is minimized. If an emergency warrants entry onto the rooftop, a staff biologist should be consulted and should accompany the workers onto the roof to insure that colony disturbance is kept to a minimum. The number of persons accessing the roof should be minimized, as should the duration of time spent on the roof. One long visit may cause less overall disturbance than several shorter duration visits. Early morning (before 10:00 AM) or evening (after 4:00 PM) access will minimize the stress on nesting adults and young that might result from heat during mid-day. Visits should be limited to the edges of the roof away from the colony as much as possible.

There are several improvements that could be made to buildings on which these birds are nesting that would enhance the birds nesting success rate:

1. Roof edges. A lip or parapet on the edge of a roof prevents eggs and chicks from washing or blowing off the edge, and it deters mobile chicks from running off the edge. A 15-30 cm lip is sufficient protection for eggs and chicks. If there is no lip or parapet on a building, a suitable lip can be made from hardware cloth bent into an "L" shape. The screen can be secured to the roof with 2 x 4s or cinder blocks, or could be permanently attached to the roof or the side of the building. A 1.3 cm mesh size is optimal (any larger and chicks might fit through; smaller mesh has more wind resistance).

2. Shade and shelter. Although roofs are generally cooler than beach nesting habitat, the lack of shade and cover can be a serious problem. Cover protects chicks from predators and provides shade during the heat of the day. Some roofs have many structures that provide for these needs while others have almost no cover. A simple solution is to place a few cinder blocks on top of the roof.

3. Drainage system. Many chicks are killed when they are washed off of roofs through drainage pipes or openings. It is not difficult to provide screens for drains that prevent this from occurring. Screens should be of 1.3 cm or less mesh size. It is important that screens be cleaned prior to nesting season to prevent flooding that could drown eggs and chicks.

Another consideration is the location and condition of feeding areas for the colony. Least Terns and Black Skimmers catch small fish in fresh or saltwater near the colony location. Often the birds will fish in retention ponds located near the colony building. The quality and quantity of water in these ponds may be crucial to the health of the adults and their offspring. If pollution from runoff contaminates these ponds, toxins may accumulate in the bird's tissues, possibly resulting in lowered nesting success, abnormal development of young, or even death of the adults. If the retention ponds were drained during nesting season, this would eliminate a crucial resource for the nesting birds. Therefore, it is important to consider potential impacts to waters in which these birds forage.

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Returning Least Terns Find Expanded Home at Alameda Wildlife Refuge

In late April and May, when a colony of California Least Terns completed its arduous, roughly 2,700-mile trip from Latin America to nest at the Alameda Wildlife Refuge, a pleasant surprise awaited them. They found their old nesting site had nearly doubled in size to over nine acres! The birds also found their nesting area lined with a new, oyster shell ground-cover for camouflage and the entire area protected by a specially designed, rabbit-proof fence. Such a welcome home for the endangered terns is due to the dedicated efforts of Golden Gate Audubon's Friends of Alameda Wildlife Refuge (FAWR) and to U.S. Fish and Wildlife Service (FWS) biologists. The terns also have to thank a class of 50 children from West End Alameda elementary schools, who spent a day in March spreading new oyster shell ground cover for the birds' benefit.

Successful breeding and higher numbers of terns nesting in Alameda over the last 20 years appeared to be causing density bickering. Chicks would sometimes wander into other terns' territory and get hammered with a pointy beak. More than 300 nests seemed to be too many in less than six acres.

Led by biologists Chris Bandy and Rachel Hurt, FWS found the means to expand the colony. The U.S. Navy still owns the land that has been proposed for the Alameda Wildlife Refuge, but the tern colony and the area's wildlife resources are managed by FWS. After initial delays in the project—such as the difficulty in finding contractors willing to install a new fence with recycled materials—the nesting-site expansion was completed just in time, and last-minute details were finished before the terns' arrival. The new fencing is designed to keep jack rabbits out of the colony. New fence poles are cut lower than the top of the fence to remove larger avian predator perches. The old fence (installed in the 1980s) was not entirely chick-friendly. The new fence offers a gentle barrier between the nest site and the outside world with a smooth plastic mesh border placed along the inside bottom of the chain link fencing.

The new ground substrate is a coarse, heavy sand from Angel Island. A load of oyster shell was brought in and added for chick shelters and predator distraction. And a new cinder-block grid system has been installed for keeping track of nest locations.

While so much habitat has been reduced or lost altogether for so many birds, GoldenGate Audubon and its tireless volunteers are proud to have an enlarged and safer habitat for these remarkable little terns. It will be interesting to see where they settle. Will they use the new area for nesting or prefer their old, familiar grounds? Come and see for yourself on the "Return of the Terns Day" on Sunday, June 13th.

-Leora Feeney, FAWR Chair & biologist

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Effects of Management Strategies on the Reproductive Success of Least Terns on Dredge Spoil in Georgia

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Abstract - *Sterna antillarum antillarum* (Eastern Least Tern) historically nested on Atlantic Coast beaches and barrier island shores, but has moved inland to artificial habitats, such as dredge-spoil sites, as available natural habitat has been lost to development and increased human recreational activities. Least Terns readily nest on artificial sites, but the effects of different habitat characteristics and depredation conditions on reproductive success are unclear. We examined the effects of management strategies, disking and electric fencing, on daily survival rate (DSR) and 21-day survival rate (DSR^{21}) of clutches, and on apparent nesting success on a dredge-spoil site in Georgia from 1993 through 1998. All 3 estimates of reproductive success increased as management intensity increased. Significantly ($\chi^2_2 = 185.8$, $P < 0.001$), DSR increased from 0.88 (1993, no management) to 0.97 (1998, disking in March to remove vegetation and enclosure with an electric fence). Corresponding DSR^{21} were 0.06 and 0.59, respectively. Artificial nesting sites can be improved by management actions, and such work may be increasingly important as natural habitat for beach-nesting birds continues to decline in availability and quality.

Introduction

There are 3 recognized subspecies of *Sterna antillarum* Lesson (Least Tern) in North America: *S. a. browni* (California), *S. a. athalassos* (Interior), and *S. a. antillarum* (Eastern) (American Ornithologists' Union 1957, Draheim and Haig 2005; but see Whittier et al. 2006). The Eastern subspecies is distributed from southwestern Maine to the Florida Keys and west along the Gulf Coast to Texas (US Department of Interior 1983). Although the Eastern subspecies is not listed by the US Fish and Wildlife Service under the Endangered Species Act, it is listed as "rare" by the Georgia Department of Natural Resources (2004).

Least Terns nest in colonies from April to mid-June along the Atlantic Coast. Their nests are a shallow scrape made in dry sand, rarely lined with shell fragments. They lay 2 or 3 eggs; incubation begins with the first egg and lasts 20–25 days, or an average of 21 days (Hays 1980, Massey 1974). Typically, Least Terns only rear 1 brood per year (Burleigh 1958).

Historically, Least Terns nested on beaches, sand spits, and barrier island shores, but they have moved inland to sites such as roof-tops (Fisk 1978, Cimbaro 1993, Cooper 1994, Gore and Kinnison 1991, Krogh and

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Schweitzer 1999) and dredge-spoil sites (Krogh and Schweitzer 1999, Kushlan and White 1985, McNair 2000, Miller 1994) as available shore habitat has declined. The quality of these inland sites for nesting is questionable. Estimated apparent nesting success on Georgia barrier islands (Ossabaw, Sapelo, and Little St. Simons) ranged from 0–40% with 10% nest abandonment (Corbat 1990). Krogh and Schweitzer (1999) calculated apparent nesting success for different habitat types in Georgia. Apparent nesting success on beach habitat (Ossabaw and Sea Islands) ranged from 0–29%. On dredge-spoil habitat (Crab Island, Andrews Island, and Mainside Spoil), apparent nesting success ranged from 0–32%, and on flat gravel roofs, it ranged from 22.7–53%. Mallach and Leberg (1999) found that the fine texture of dredged spoil was not as favorable to nesting success as fragmented shell substrates. Kotliar and Burger (1986) found that dredge-spoil sites had a greater colony turnover rate and smaller colonies than beach sites.

Causes of nest failure include predation on eggs and chicks by mammals (Burger and Gochfeld 1990, Rimmer and Deblinger 1992), birds (Jenks-Jay 1982, O'Connell and Beck 2002, Rimmer and Deblinger 1992), and *Solenopsis xyloni* McCook (southern fire ants; Hooper-Bui et al. 2004); extreme weather events (e.g., hail, winds, thunderstorms); tidal flooding (Cowgill 1989, O'Connell and Beck 2002); and human disturbance (Burger 1984, Burger and Gochfeld 1990). Kotliar and Burger (1986) concluded that depredation events were more likely at inland dredge-spoil sites. Fencing has been used successfully to discourage predation and increase nesting success of Least Tern and other beach-nesting bird colonies (Goodrich 1982, Minsky 1980, Rimmer and Deblinger 1992).

We conducted this project to determine the nesting success of Least Terns on an inland dredge-spoil site relative to management activities. We hypothesized that nesting success would increase as the intensity of management practices increased. Our findings will be useful for the conservation of other beach-nesting, migratory bird species as natural beach habitat is progressively diminished, and more birds are forced to move inland to similar dredge-spoil sites.

Study Area

We conducted this study on Andrews Island (31º07'N, 81º30'W), Brunswick, Glynn County, GA. Andrews Island is a 312-ha, dredge-spoil site located in the Turtle River, a tributary to the Brunswick River, St. Simons Sound, and the Atlantic Ocean. An earthen causeway connected the island to the mainland. Access to the island was limited by a locked gate and fence at the causeway. Vegetation within the spoil areas included *Eupatorium capillifolium* (Lam.) Small (dogfennel), *Andropogon virginicus* L. (broomsedge), *Tamarix gallica* L. (tamarisk), *Myrica cerifera* (L.) Small (wax myrtle), *Baccharis halimifolia* L. (eastern baccharis), and other low-growing vegetation. Silt and clay dredged from the Brunswick River covered

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most of the island, but a small number of areas were covered in sand and shell from newly dredged portions of the river. Least Terns nested within an 8-ha site in the southwestern corner of the island each year.

Methods

We monitored Least Tern nests between 0700 and 1000 AM, twice a week in May and once a week in June and July from 1993–1998, except in 1994, when all monitoring was done once a week. We developed a grid system over the 8-ha site, within which we walked parallel transects 6 m apart, from which we located nests. We placed a 15-cm long, uniquely numbered wooden marker approximately 0.5 m east of each active nest, and recorded the number of eggs present in each nest. In subsequent visits, if a nest was empty, we recorded the presence of chicks, signs of depredation, or signs of washing-out from storms to determine nest fate.

During each March 1994–1998, the 8-ha nesting site was disked to remove vegetation. A mesh (30.5-cm width x 8.25-cm height [12-in. width x 3.25-in. height]), battery-charged electric fence, was placed around the site in 1998. During the nesting season, signs were posted to deter human interference. Hence, our hypothesis that nesting success would increase with increasing management intensity, was tested relative to 3 management actions—no management, disking in March, and electric fence installation to exclude mammalian predators as well as disking in March.

For each year of the study, we used the program MAYFIELD (Bart and Robson 1982, Hines 1996a, Mayfield 1961) to estimate the daily survival rate (DSR) and 21-day survivorship rates (DSR^{21}) of clutches as measures of reproductive success. We calculated the annual apparent nesting success (number of successful nests/total number of nests) for compatibility with previous studies that only used this estimate. We defined a successful nest as one where at least 1 egg hatched. Program CONTRAST (Hines 1996b, Hines and Sauer 1989, Sauer and Williams 1989) was used to make multiple comparisons of rate data ($P < 0.05$ for all tests), incorporating associated variance and covariance estimates. Data were sorted by management practice: no management (1993), disking in March (1994–1997), and electric fencing as well as disking in March (1998). For comparisons of 3 rates, CONTRAST used an asymptotically chi-square quadratic model, a matrix within which chi-square tests determined differences among rates.

Results

Least Terns began nesting on Andrews Island during early April each year. We monitored from 216 to 459 nests annually (Table 1). The estimated 21-day survivorship rate ranged from 0.06 during 1993, when there was no habitat enhancement or protection from mammalian predators, to 0.59 during 1998, when management included disking in March to reduce vegetation and electric fencing to exclude mammals. The cause of nest failure in 1993

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was unknown. From 1994–1997, we estimated that 2.0% of failed nests were depredated by southern fire ants, 4.8% were preyed on by mammals, 0.1% were lost to avian predators, and 93.1% were lost for unknown reasons. In 1998, 4.4% of failed nests were lost to southern fire ants, 1.4% were lost to avian predators, and 94.2% were lost for unknown reasons.

Daily survival rates increased as the level of management activity increased ($\chi^2_2 = 185.8$, $P < 0.001$; Table 1). The daily survival rate for 1993 (no management) was 0.88, the daily survival rate for 1994–1997 (March disking) was 0.95, and the daily survival rate for 1998 (March disking and electric fence) was 0.97. Similarly, 21-day survivorship rates increased as management activity increased: 0.06, 0.41, and 0.59, for no management, March disking, and March disking and electric fence, respectively.

Discussion

The Eastern population of the Least Tern is not federally endangered, but its population status in some states is rare or of concern, and in Georgia, it is listed as rare. Consequently, conservation actions such as increased protection and enhancement of its nesting sites are warranted and will benefit other species with similar listing status and nesting habits, such as *Charadrius wilsonia* Ord. (Wilson's Plover), *C. melodus* Ord. (Piping Plover), *Haematopus palliadus* Temminck (American Oystercatcher), and *Rynchops niger* Linnaeus (Black Skimmer).

Because the Least Tern is an adaptable species, likely because of its habit of using ephemeral, sandy areas for nesting, it accepts artificial sites for nesting when natural beach sites are scarce due to development or unsuitable because of disturbance by human activities. When species are excluded from natural nesting habitats and must seek alternate sites, it is

Table 1. Least Tern nesting data from a dredge-spoil island, Andrews Island, GA, 1993–1998.

Year	Number of nests	Treatment	Daily survival rate[A]	95% confidence interval: Lower	95% confidence interval: Upper	21-day survival rate[B]	Apparent nesting success[C]
1993	251	None	0.8776	0.8617	0.8936	0.0645	0.092
1994	365	Disking[D]	0.9565	0.9506	0.9625	0.3930	0.340
1995	459	Disking	0.9725	0.9690	0.9761	0.5568	0.514
1996	378	Disking	0.9168	0.9078	0.9257	0.1613	0.161
1997	216	Disking	0.9693	0.9640	0.9745	0.5195	0.394
1998	362	Disking and electric fence	0.9749	0.9714	0.9785	0.5864	0.486

[A]Daily survival rate of clutches was calculated using program MAYFIELD (Bart and Robson 1982, Hines 1996a, Mayfield 1961).
[B]Survival rate of clutches where mean length of incubation is 21 days (Bart and Robson 1982).
[C]Apparent nesting success = number of successful nests/total number of nests. Successful nests were those in which at least 1 egg hatched.
[D]All disking was conducted in March.

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expected that their reproductive success rate would decline. Nesting on dredge spoil may lead to lower reproductive rates than those on natural beach sites due to increased predation pressure (Kotliar and Burger 1986), exposure to contaminants (Winger et al. 2000), impermeable soils (Mallach and Leberg 1999), and increased disturbance from human activities (Kotliar and Burger 1986). Reproductive rates on natural beach habitats decline when predation rates (*Sus scrofa* Linnaeus on Ossabow Island) and disturbance from recreationists (Sea Island) are high (Krogh and Schweitzer 1999). We suspected that the reproductive success of Least Terns would increase if appropriate and intensive management actions were implemented, in this case, at a dredge-spoil site on Andrews Island, GA.

The overall apparent nesting success from 6 years of data collection ranged from 9.2–51.4%, and was slightly greater than other measures of apparent nesting success reported in Georgia on beach (0–40%, Corbat 1990; 0–29%, Krogh and Schweitzer 1999) and dredged-spoil sites (0–32%, Krogh and Schweitzer 1999). Estimates of apparent nesting success on roof sites (22.7–53%, Krogh and Schweitzer 1999) were slightly higher than those in this study at the dredge-spoil site. Roof sites are protected from most mammalian predators, but are susceptible to avian predation (Voigts 1999), environmental extremes, and may not have parapets that prevent eggs and chicks from falling (Krogh and Schweitzer 1999). The relatively greater apparent nesting success at the Andrews Island dredge-spoil site was due to implementation of management strategies in the last 5 years of the study, specifically, March disking to eliminate vegetation at the beginning of the nesting season and electric fencing to exclude mammalian predators. Statistical analyses of daily survival rates of clutches concurred with the observation of increasing apparent nesting success and detected significant increases in daily survival rates as management intensity increased. The 21-day survivorship rates followed suit and increased with increasing management of the dredge-spoil site.

There are several management practices that improve natural and artificial habitats when natural nesting conditions are unavailable or of poor quality, and selection of one or more practice(s) may significantly improve reproductive rates of vulnerable populations, as demonstrated in this and other studies. Terns and Black Skimmers readily nest on dredged spoil, and adding shell to the dredge-spoil substrate enhances the site (Mallach and Leberg 1999). Erecting an electric fence around colonies successfully excludes most mammalian predators and increases reproductive success (Minsky 1980, Rimmer and Deblinger 1992, Sargeant et al. 1974). Various "chick shelters" may provide refugia and protect chicks from avian predation (Jenks-Jay 1982). Artificial nest structures designed to elevate nests off the ground to prevent them from washing out in tidal flooding have been successful in some studies (Loftin and Thompson 1979). Disking and fencing enhanced the dredge-spoil site on Andrews Island in this study.

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Beach-nesting birds along the Atlantic Coast must adapt to increased development and human recreation. One adaptive response is to seek alternative nesting sites, such as dredge-spoil islands used increasingly in New Jersey and North Carolina (Erwin et al. 2003). Coastal biologists must be aware of alternative habitats selected by these species and increase management activities that optimize nesting conditions (Erwin et al. 2003) to maintain or increase reproductive rates of species of concern.

Acknowledgments

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A report on the 2001 breeding season at the Little Tern colony Beacon Lagoons Nature Reserve Easington, East Yorkshire

Martin G Stoyle

October 2001

This project was sponsored by English Nature and the South Holderness Countryside Society and was managed by Spurn Bird Observatory Trust

Contents

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1. Summary

The first Little Tern arrived back at the Lagoons on the 20th of April. The number of terns was still on the low side at the start of the warden's contract on the 11th May, with only 30 birds present. Courtship was prolonged, and the first terns weren't on eggs until the 28th May. By the end of May there were only 5 breeding pairs.

The number of pairs gradually built up to a maximum of 44 breeding pairs on the 19th June, which was also the same day the first chicks hatched. By the end of June a total of 19 chicks had hatched. A lack of predators in the area at this time saw all the chicks still present at the end of June. Human disturbance was also light for the vast majority of the time.

The number of hatched chicks had increased to 28 by the 2nd July. However the appearance of a female Kestrel, signalled what was to be the end of the colony in 2001. Over the next week and a half the Kestrel decimated the colony, taking most, if not all, of the unfledged Little Tern chicks. Two chicks fledged on the 15th and left with the remaining adults. A third juvenile was seen in front of Beacon Ponds hide on the 26th, being the last bird to fledge. Two Little Terns at Beacon Ponds on the 28th were the last to be seen in the area.

This represents the worst season since 1997 for the Easington Little Tern colony.

2. Acknowledgements

Many thanks to English Nature and the South Holderness Countryside Society for providing the project funding and to Spurn Bird Observatory Trust for managing the project. Without the support of these organisations the project would not have been possible in 2001.

Thanks also to Craig Ralston and the volunteers at York University, for giving up their time to help with the fencing, and also for providing a vehicle to move materials to the reserve.

The protection scheme couldn't continue without volunteers, who help out with wardening and the many practical tasks undertaken around the reserve. Many thanks to Betty Smallwood, Frank Kennington, and Michael and Adam Stoyle, for wardening and to Liz Walters and Paul Massey for their invaluable assistance with many practical tasks throughout the season.

Thanks also to Barry Spence for ringing the tern chicks, and giving me lots of helpful advice, which made my job a great deal easier.

3. Weather

May

The weather during May was generally warm and sunny, with occasional heavy showers, but no prolonged periods of heavy rain. The winds were generally from the northerly quarter during the first fifteen days of the month, and then from the southwest until the month's end.

June

June started with strong northerly winds building to gale force by the 2nd, backing to the westerly quarter by the 3rd and then dropping to force 2-4 (Beaufort scale) until the 12th. They then veered southeast until the 20th, before returning to northerlies until the month's end. Hot humid weather prevailed throughout the month.

July

Light winds dominated the month coming mainly from the northwest and southeast. It was a generally sunny month with occasional heavy showers.

4. The Little Tern colony month by month

April

There was little coverage of the site during the month as the Little Tern warden had yet to begin his contract. The first Little Terns arrived back at the site on the 20th, with numbers staying in low single figures until the month's end. Two Little Terns were displaying over the Lagoons on the 28th.

May

The Little Tern warden started on the 11th. Many Little Terns were now in full display, though numbers fluctuated greatly, with between five and forty birds present. The first pairs were noted nest prospecting on the 20th, with seven pairs nest scraping on the 22nd. Two pairs were seen to be incubating on the 28th, with six pairs sitting on the 30th.

Up to eighty-nine Little Terns were present intermittently by the end of the month. These were mainly seen, and counted, whilst roosting on the beach. Two Carrion Crows were making frequent visits to the colony during the last ten days of the month, which caused some concern as the Little Terns did not easily drive them off.

June

The month began with a strong northerly gale, which combined with high spring tides, caused concern for the terns that were incubating. However the sea didn't breach the low dunes, thus never flooding the breeding area. Large amounts of sand were blown through the colony, causing two of the incubating pairs to desert their nests. These were subsequently covered with sand. Four pairs that were nest prospecting on the beach to the south of the area, decided to abandon the area, and a few days later were seen prospecting in the traditional breeding area.

The number of sitting birds increased daily over the next two weeks. Disturbance was relatively light during this period, although two Carrion Crows were still visiting the area. However with an increased number of incubating pairs, these were easily driven off. A freshly laid egg found almost intact at the side of the lagoons on the 12th, had been removed from its nest by a male Little Tern, that had been displaying to a female that had already laid. Progress continued smoothly and by the 14th there were 35 breeding pairs, rising to 41 by the 15th. The weather had been kind throughout most of June with light winds mainly from the southern quarter. This combined with a lack of predators made for good breeding conditions and the first four chicks hatched on schedule on the 19th. This was also the day the number of breeding pairs reached a maximum of 44.

The number of hatched chicks increased almost daily and by the month's end 15 chicks were present, including one bird that had been incubated for 29 days! Fox tracks were found around the colony, though no evidence of chick predation was noted. The good weather continued and everything was looking conducive for a successful breeding season.

July

The 1st saw four more chicks hatch. Human disturbance on this date was high and the adult Little Terns wouldn't land for long to feed their chicks. At least four Little Tern chicks were attacked by adult Ringed Plovers in the afternoon, when the tern chicks wandered into their territory. The number of chicks increased again on the 2nd to 23.

The appearance of a female Kestrel at around 4pm, on the 2nd, was to spell the end for the colony. By the end of the day the Kestrel had made five more visits, predating a chick on each occasion, and leaving to the northwest. Little Tern activity was much reduced on the 3rd; the Kestrel had predated over 20 chicks in less than 24 hours!

Over the next five days the Kestrel completely decimated the colony taking over 70 chicks and often making over twenty visits a day. The method of predation was more akin to Merlin or Sparrowhawk. The bird would sit on Long Bank watching, before attacking low and fast directly into the colony, then making off quickly with the predated chick. The Little Terns seemed completely unable to defend against this style of hunting. Even when the Kestrel was flushed by the warden she would usually return within half an hour.

By the 8th the number of Little Terns in the area was much reduced. Although some had started displaying again, it was a rather half-hearted affair, involving high level chasing but no fish passing. On the 10th, hope for some chicks still being alive was fuelled by the sight of two Little Terns hovering with fish over the area of dunes to the north of the colony. The fish was just dropped into the dunes, with the adult terns quickly flying away. This was presumably done so as not to give away the precise location of their chicks. Late in the afternoon, of the 10th, two juveniles were seen on the beach. Over the next few days these birds were seen making short flights around Beacon Ponds. After a particularly heavy shower on the 11th a reasonable sized Little Tern chick was found well down the beach in a pool of water. Although cold it seemed relatively all right, and after been warmed up was returned to the dunes.

The juvenile Little Terns left the area on the 15th and were not seen again. On the 26th another juvenile Little Tern was seen in front of Beacon Ponds hide with one adult. This was the last bird to fledge, and they were also the last Little Terns seen in the area. This bought to a close what had started out a very promising breeding season.

5. <u>Breeding success of Little Terns at Easington 1977 to 2001</u>

Year	No. of pairs	No. of young fledged	Productivity
1977	5	2	0.4
1978	4	0	0
1979	4-5	0	0
1980	6	0	0
1981	4-5	0	0
1982	4	8	2.0
1983	6+	15	2.5
1984	8	23	2.88
1985	11	8	0.72
1986	22	5	0.23
1987	2	0	0
1988	3	4	1.33
1989	20-25	1	0.04
1990	31	29	0.94
1991	20	0	0
1992	34	11	0.32
1993	62	20	0.32
1994	65	29	0.45
1995	71	4	0.06
1996	49	31	0.63
1997	42	2	0.05

1998	41	42	1.02
1999	54	45	0.83
2000	49	9+	0.18
2001	44	3	0.07

6. <u>Wardening and visitors</u>
Most daylight hours were covered, either by the warden or by a small group of volunteers. The public in general caused little disturbance to the terns. There were 26 incursions into the colony during the breeding season, all of which were by people who claimed to have not seen or misinterpreted the warning signs. These were always resolved quickly once the situation was explained.

7. <u>Reserve management</u>

<u>Fencing</u>
The perimeter fence that surrounds the reserve during the breeding season was erected on the 2nd May, and taken down on the 5th August after the colony had dispersed from the area.The main function of this fence is to act as a visible deterrent to the general public, used in conjunction with breeding bird signs. This dramatically cuts down on incursions, by the public, into the breeding area.

<u>Electric Fencing</u>
The electric fence that surrounds the traditional breeding area was erected on the 1st June and removed at the end of July. The main function of this fence is to protect against terrestrial predators, such as foxes, which mainly hunt at night when the reserve is unmanned. It also helps to keep people out of the main breeding area, who have inadvertently wandered into the boundaries of the colony.

<u>Hide maintenance</u>
Both the hide at Beacon Lagoons, and the tern wardens hut, have fallen into a bad state of repair over the last few years, so it was decided that some long over due maintenance needed to be undertaken.Both buildings were painted whilst the Beacon Lagoons hide received some new wooden plank screens. These replaced the original reed screens which were now dilapidated and beyond repair.

<u>Tern Rafts</u>

During the first part of the warden's contract the Common Tern rafts, which are usually positioned on Beacon Lagoons, had broken free from their moorings the previous winter and were laying in a bad state of repair. These were repaired and repositioned, attracting two pairs of Common Terns, which bred. However they both failed to fledge any chicks.

8. <u>Predator protection measures</u>

<u>Electric Fence</u>
Once again an electric fence was erected around the main breeding area. This is to protect against terrestrial predators such as foxes. No Little Tern losses were thought to occur through terrestrial predators. This was thought to be a direct result of the electric fence.

<u>Chick Shelters</u>
During the 2001 breeding season three different types of chick shelters were used.

Plastic Pipes - These were basically laid on the ground with a covering of sand in the bottom of the pipe. These were not used by the chicks at all during the 2001 season. This method has been used at Easington for several years, without very much success. However other colonies have achieved good results using this type of shelter.

Wooden Shelters - These are basically wooden tunnels, around three feet long, and one foot wide. Chicks were seen to use these on a regular basis, in hot sunny weather, and also in high wind and rain. These were the most often used and effective type of shelter.

Natural Shelters - These shelters were made from natural resources at hand. Flat pieces of stone or wood were propped up on large rocks, to create a small tunnel. These were also used by the terns on a regular basis, again to protect against avian predators, and also against rough weather. These were probably used as often as the wooden shelters, though it was hard to monitor exact use without causing too much disturbance to the colony.

Discussion

The use of an electric fence is obviously a great way of keeping terrestrial predators out of the colony. Easington Little Tern chicks seem to favour natural wooden shelters as opposed to plastic pipes, so a greater number of this type of shelter should help prevent losses from bad weather and avian predators in future years.
Further work to investigate alternative shelters should be undertaken.

9. Predators

The following ground and avian predators were recorded in, or near, the colony during 2001.

Fox

Fresh fox tracks were found on a number of occasions throughout the breeding season, though no evidence of predation was found. This lack of tern predation was probably due to the large numbers of rabbits in the general area, providing a readily available food source. The foxes therefore had no need to resort to predating the Little Tern colony.

Stoat and weasel

Stoat or weasel tracks were found on a number of occasions, with just one confirmed sighting of a stoat on the 28th June. No known losses occurred to this species in 2001

Sparrowhawk

The only sighting was of a male flying south over Long Bank on the 12th June.

Kestrel

Sporadic sightings of Kestrels were seen during the early breeding season, though these didn't cause a huge amount of disturbance. The appearance of an adult female on the 2nd of July was to spell the end for the colony in 2001. The Kestrel often made twenty visits per day, taking seventy-five chicks over a two-week period. Some Little Tern chicks were even predated only minutes after hatching.

This has been the worst year ever for Kestrel predation at the Easington colony, after suspected predation during the 2000 breeding season. The predation in 2001 was probably down to just one individual. The problems caused by Kestrel predation will have to be addressed in future years, if Easington is to remain a major Little Tern colony.

Hobby

During the first half of June several visits were made to the colony by this species. Though they caused a huge amount of disturbance, no actual chasing was undertaken, and fortunately no adult terns were lost, as they have been in the past.

Carrion Crow
Up to four birds were present throughout the season, mostly frequenting the Long Bank area. Any birds straying into the colony were quickly seen off by the Little Terns. No losses were due to this species during the 2001 breeding season.

Barn Owl
Two birds were regularly present around the Long Bank area during the breeding season. These seemed to pose no threat to the Little Terns, and any prey items observed were always small voles. Fortunately they never found the easy source of food only a few yards away. No losses were due to this species during the 2001 breeding season.

Grey Heron
These never posed a really serious threat to the colony, but whenever one came near they were mobbed constantly until well out of the area. No losses were due to this species during the 2001 breeding season.

10. Ringing and colour ring sightings

A total of 23 Tern chicks were ringed using the Easington colour rings (mauve). These were placed on the left leg, with a standard BTO metal ring on the right leg. The colour ringing scheme was suspended with the arrival of the female Kestrel.
All visits into the colony were covered by schedule 1 licenses issued by English Nature.

Colour ringed birds
Sightings of colour-ringed birds from other colonies were frequent throughout the season. Three pairs from other colonies bred at Easington. These were a pair with red rings on their left legs, two pairs with blue rings on their left legs, and a pair with green rings on their left legs.

Colour ring sightings
Apart from the breeding birds mentioned above, these were as follows-
14th May Four birds with blue rings.
14th May One bird with a green ring.
15th May Two birds with blue rings.
15th May One bird with a red ring.
19th May One bird with a blue ring.
19th May One bird with a green ring.
20th May One bird with a blue ring.
26th May One bird with a blue ring.
30th May One bird with a blue ring.
20th June One bird with a mauve ring.

Key to Little Tern colour ring colours

Colour of ring	Location where ringed
Mauve	Easington and Spurn, East Yorkshire
Red	Tetney and Gibraltar Point, Lincolnshire
Blue	Teeside
Green	Norfolk

11. Discussion

There was a drop in the number of breeding pairs from the last two years, which is strange considering the amount of suitable breeding habitat, especially to the south of the tern wardens hut. However a more pressing issue is the presence of the female Kestrel, which decimated the colony. This bird is also thought to have probably predated several chicks during the 2000 season.

Proposals
The area to the south of the tern hut was used this season, though not to the extent it could have been. To encourage further pairs, breeding decoys and sound recordings of displaying birds, could be used, as suggested in previous years. This could increase the chances of breeding success and hopefully encourage a greater number of breeding pairs.

The threat from avian predators could be minimised by placing a Common Tern raft on the lagoon adjacent to the main breeding area. Common Terns are much more veracious at protecting their eggs and young, and are much more likely to drive away falcons, such as Kestrels and Merlin's.

12. Other birds at Beacon Lagoons

The following species listed as birds of conservation concern by the RSPB were also recorded at Beacon Lagoons during the project.

In addition to breeding birds, Beacon Lagoons are also an important area for roosting waders, terns and wildfowl whilst on passage.

Shelduck
Up to 11 birds were seen regularly until the end of May. Shelduck is an RSPB Bird of Conservation Concern (BOCC) on the Amber list (BL, WI, WL).

Wigeon
A male and female were present all summer though no evidence of breeding was noted. Wigeon is a BOCC on the Amber list (WI, WL).

Teal
A large flock comprising 53 birds was noted on the 5th August on Beacon Ponds. Teal is a BOCC on the Amber list (WI).

Scaup
A single male was on Beacon Ponds from the 1st until the 4th August. Scaup is a BOCC on the Amber list (BR, SPEC2&3).

Goldeneye
A single male was on Beacon Ponds on the 28th July. Goldeneye is a BOCC on the Amber list (BR, WL).

Kestrel

Regular but sporadic sightings of Kestrel were noted throughout the Little Tern breeding season, mainly hunting over the fields at the northern end of the reserve. Sightings became more frequent with the arrival of the rogue female that was breeding in nearby Easington. Kestrel is a BOCC on the Amber list (BDM, SPEC 2&3).

Oystercatcher
Five pairs bred within the reserve boundary, with the maximum number of passage birds peaking at 62 on 16th August. Oystercatcher is a BOCC on the Amber list (BI, WL).

Grey Plover
Small numbers were seen on passage in spring. Autumn passage started from mid-July with numbers peaking in the low 20s during mid-August. Grey Plover is a BOCC on the Amber list (WI, WL).

Dunlin
Small numbers were seen on passage in May. Autumn passage migrants were noted from early-July, building up to a peak of 5000 by late-August. Dunlin is a BOCC on the Amber list (WI, WL, SPEC 2&3).

Ruff
Two summer plumaged males were present on the 27th and 28th July. Ruff is a BOCC on the Amber list (BR, WL).

Bar-tailed Godwit
A maximum count of 34 on the 17th August. Bar-tailed Godwit is a BOCC on the Amber list (WI, WL, SPEC 2&3).

Redshank
Regularly seen roosting on Beacon Ponds from early-July with numbers exceeding 8000 towards the end of August. Redshank is a BOCC on the Amber list (WI, SPEC 2&3).

Greenshank
Regularly seen feeding at southern end of Beacon Ponds from mid-July, with a maximum of 17 on 21st August. Greenshank is a BOCC on the Amber list (BL).

Little Gull
Large flocks of up to 70 birds regularly visited Beacon Ponds during August. Little Gull is a BOCC on the Amber list (BR, SPEC 2&3).

Sandwich Tern
Large numbers roosted on Beacon Ponds from mid-July, with up to 3000 present on most days in August. Sandwich Tern is a BOCC on the Amber list (BL, SPEC 2&3).

Sand Martin
A pair nested for the first time within the reserve boundaries, successfully fledging two young. Sand Martin is a BOCC on the Amber list (SPEC 2&3).

Skylark
Eight pairs nested within the reserve boundary. Skylark is a BOCC on the Red list (BD).

Tree Sparrow
Up to 30 birds were seen regularly at the northern end of the reserve. Tree Sparrow is a BOCC on the Red list (BD).

Linnet
Two pairs bred, and up to 50 birds were regularly seen at the northern end of the reserve. Linnet is a BOCC on the Red list (BD).

Reed Bunting

A pair bred and two other birds were present from the end of June. Reed Bunting is a BOCC on the Red list (BD).

Corn Bunting
A pair bred raising two young, with an additional three birds present from mid-August. Corn Bunting is a BOCC on the Red list (BD, HD).

RSPB Birds of Conservation Concern (BOCC)
Red list criteria
BD = >50% decline of the UK breeding population, or range, over the previous 25 years.
HD = Historical population decline in the UK between 1800-1995.
Amber list criteria
BDM = a moderate decline (25-49%) in the UK breeding population, or range, over the previous 25 years.
BR = five year mean of 0.2-300 breeding pairs in the UK.
WI = >20% of European breeding population in the UK.
BL = >50% of the UK breeding population can be found in 10 or fewer sites, but not BR.
WL = >50% of the UK non-breeding population can be found in 10 or fewer sites.
SPEC 2&3 = species with an unfavourable conservation status in Europe.