THE STATUS OF THE CALIFORNIA LEAST TERN

AT SAN DIEGO UNIFIED PORT DISTRICT PROPERTIES

IN 2016

Prepared under Contract

For

San Diego Unified Port District

Photo by Kate Goodenough

By

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SUMMARY

Prior to mid-January 2016, most of the nesting area at D Street Fill was recontoured, leveled at a higher elevation, and graded as a component of a wetland mitigation project completed by San Diego Gas and Electric. In preparation for the nesting season, U.S. Fish and Wildlife Service staff and contractors applied herbicide to invasive plant species. Due to late rains and resulting seedling growth, in late March and again in late April mechanical scraping of the site to reduce vegetation and enhance it for use by least terns and snowy plovers was completed. Biological monitors under contract with the Port manually removed non-native invasive plants from the site, pruned back vegetation to reduce cover and potential raptor perches, surveyed the grid system, and placed decoys and ceramic tiles for chick shelters. Predator management was conducted by personnel of US Department of Agriculture, Wildlife Services, and is to be reported separately. Monitoring was conducted from mid-February through early August, one to three days per week.

Least terns were first observed at the D Street Fill on 11 April 2016. They were observed each visit after that through 26 July. At least 118 nests were initiated by 91 to 106 estimated pairs between 29 April and 11 July. The maximum number of concurrently active nests was 90 on 24 May, and the maximum number of concurrently active nests and broods was 87 nests with four broods of chicks on 27 May. At least 12 nests were suspected to have resulted from renesting by pairs that lost earlier clutches.

One hundred and forty-nine chicks from 89 nests hatched successfully. It is estimated that 21 to 22 chicks reached fledgling age and survived to fledge from the site. The outcome of five nests with seven eggs was uncertain, but lack of evidence of hatching or chick presence indicates probable depredation. At least five nests with seven eggs were depredated, most suspected to have been taken by northern harrier but one possibly by common raven. Twenty-one nests with 27 eggs were abandoned pre-term, and six eggs failed to hatch and were abandoned after the other egg in each clutch hatched successfully.

One adult, one fledgling, and 58 chicks were found with no obvious causes of death. Remains of one adult were found below a perched peregrine falcon, and piles of feathers or parts of an additional five adults, one fledgling, and one chick suggested predation by peregrine. Two chicks were observed being taken by a northern harrier. The carcass of one partially hatched chick was found away from the nest and suspected of having been dropped by a harrier or gull-billed tern. No other definitive evidence of chick depredation was found, but lack of observations, recaptures, fledglings, and attentive adults indicates that others were likely preyed on. The disappearance of up to 63 to 65 chicks coincided with documented depredation and/or daily disturbances to the colony by northern harrier, American kestrel, and peregrine falcon, and visits by common raven. Other potential predator species observed in the area included ant species, great blue heron, great egret, Cooper's hawk, red-tailed hawk, gulls, American crow, European starling, western meadowlark, opossum, rats, California ground squirrel, coyote, feral cat, and striped skunk.

There were no western snowy plovers documented at D Street Fill during the peak of nesting season from mid-March through August, and no nests were established by snowy plovers this season. However, 64 plovers were observed foraging on adjacent mudflats during ebbing or low tides prior to nesting season, and 29 to 44 following nesting season. Band combinations observed included origins in San Diego County, Baja California, and Oregon.

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INTRODUCTION

The California least tern (*Sternula antillarum browni*)(tern) once nested in large, loose colonies on beaches throughout Southern California. Increasing urbanization and habitat loss have led to the decline of its population and shifted much of the nesting to less traditional colony sites such as landfills and airports (California Least Tern Recovery Team 1977). The subspecies has been listed as endangered since 1972 (California Department of Fish and Game 1972, US Bureau of Sport Fisheries and Wildlife 1973). The population in California in 1973 was thought to be as low as 300 nesting pairs; by 2009, the population had grown to an estimated 7130 nesting pairs (Marschalek 2009). The breeding population in 2015 was estimated to be 4202 to 5295 pairs (Frost 2015).

This report addresses monitoring and management of the least tern colony site at the "D Street Fill" on the eastern shore of San Diego Bay and south of the mouth of the Sweetwater River under contract with the San Diego Unified Port District (Port) during the 2016 breeding season. San Diego International Airport - Lindbergh Field and the Chula Vista Wildlife Reserve are two other nesting sites located on facilities and properties adjacent to San Diego Bay and within jurisdiction of the Port, but monitoring in recent years has been under separate contract through the San Diego County Regional Airport Authority (Figure 1).

Guidelines were established by the U.S. Fish and Wildlife Service (USFWS) through informal consultation conducted for the maintenance of the D Street Fill within the Sweetwater Marsh National Wildlife Refuge Planning Area. Work was conducted under Federal Fish & Wildlife Endangered & Threatened Species Permit number TE-789255, Federal Bird Marking & Salvage Permit number 20047-H, National Wildlife Refuge Special Use Permit, and State of California Department of Fish & Wildlife (CDFW) Memorandum of Understanding (MOU) regarding California least tern and western snowy plover (*Charadrius nivosus nivosus*).

STUDY AREA

Least terns have nested on the sand-shell substrate of dredge spoil at the "D Street Fill",

south of the mouth of the Sweetwater River, along the eastern shore of San Diego Bay, since 1973 (WESTEC 1981). This site is managed jointly by the Port and the USFWS as part of the Sweetwater Marsh National Wildlife Refuge. Colony size and reproductive success have varied widely from year to year depending on the availability of nesting habitat with low vegetation height and density; availability of prey fish; predation and predator presence; and human disturbance. Annual least tern productivity at D Street Fill is summarized in Appendix A. Notable events in the site's history included it being abandoned by nesting terns in 1981 and 1990 (Copper 1981, Obst and Johnston 1992), and the colony being re-established with up to 135 nests in 1992 (Caffrey 1993). At least 41 nests were established at D Street in 1997, but there were significant losses to predation, and only seven nests were established in 1998 (Patton 1998a & 1998b). Nest numbers increased to 36 in 1999, but remained relatively low through 2002 when 24 nests were initiated (Patton 1999, 2000, 2001, 2002). Numbers then increased with 91 nests in 2003 and 111 in 2004. Since 2005, annual nest numbers have ranged from 100 in 2006 to 148 in 2008 and 2014; and annual fledgling production has ranged from nine individuals in 2012 to 36 in 2014 (Patton 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015). Over the past 10 years, annual numbers of fledglings produced per nest have ranged from 0.08 to 0.29 and numbers of fledglings per pair from 0.10 to 0.33.

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Nests	100	130	148	132	119	116	114	144	148	123
Fledglings	18-29	25-28	17-24	19-29	15-27	25-32	9	23-32	28-36	21-34

The site consists of a roughly rectangular peninsula of dredge deposits with relatively even topography, bordered by saltmarsh, mudflats, and San Diego Bay to the west, the historic Sweetwater River channel and saltmarsh to the south, the Sweetwater River flood control channel and saltmarsh to the north, and channels and saltmarsh of Sweetwater and Paradise Marshes to the east. A vehicle bridge and railroad trestle provide access from the north, a second trestle provides access from the south, but chain-link fencing and bollards limit accessibility to the bridges. The area of historic use by terns is further protected by a six-foot-tall chain link fence running north-south across the eastern end of the site and is closed to unauthorized access. Vegetation is diminished by mechanical grading or dragging prior to each nesting season and species assemblages altered to resemble coastal strand habitat. Ceramic tiles are laid out at grid intersections of 30 meter

squares to assist in nest mapping and provide shade and shelter for chicks.

Aerial view of Sweetwater Marsh, D Street Fill, and Sweetwater River.

METHODS

Site Preparation

Prior to mid-January 2016, most of the surface of the nesting area had been graded as a component of a wetland mitigation project completed by San Diego Gas and Electric. Sandy surface substrate was scraped from the nesting area and stock-piled; then soil excavated from the southeastern portion of the site was deposited throughout the nesting area; left to settle and dry; contoured; then capped by the original sandy substrate. This resulted in an increased elevation of the majority of the nesting area and more uniformly level surface. The eastern portion of the nesting area (grid rows 18 through 24) was left heavily furrowed. This was initially intended as erosion control for the mitigation project; but then was left in an effort to limit the spread of seeds following discovery of a highly invasive non-native weed, broad-leaved or perennial pepperweed (*Lepidium latifolium*), that had apparently been introduced to the site by equipment involved in the mitigation project. Monitors flagged individuals or patches of *Lepidium*, including within grids 16 and 17 of the prepared nesting area, and staff of the San Diego National Wildlife Refuge Complex applied herbicide.

Prior to any site preparation efforts after mid-February, the site was surveyed for the presence, courting or nesting of western snowy plovers, and for nests of other species. Late rainfall resulted in substantial seedling growth and the need for additional site preparation efforts. In late March and again in late April, staff and contractors of the San Diego National Wildlife Refuge Complex conducted mechanical scraping of the site to reduce vegetation and further enhance it for use by terns and snowy plovers. Additional new growth of vegetation in the nesting area was reduced by manual weeding, most notably mustard (*Brassica*) species. Vegetation around the periphery of the cleared area was pruned back by contract monitors to limit predator perches and cover, most notably *Baccharis* species. Manual weeding also targeted reducing invasive plant species, particularly iceplant (*Carpobrotus* sp.), garland chrysanthemum (*Glebionis coronaria*), and Russian thistle (*Salsola* sp.).

Monitors surveyed a 30 m grid system and placed ceramic roofing tiles at each grid intersection to assist in nest mapping and provide shade and shelter for chicks. Existing perimeter signs indicating that the area is an endangered species nesting site were repaired or replaced. Plastic and papier-mache decoys were placed in four groups of 20 each in the central portion of the cleared site and in the western third where the majority of nests have occurred in the past. At least half of each decoy group was arranged to simulate single birds (spaced 1.0 to 2.0 m apart) and the remainder of each decoy group set as pairs of birds (spaced approximately 15.0 cm apart) according to Burger (1988).

Mechanical scraping to reduce vegetation and prepare the site for least tern nesting.

Monitoring

The site was monitored one to three times per week by one to six people for one to four hours. Each visit was supervised by at least one senior monitor with extensive experience with nesting least terns, snowy plovers, and their young. Once to twice-weekly monitoring for snowy plovers was conducted at D Street Fill beginning in mid-February, although surveys in early March and early April were aborted due to rain. The site was monitored for terns and plovers for approximately two hours each visit from 15 through 30 April. During the peak season of May through July, monitoring time was increased to four hours per visit to accommodate nest location, marking, and chick banding and recapture. The time of day of the site visits varied, but efforts were made to conduct censuses during the cooler hours of the day (before 1300 or after 1600) to avoid causing heat stress to chicks. Monitoring was rescheduled in cases of precipitation or high winds. Due to the continued presence of terns, monitoring continued twice per week to early August until the terns departed. Monitoring was discontinued when no least terns had been observed for three consecutive visits. The final monitoring visit for 2016 was on 9 August for D Street Fill.

Monitoring methodology was adapted from that described by Foster, Hyde, and Patton (1982). Monitoring visits typically involved scanning the site from the perimeter with binoculars and/or spotting scope and recording observations in a site log book, on daily site maps, and on daily standardized data forms (Appendix B). Log books, master nest lists, maps, band lists, and specimen/mortality lists were maintained for each site. Log book entries were made for every visit, including the name(s) of the observer(s), the date and the times of the visit, and any significant observations. To minimize disturbance, additional observations were made from within a portable blind used within the colony and along the perimeter. Likewise, observations were made using the vehicle as a blind from along the perimeter road.

Each visit, transects were walked along the grid system to locate and record nests, chicks, or signs of disturbance. Monitors noted presence and location of predators on or in the vicinity of the site. Conditions of nests and decoys were checked, and any abandoned eggs, eggshell fragments, bone, feathers, carcasses, or damaged decoys were collected. If tracks or other signs of predator presence were noted, predator management personnel were notified. Egg abandonment or nonviability was determined by the eggs being present over 40 days or the eggs being cool and unturned with no attending adult observed at or near the nest for at least three consecutive visits.

Nests located at D Street Fill were marked by numbered wooden tongue depressors placed vertically in the sand one to two meters west of each nest. Nest numbers were assigned by order of discovery.

Chick Banding

An attempt was made to band all chicks. Chicks were banded on the right leg with an individually numbered USFWS metal band. Whenever feasible, the chicks were weighed with an Acculab 150 or Ohaus 320 gram electronic scale and a right wing chord measurement taken, both at initial banding and each recapture. One or both of these measurements were at times omitted to save time and reduce disturbance to the colony. The nest number from which the chick originated was noted if known. Band recapture data was used to estimate chick survival and fledging success, and band recovery data was used to quantify mortality and predation. In addition, banding of chicks provides for future recapture and recovery of bands to document longevity, dispersal, and to correlate age and colony of origin with breeding location, effort, success, and other factors.

Taking growth measurements of a least tern chick. Photo by Kate Goodenough

Fledgling Estimation

Estimates of fledgling numbers were derived from a combination of two approaches: the

first being to assume that all chicks recaptured with a wing length of 67 to 84 millimeters (14 to 17 days of age; unpublished data, C. Collins, E. Copper) or greater will fledge; the second, to total the number of fledglings observed every two to three weeks, on the assumption that fledged birds stay approximately two weeks at the colony after fledging (Thompson and Slack 1984, Massey 1989). The resulting range was used to estimate of the number surviving to fledging age. The number of documented dead or depredated fledglings was then subtracted for the estimate of young surviving to fledge from the site.

Predator Management

Management of avian and mammalian predators was conducted by personnel of the U.S. Department of Agriculture, Wildlife Services (USDA WS) under a separate contract. Predator management activities are to be reported separately by that agency. Sick or injured birds were taken to Project Wildlife for veterinary treatment and possible rehabilitation and release. Abandoned egg, chick and adult carcass specimens were collected and frozen, pending direction from USFWS for isotope and/or contaminant analysis.

RESULTS AND DISCUSSION

Least terns were observed from 11 April through 2 August 2016 at and adjacent to properties and facilities of the Port. At the three Port and San Diego County Regional Airport Authority sites, 231 nests were established from 29 April to 12 July (Appendix C). At least 46 to 57 tern young are estimated to have fledged from San Diego International Airport - Lindbergh Field, D Street Fill, and Chula Vista Wildlife Reserve.

Breeding Chronology

California least terns were observed at the D Street Fill nesting site from 11 April through 26 July. Approximately 91 to 106 pairs established 118 nests spread throughout the site but with most in the central western portion of the site (Figure 2). Observations of birds late in the season consisted of foraging along adjacent shoreline and loafing on the adjacent mudflats.

The pair estimation method used for the CDFW breeding pair index for tracking long-term trends is based on the total number of nests established before 15 June plus half the number of nests established 15 June and later. This two-tiered approach is an attempt to standardize pair estimates and take into account the renesting of pairs that had lost earlier clutches as well as young birds breeding for the first time and arriving late from wintering grounds (Massey and Atwood 1981). However, given the lack of productivity in recent seasons, particularly with significant predation around San Diego Bay, the question has been raised as to whether the maximum number of concurrently active nests may be a more accurate measure of the number of breeding pairs. The CDFW method results in a maximum index estimate of 113 breeding pairs this season. However, up to 11 nests and at least one brood were lost prior to 20 June. Timing of these losses and new nest initiations suggests that at least 12 nests could have resulted from renesting by pairs that had lost earlier clutches or broods, leading to a maximum number of 106 breeding pairs. The maximum number of concurrently active nests was 90 on 24 May, but the maximum number of concurrently active nests and broods was 91 with 87 nests and four broods of chicks on 27 May.

Typically, nest initiation occurs in early May (Massey 1974), with this year's first nest in late April being among the earliest. Figure 3 depicts graphically the chronology of nesting events at the D Street Fill in 2016. The numbers of active nests plotted in Figure 3 were those nests being tended by an adult. The majority of nests (86%) were initiated between 29 April and 5 June. Seven more nests were then established from 7 to 14 June. Seven nests were established from 21 to 28 June, then two more on 5 July. The remaining nest was found on 12 July with two eggs. The number of active nests plotted in Figure 3 diverged from the number of total nests in early May due to the predation of the first nest and abandonment of the second. Divergence between numbers of active and total nests increased in late May through June with predation of another nest, additional nest abandonments, and hatching of chicks. Active nest numbers dropped through June and early July with chicks hatching, reduced nest initiation, and losses to nest abandonment and predation.

Nest Distribution

All nesting attempts occurred on the sparsely vegetated, mechanically cleared portion of the site, with light-colored sand-shell substrate (Figure 2 and Appendix C). Late spring rainfall resulted in significant vegetative cover in portions of the site. The majority of nests were located in the

central western half of the site with the densest nesting in the southwest portion of this concentration of nests. Other nests were established radiating from this primary concentration of nests, with a secondary scattering of nests extending to the east. The advantages of group defense and/or adherence and the influence of colony formation/nest-site selection factors on nest distribution patterns within a colony have been previously demonstrated (Coulson 1968, Siegal-Causey and Hunt 1986, Patton and Foster 1984).

Least tern nest distribution at D Street Fill in 2016.

This season, 13 nests were established farther east in the site than most nests in past years. Reasons for this expansion in nest distribution are speculative, but likely include vegetation reducing the area available for nesting elsewhere on the site; predator disturbance in the main colony nest cluster; and proximity to the restored tidal channel along the northeast edge of the site with its increased prey availability. Although most nests each year have been focused in the central western site, terns and plovers regularly nested farther east when the site had significantly more open area and less peripheral vegetation in the 1980s.

Appendix D lists nest numbers and distribution for the site over the past ten years.

Generally each season the site is cleared so that 30 m wide grid rows numbered 1 through 24 are established west to east on the site, although clearing in some years has not extended beyond row 19 (see Figure 2). From 1997 through 2003, no nests were documented east of grid row 12. Three nests were established in rows 13 and 14 in 2004, and one nest was in row 13 in 2005. Since 2006, eight to 20 nests have been established each season in rows 13 through 20. Each year at least since 1997 this area has been cleared of vegetation, except in 2005 when miscommunication resulted in the eastern portion of the site not being disked. In 2003, a portion of the northeastern fill north of rows 18 through 24 was excavated for saltmarsh and tidal channel restoration. In 2011, prior to the breeding season, a portion of the northwestern fill, grid rows 1 through 10, A through E, was excavated for the L-ditch mitigation project. Terns have been observed foraging in the channels of both these mitigation areas and roosting with their fledglings on adjacent shoreline. Terns were not observed using the newly excavated channels in the southeastern portion of the site this season, but are likely to in the future.

Clutch Size

Ninety-one to 106 estimated pairs of least terns established 118 nests with 196 eggs at the D Street Fill in 2016. The average clutch size was 1.66 eggs per nest with 78 two-egg clutches and 40 single egg clutches (Table 1). This average clutch size was lower than the 2.15 recorded by Massey in her initial study of least tern breeding biology (1974) but slightly above the 1.63 average recorded at this site over the ten previous years (Appendix C). Reduced average clutch sizes have been noted to indicate locally reduced food availability (Atwood and Kelly 1984).

Hatching Success

Over 76 percent of the eggs at D Street Fill hatched successfully this season, resulting in an average of 1.26 chicks per nest and 1.67 chicks per nest that experienced hatching (Table 1). This was lower than last year but a substantial increase over that of the 2012 season when nest predation and abandonment severely limited hatching success (Patton 2012, 2015). Nest abandonment was still the primary known limiting factor to hatching success, with 18 percent of nests abandoned pre-term (21 nests). Six additional eggs were abandoned after the other egg in each clutch hatched. Although only five nests were documented to have been depredated, the outcome of five additional

nests was unknown and predation likely, either of eggs or of recently hatched chicks. These undetermined nest outcomes coincided with documented predation of eggs and chicks. Nest abandonments were likely influenced by predator presence and/or possible depredation of one or both adults.

Least tern pair at nest with nest marker visible to the right. Photo by Kate Goodenough

Chick Banding

In 2016, 80 chicks from at least 52 to 55 nests were banded at D Street Fill. Chicks were banded on the right leg with USFWS metal bands individually numbered 2421-51221 through 51300.

Fledging Success and Seasonal Production

In 2016, 21 to 22 chicks are estimated to have reached fledging age this season and to have survived to fledge from the colony. Productivity was thus 0.18 to 0.19 fledglings per nest, 0.20 to 0.24 per pair. Although relatively low, this was a substantial increase over that of 2012 when fledgling success was severely limited by predation and mortality to only nine fledglings (Patton 2012).

Figure 4 depicts daily numbers of hatchings and observed numbers of fledglings. The temporal distribution of hatching reflected the early pulse of nesting and corresponding hatching of 95 percent of the chicks from 27 May to 17 June. This pattern in hatching numbers is in turn

reflected in the numbers of fledglings three weeks later. However, the contrast between the two curves is notable, with daily numbers of observed fledglings reduced from earlier hatching numbers due to mortality and predation limiting the number of chicks reaching fledging age. Fledglings generally remain at the colony site for two weeks after first flying, as reflected in the number of observed fledglings peaking later than three weeks after the peak of hatching. Fledgling numbers dropped as the young gained flight experience and dispersed from the colony with the adults. The late season variations in day-to-day observed numbers of fledglings indicated dispersal to foraging and roosting areas and return visits to the colony site.

Chick recovery for band recapture and growth measurement data was complicated at times by vegetative cover conditions, weather fluctuations, and predator presence. Fledgling survival estimates were complicated by fledgling mobility, the inability to collect recapture data to identify individuals, their tendency to shift to roost and forage along the shoreline of the bay, and possibly by the arrival of fledglings from other colonies. However, the consistency of twice-weekly counts of numbers of chicks observed, recaptures, and fledglings, with the corresponding observations of predator presence, depredation, and recovery of carcasses, supports the accuracy of this season's fledgling estimate.

Least tern fledgling. Photo by Kate Goodenough

Mortality

Eighteen percent of nests (21 nests) with 27 eggs were abandoned after one to 34 days of incubation (Table 2). Eggs of six two-egg clutches failed to hatch and were abandoned after the other in each clutch hatched, and another was abandoned after uncertain outcome of the other egg in its clutch. One adult, one fledgling, and 58 chicks were found dead of undetermined causes (40 percent of those hatched).

	Hatched	Abandoned Pre-term	Abandoned Post-term (Failed to Hatch)	Uncertain Outcome	Predation	Non-predation Mortality
Nests	89	21	6	5	5	
Eggs	149	27	6	7	7	
Chicks					4	58
Fledglings					1	1
Adults					5	1

The majority of chick mortality and nest abandonment occurred through June and early July when depredation and daily disturbances to the colony by predators were documented. Some nest abandonment and chick mortality were possibly related to depredation of one or both adults. The high number of chick deaths also coincided with high mortality rates reported at other colonies (J. Boylan, pers. comm.), and with delayed nesting and lower than usual numbers of most breeding species of seabirds in the county (R.P., unpubl. data). Such mortality may be related to localized decreases in prey fish availability during this critical period of the season, possibly due to shifting currents or sea surface temperatures. However, without regular sampling of the appropriate size fish, such conclusions as to fluctuations in prey availability are only speculative.

Predation

Five nests with seven eggs were reported as having been depredated this season (Tables 1 and 2). The first nest was depredated with both common raven (*Corvus corax*) and northern harrier (*Circus cyaneus*) observed in the area so either were suspected as responsible. One depredated egg was found with beak holes and indentation indicating harrier predation, and harriers were suspected in the predation of the three other nests. The outcomes of five other nests with seven eggs were uncertain, but lack of evidence of hatching or chick presence indicated probable depredation. Gull-

billed terns (*Gelochelidon nilotica*) were observed foraging around and within the nesting area during the period of nest losses. Early in the season, the nest of a horned lark (*Eremophila alpestris*) was observed being depredated by a raven, and ravens had been seen at the site during the dates of tern nest and chick losses. Northern harriers had been observed hunting within the colony during the period of egg and chick loss as well.

The fresh remains of one adult least tern was recovered below a perched peregrine falcon (*Falco peregrinus*). A peregrine was suspected of being responsible for the piles of plucked feathers and body parts of another four adults, one fledgling, and one chick. Two chicks were observed being taken by a northern harrier. One chick was found dead still partially in the shell it was hatching from and located well away from the nest, so was suspected of having been dropped by a harrier or gull-billed tern. Additional chicks were suspected of being taken by each of these species.

	Northern Harrier	Harrier or Raven	Harrier or Gull-billed Tern	Peregrine Falcon
Nests	4	1		
Eggs	5	2		
Chicks	2		1	1
Fledglings				1
Adults				5

No other definitive evidence of chick depredation was found, but lack of observations, recaptures, fledglings, and attentive adults indicates that others were likely preyed on. The disappearance of up to 63 to 65 chicks coincided with documented depredation and daily disturbances to the colony by northern harrier, American kestrel (*Falco sparverius*), and peregrine falcon, and visits by common raven. Other potential predator species observed in the area included ant species, great blue heron (*Ardea herodias*), great egret (*Ardea alba*), Cooper's hawk (*Accipiter cooperii*), red-tailed hawk (*Buteo jamaicensis*), gull species (*Larus* spp.), American crow (*Corvus brachyrhynchos*), European starling (*Sturnus vulgaris*), western meadowlark (*Sturnella neglecta*), opossum (*Didelphis virginiana*), rats (*Rattus* spp.), California ground squirrel (*Spermophilus beecheyi*), coyote (*Canis latrans*), feral cat (*Felis catus*), and striped skunk (*Mephitis mephitis*).

Snowy Plovers and Other Species

The maximum number of snowy plovers recorded on a single survey this year was 64 which were observed foraging pre-season on mudflats west of the nesting site (Appendix E-1). At least 29 were observed foraging post-season. However, none were observed during the peak of nesting season from late March through August and no nests were found. Site suitability for nesting by snowy plovers had decreased due to encroaching saltmarsh vegetation and its increasing density where mudflats used to exist adjacent to the southwest and northwest fill so that plovers and young no longer have access between foraging and nesting habitats. The last documented nesting attempt by snowy plovers at D Street Fill was in 2000. The excavation of the northwest edge of the site to an unvegetated gentler slope adjacent to mudflats in 2011 increased the potential for plover use of the site and for nesting to be re-established. However, saltmarsh vegetation has filled in along this shoreline as well.

Observations of snowy plovers this season again demonstrated the importance of Sweetwater Marsh bayfront tidal flats to the species. Color-banded plovers observed roosting at high tide along ocean-facing beaches of Naval Amphibious Base Coronado have been observed to spread out along the beach as tide ebbs, then cross the bay to forage as mudflats adjacent to the mouth of the Sweetwater River are exposed during receding low tide (unpubl. data, E. Copper and US Navy). The distance to the flats adjacent to the D Street Fill and Sweetwater Marsh is approximately 1.75 miles from the Orange Beach/north Silver Strand State Beach roost site and 3.25 miles from the Red/Yellow Beach roost site. The numbers of foraging birds observed off D Street Fill represent a good proportion of those roosting along the Silver Strand. Band combinations observed this season included snowy plover origins elsewhere in San Diego County, in Baja California, and in Oregon (Appendix E-2).

No attempt was made to document all nests or all species nesting at D Street Fill. However, nests encountered during monitoring for terns and snowy plovers were marked, mapped, and contents recorded (Figure 2). Killdeer (*Charadrius vociferus*) established at least four nests within the interior and on the west slope of the site. Horned larks appeared to nest throughout the site, and at least 10 nests were found within the tern colony. Belding's savannah sparrows (*Passerculus*

sandwichensis beldingi) and western meadowlarks were present and singing throughout the season, indicating probable nesting of both species adjacent to the prepared colony site. Although breeding was not confirmed, a federally endangered light-footed clapper rail (*Rallus longirostris levipes*) was observed along the northeast shore. Other sensitive species observed on-site this season included San Diego black-tailed jackrabbit (*Lepus californicus bennettii*), and two low-growing coastal strand plant species considered endangered by the California Native Plant Society (CNPS): coast wooly-heads (*Nemacaulis denudata*) and Nuttall's lotus (*Lotus nuttallianus = Acmispon prostratus*).

Least tern chick under ceramic tile shelter. Photo by Kate Goodenough

MANAGEMENT RECOMMENDATIONS

Site preparation, monitoring, and predator management efforts should continue as implemented in 1997 and modified each season since. Marking of permanent grid intersections with rebar or PVC would reduce site preparation time and cost. The use of a portable tower blind may enhance chick counting and recapture efforts. The use of color bands to identify least tern chicks by natal colony would enhance fledgling estimates and provide long-term data and insight on colony dynamics and recruitment.

Mechanical scraping of the site should continue and be planned for mid-February each

season to precede potential snowy plover nest-site selection, with additional vegetation control done by early April if no plovers are nesting. Within the limitations of recent budget reductions, efforts should be made to secure appropriate staff, equipment, and budget prior to each season to ensure adequate site preparation. This would include experienced operator(s) communicating with monitors, agency, and Wildlife Services personnel, and access to a road grader or a four-wheel-drive tractor with Gannon box or equivalent box scraper.

Additional mechanical scraping to reduce vegetation in the off-season has been recommended previously and should continue to be considered as an option. The possibility of herbicide application should continue to be considered, particularly in light of the shift in abundance and distribution of mustard throughout the site this season. Continued monitoring and herbicide treatment of perennial pepperweed will be necessary. Non-native and peripheral scrub vegetation should continue to be removed to reduce encroachment of these species on the site as well as to reduce potential predator perches. Efforts in recent years have been successful in reducing non-native invasive plant species, including iceplant, mustard, sea-rocket (*Cakile maritima*), cocklebur (*Xanthium spinosum*), pampas grass (*Cortaderia* sp.), garland chrysanthemum, sweet fennel (*Foeniculum vulgare*), Russian thistle (*Salsola tragus*), Brazilian pepper tree (*Schinus terebinthifolius*), tamarisk and *Acacia* sp.. Coordination is needed in removal of any piles of vegetation or soil generated. Previous seasons, piles of manually removed iceplant had been deposited and left within the nesting site, creating small hummocks used by raptors and corvids, and creating the potential for the site-clearing equipment to spread the iceplant into the nesting area.

If snowy plover nesting is to be re-established, the access points between upland nesting habitat and tidal flat foraging habitat would need to be maintained and expanded. Encroachment of vegetation along the fill periphery and increasing density of saltmarsh vegetation between the fill and western tidal mudflats appears to have formed enough of a barrier to plover chicks that site-selecting adults have abandoned D Street as a nesting site. Non-vegetated pathways at least three to eight meters wide would need to be cleared through the saltmarsh to make the site again suitable for use by snowy plovers. However, current regulatory processes appear to not recognize the importance of non-vegetated tidal mudflat habitat for shorebirds and to prevent maintenance or creation of such pathways without mitigation for saltmarsh.

The signs installed in past seasons and replaced this season may have reduced human intrusion into nesting areas. Interpretive/informational signs or kiosks at entrances or adjacent focal points of public activity, recreation, viewing, or access would lessen the need for confrontation or law enforcement, lessen the likelihood of impacts such as colony disturbance, chick and egg losses, and increase public awareness, cooperation, understanding, and support. To limit use by perching raptors, all signs should be topped with anti-perching hardware such as Nixalite.

The level of predation each season, despite the prompt response by USDA WS staff to perceived predation problems or threats, illustrates the difficulty in management of endangered species on the periphery of urbanized areas. The difficulty in dealing with evasive predators justifies continued reliance on the experienced staff of USDA WS for predator management. In light of the continued decline in the local snowy plover population, proactive monitoring of potential predator species should begin at least by 1 March if not 1 February, and precautionary trapping efforts maintained at all sites throughout the season. The administrative difficulties experienced by USDA WS personnel in recent seasons in attempting to obtain permission to live-trap and relocate harriers and peregrines need to be addressed and protocol established before each season. Likewise, the ability to hold trapped raptors until late in the season to limit continued impacts if/when they return following release should be reinstated. The recent requirements to release raptors within 72 hours of trapping has been shown to have limited effectiveness in reducing predation and limited success in improving raptor health or survivability (USDA WS data; B. Shemai USMC data).

The populations of scavengers and potential predators such as corvids and gulls have increased dramatically in Southern California in recent years. An aggressive policy of corvid removal and deterrence to gull nesting should be incorporated at each site. Daily disturbance to gulls loitering at sites may be necessary, and if that is not sufficient, removal of nesting individuals and their eggs may be warranted. Control of other mammalian and avian predators should continue, and permits, personnel, and equipment secured for at least early March through September.

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TABLES

Table 1. Least tern nest and egg data, D Street Fill, 2016.

	nests*	eggs
Total	118	196
1 egg clutch	40	40
2 eggs	78	156
Known Hatch		
Total	89*	149
1 egg	22	22
2 eggs	67*	127
Uncertain Outcome		
Total	5*	7
1 egg	2	2
2 eggs	3*	5
Failed to Hatch		
Total	32*	40
1 egg	16	16
2 eggs	16*	24
Depredated		
Total	5*	7
1 egg	2	2
2 eggs	3*	5
Abandoned (pre-term)		
Total	21*	27
1 egg	14	14
2 eggs	7*	13
Abandoned post-term/nonviable		
Total	6*	6
1 egg	0	0
2 eggs	6*	6

* inclusion in more than one category: one egg each of six two-egg clutches was abandoned/failed to hatch after the other hatched; one egg of a two-egg clutch was abandoned after uncertain outcome of the other egg; one egg of a two-egg clutch hatched after the other was depredated.

Table 2. Documented causes of least tern mortality, D Street Fill, 2016.

Cause	Least Tern Age Class	Total Losses D Street Fill
Total:		
	egg	40
	chick	62*
	fledgling	2
	adult	6
Predation*:		
Common Raven or Northern Harrier		
	egg	2
Northern Harrier or Gull-billed Tern		
	chick	1
Northern Harrier		
	egg	5
	chick	2
Peregrine Falcon		
	chick	1
	fledgling	1
	adult	5
Non-predation Mortality:		
Abandonment (pre-term)		
	egg	27
Unknown		
Abandoned post-term/nonviable		
	egg	6
No visible trauma		
	chick	58*
	fledgling	1
	adult	1

*daily-observed chick numbers and recapture data indicate additional losses of up to 63-65 chicks, species suspected as responsible for losses include northern harrier, American kestrel, and peregrine falcon, with possible losses also to ant species. One adult, one fledgling, and 58 chicks were found with no obvious causes of death. Remains of one adult were found below a perched peregrine falcon, and piles of feathers or parts of an additional five adults, one fledgling, and one chick suggested predation by peregrine. Two chicks were observed being taken by a northern harrier. The carcass of one partially hatched chick was found away from the nest and suspected of having been dropped by a harrier or gull-billed tern. At least five nests with seven eggs were depredated, most suspected to have been taken by northern harrier but one possibly by common raven. An additional previously abandoned egg was suspected scavenged by harrier.

FIGURES

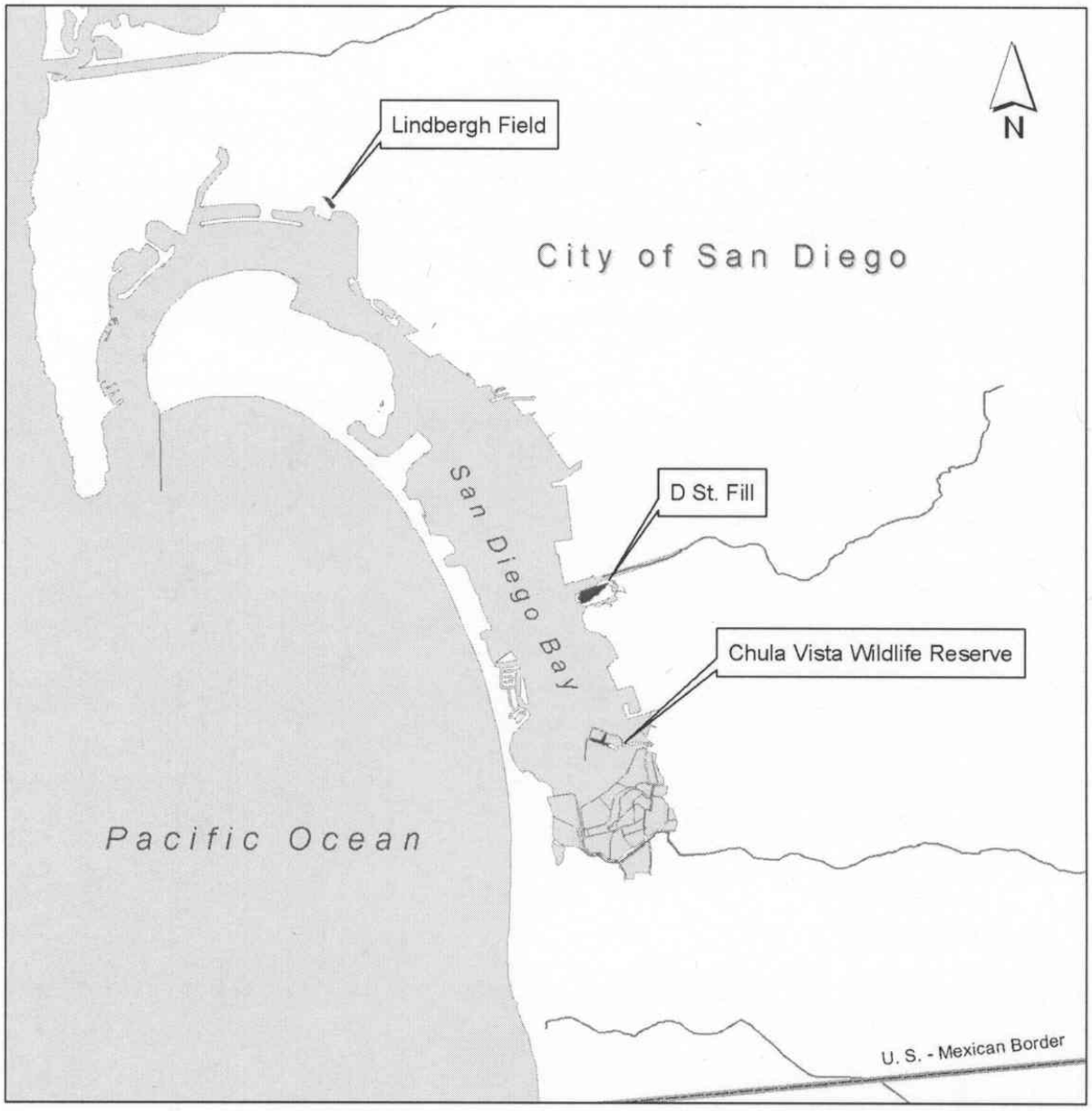


Figure 1. San Diego Unified Port District and San Diego County Regional Airport Authority least tern nesting sites, 2016.

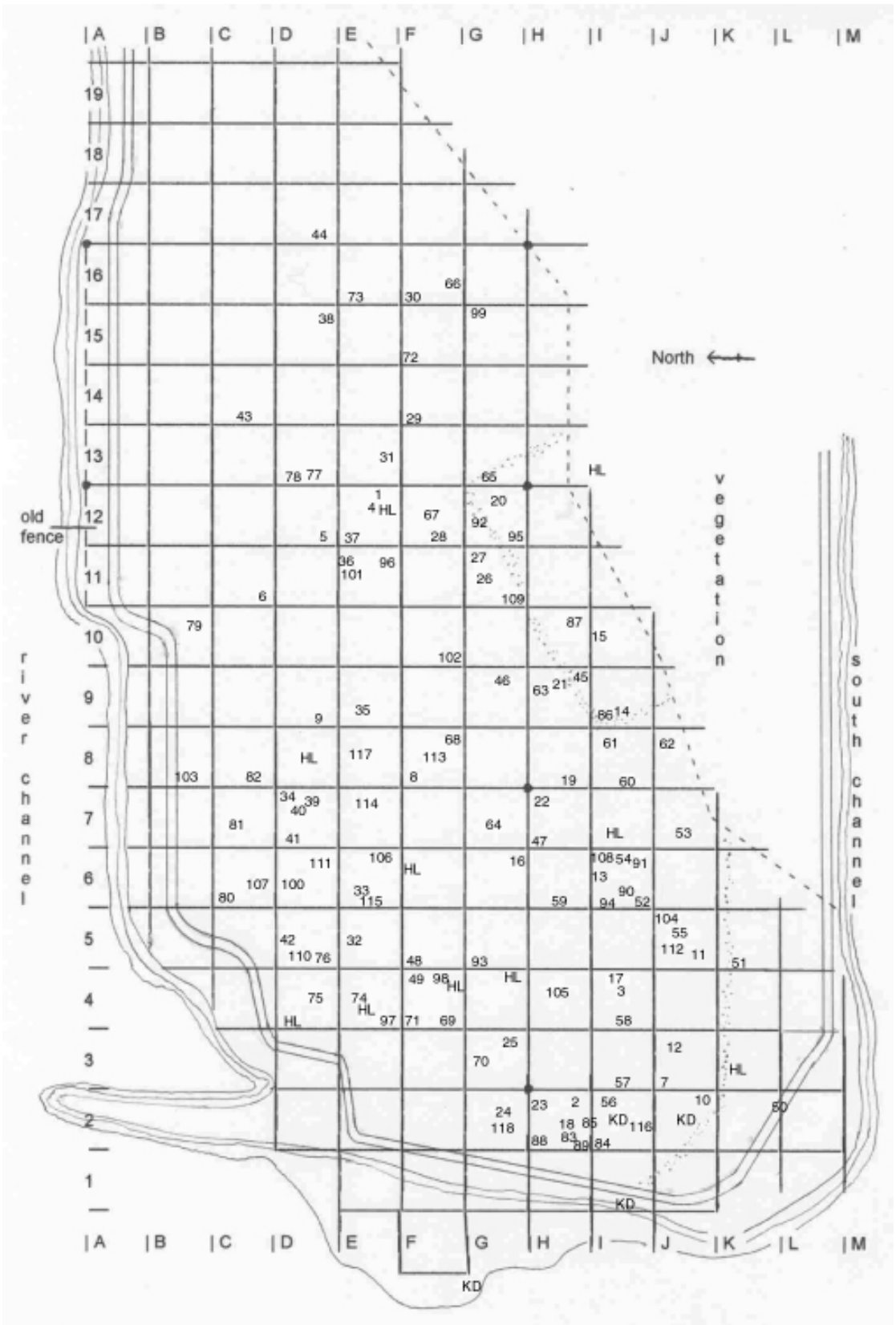


Figure 2. Least tern nest distribution, D Street Fill, 2016.

Figure 3. Least tern breeding chronology, D Street Fill, 2016.

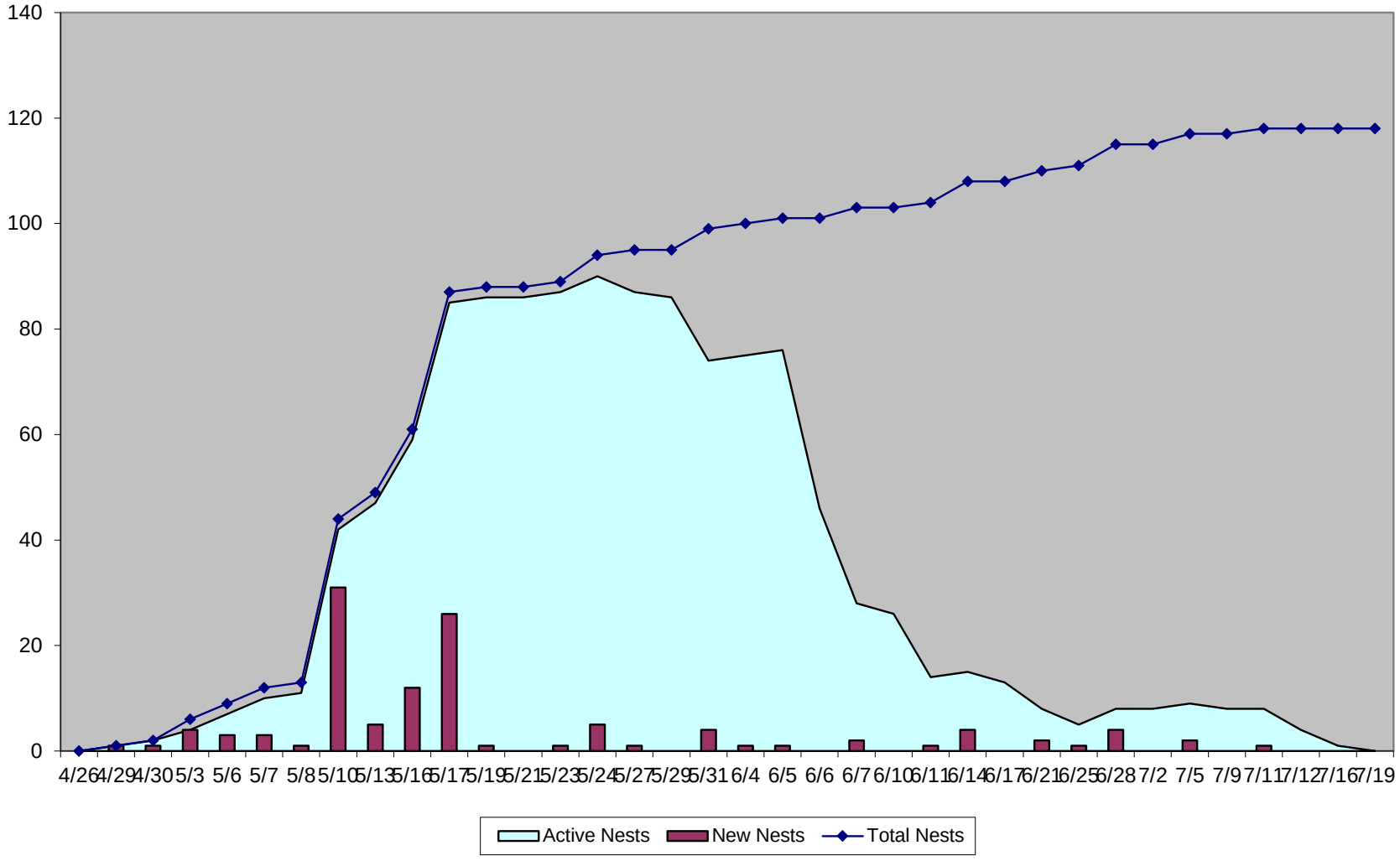
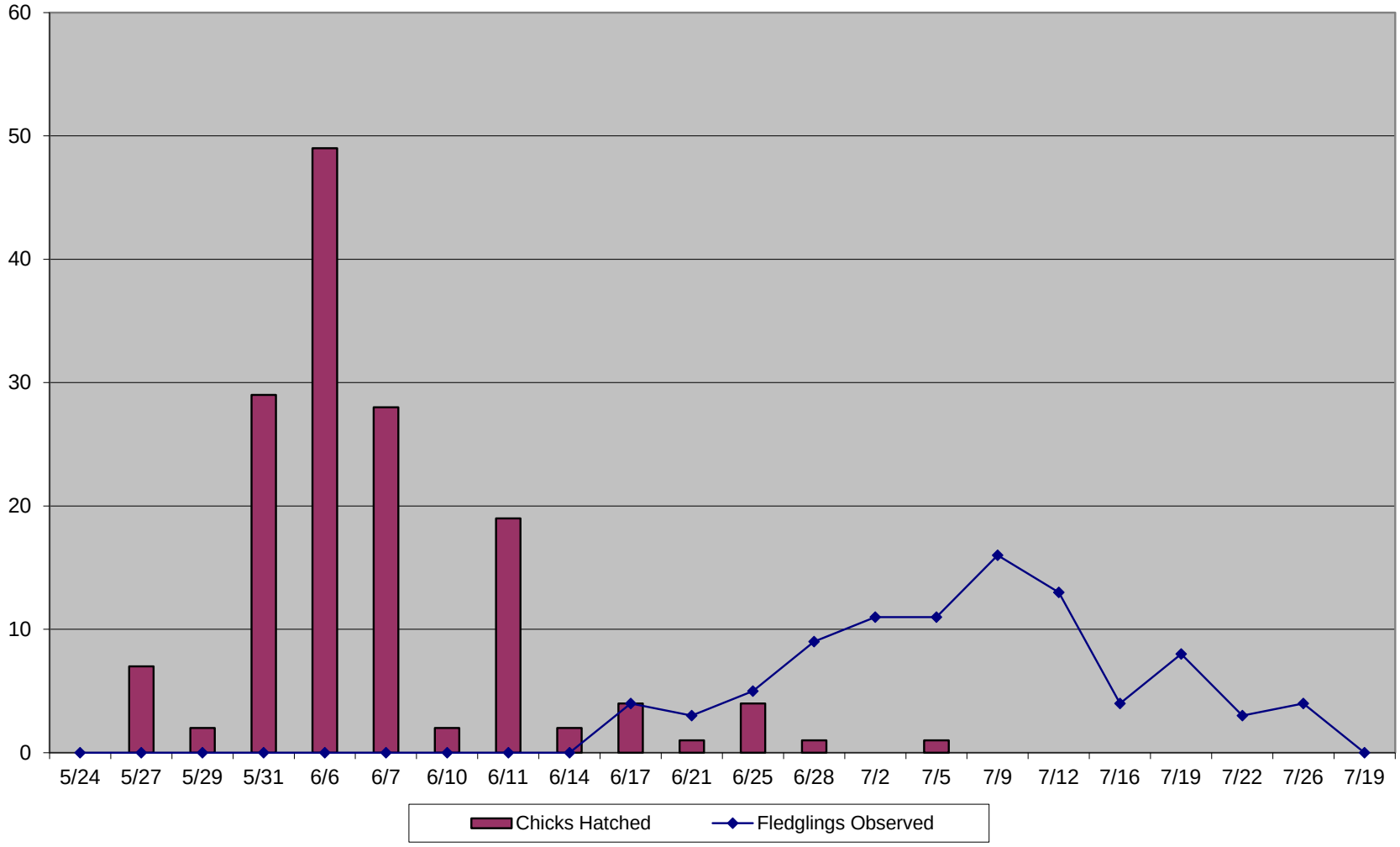


Figure 4. Least tern productivity chronology, D Street Fill, 2016.



APPENDICES

Appendix A. Summary of documented California least tern breeding, D Street Fill and Sweetwater Marsh.

	Estimated Number of Breeding Pairs		Number of	Estimated Number of Fledglings	
Year	Minimum	Maximum	Nests	Minimum	Maximum
1973	4	20	4+	11	11
1974	36	36	36	0	0
1975	10	10	10	0	0
1976	24	24	33	0	0
1977	40	40	40	20	25
1978	47	47	47	15	15
1979	24	28	28	15	20
1980	12	15	15	0	0
1981	0	0	0	0	0
1982	1	1	1	2	2
1983	1	1	1	0	0
1984	16	29	41	15	15
1985	41	47	47	0	0
1986	5	6	10	7	7
1987	28	28	28	10	10
1988	19	19	19	0	0
1989	2	2	2	0	0
1990	0	0	0	0	0
1991	45	47	59	38	42
1992	135	135	135	14	24
1993	23	23	32	1	1
1994	8	8	9	3	3
1995	26	26	27	22	28
1996	25	25	28	15	35
1997	38	38	41	0	0
1998	5	7	7	8	10
1999	30	30	36	2	2
2000	28	31	34	27	30
2001	30	31	32	12	17
2002	23	23	24	8	8
2003	62	85	91	12	19
2004	77	94	111	4	11
2005	77	97	101	9	17
2006	88	94	100	18	29
2007	100	115	130	25	28
2008	133	135	148	17	24
2009	129	129	132	19	29
2010	117	117	119	15	27
2011	100	113	116	25	32
2012	78	93	114	9	9
2013	96	113	144	23	32
2014	125	129	148	28	36
2015	108	111	123	21	34
2016	91	106	118	21	22

Appendix B. Sample datasheet.

Location:		Date:	Job:	Observer(s):		
Time start:		Time stop:		On site:		
Est/Measured	Time:	Temp:	Wind Spd/Dir:	Cloud cvr (%):	Precip. (Y/N):	Tide: H L In Out
ADULTS	Total:	NESTS	Total:	New:		
CHICKS	Observed:	Est max:	New Chicks:	Fledglings Obs:	Est max:	
Mortality (Y/N):	Adult:	Fledgling:	Chick:	Egg:	Nest:	
Predation (Y/N):	Adult:	Fledgling:	Chick:	Egg:	Nest:	
Take (Y/N):	Adult:	Fledgling:	Chick:	Egg:	Nest:	
Col Live (Y/N):	Adult:	Fledgling:	Chick:	Egg:	Other:	
Col Dead (Y/N):	Adult:	Fledgling:	Chick:	Egg:	Fish:	Other:

Nest No.	Grid No.	New/ Incub.	Status	Nest No.	Grid No.	New/ Incub.	Status	Nest No.	Grid No.	New/ Incub.	Status
1				31				61			
2				32				62			
3				33				63			
4				34				64			
5				35				65			
6				36				66			
7				37				67			
8				38				68			
9				39				69			
10				40				70			
11				41				71			
12				42				72			
13				43				73			
14				44				74			
15				45				75			
16				46				76			
17				47				77			
18				48				78			
19				49				79			
20				50				80			
21				51				81			
22				52				82			
23				53				83			
24				54				84			
25				55				85			
26				56				86			
27				57				87			
28				58				88			
29				59				89			
30				60				90			

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

Predators Observed (Time, Species, Location, Activity):

Ants Y / N **Grid Location(s):**

Documented Predation/Mortality:

Human Disturbance/Take:

Comment:

Band Prefix	Band Number	Comb. L - R	Age	Wing	Weight	Cond.	Nest No.	Egg #	Grid	Comment	Recap. (Y/N)
		-									
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Band Prefix	Band Number	Comb. L - R	Age	Wing	Weight	Cond.	Nest No.	Egg #	Grid	Comment	Recap. (Y/N)

Appendix C. Summary of the status of the California least tern and western snowy plover at properties of the San Diego Unified Port District and San Diego County Regional Airport Authority in 2016.

Potential nesting sites of the endangered California least tern and western snowy plover were prepared prior to mid-April at Lindbergh Field - San Diego International Airport, D Street Fill, and Chula Vista Wildlife Reserve; and monitored from late February through August, 2016, by Robert Patton, Lea Squires, Jennifer Jackson, Thomas Myers, Kate Goodenough, Brian Foster, Elizabeth Copper, and Matt Sadowski. Mayra Garcia and staff of SDIA Environmental Affairs assisted at Lindbergh Field; and Brian Collins of Sweetwater Marsh NWR and Environment for the Americas interns Katelyn Gomez and Anita Sanchez also monitored at D Street Fill.

Least terns were observed from 11 April through 2 August 2016 at and adjacent to properties and facilities of the San Diego Unified Port District. At the three Port and San Diego County Regional Airport Authority sites, 231 nests were established from 29 April to 12 July. At least 46 to 57 young are estimated to have fledged from the sites, with productivity limited primarily by predation but also by unexplained mortality suspected to be related to locally reduced prey availability. Other limiting factors included nest abandonment, most likely related to disturbances from predators.

San Diego International Airport – Lindbergh Field & Former Naval Training Center

Prior to the terns' arrival, San Diego County Regional Airport Authority personnel applied herbicide, manually removed vegetation, and contractor Ocean Blue repaired plastic mesh chick barriers and covers over stormdrains. Zoological Society of San Diego subcontract personnel established a 30 m grid system in the primary nesting oval (03-S) and assisted in repairs to chick barriers. Monitoring was conducted April through early August one to three days per week. Predator management was conducted by personnel from USDA Wildlife Services.

Least terns were first observed foraging over the bay on 13 April and in flight over the southeast end of Lindbergh Field on 21 April 2016. They were observed each visit after that through 26 July. Breeding pair and nest numbers more than doubled from 2015 to 2016, although they remained significantly lower than those of 2014 and earlier. At least 37 nests were initiated by 31 estimated pairs between 4 May and 20 June. The maximum number of concurrently active nests was 29 on 1 June plus two broods of chicks. Five to six nests appeared to be renesting of pairs that had lost their initial clutches. All nests were established in the main nesting oval 03-S.

At least 38 chicks from 25 nests hatched successfully. It is estimated that 15 to 19 chicks reached fledgling age and 10 to 17 young survived to fledge from the site. Five nests with seven eggs were abandoned pre-term, four eggs failed to hatch and were abandoned after the other egg in each clutch hatched successfully, and one single egg clutch failed to hatch and was abandoned after prolonged incubation of 41 to 44 days. Nine eggs from seven nests were depredated, one by ants, four suspected by common ravens, and two suspected by American crows or possibly western gulls. The outcomes of two nests were uncertain, but lack of evidence of hatching or chick presence indicates probable depredation.

Five chicks and one fledgling were found dead with no apparent cause of death. One chick was depredated by ants and one was found dead being scavenged by ants, but whether they contributed to cause of death was uncertain. Three chicks and one fledgling were observed being depredated by peregrine falcons. Up to 13 to 16 additional chicks are suspected to have been

depredated, with most suspected to have been taken by peregrine falcon; but American kestrel, crow, gulls, and rats also being observed in the area during the period of losses. Other potential predators observed in the area included great blue heron, black-crowned night-heron, red-tailed hawk, loggerhead shrike, and European starling.

D Street Fill & Sweetwater Marsh NWR

In preparation for the 2016 nesting season at D Street Fill, U.S. Fish and Wildlife Service staff and contractors applied herbicide to invasive plant species; and due to late rains and resulting seedling growth, in late March and again in late April completed mechanical scraping of the site to reduce vegetation and enhance it for use by least terns and snowy plovers. Biological monitors under contract with the Port manually removed non-native invasive plants from the site, pruned back vegetation to reduce cover and potential raptor perches, surveyed the grid system, and placed decoys and ceramic tiles for chick shelters. Predator management was conducted by personnel of US Department of Agriculture, Wildlife Services, and is to be reported separately. Monitoring was conducted from mid-February through early August one to three days per week.

Least terns were first observed at the D Street Fill on 11 April 2016. They were observed each visit after that through 26 July. At least 118 nests were initiated by 91 to 106 estimated pairs between 29 April and 11 July. The maximum number of concurrently active nests was 90 on 24 May, and the maximum number of concurrently active nests and broods was 87 nests with four broods of chicks on 27 May. At least 12 nests were suspected to have resulted from renesting by pairs that lost earlier clutches.

At least 149 chicks from 89 nests hatched successfully. It is estimated that 21 to 22 chicks reached fledgling age and survived to fledge from the site. Twenty-one nests with 27 eggs were abandoned pre-term, and six eggs failed to hatch and were abandoned after the other egg in each clutch hatched successfully. At least five nests with seven eggs were depredated, most suspected to have been taken by northern harrier but one possibly by common raven. The outcome of five nests with seven eggs was uncertain, but lack of evidence of hatching or chick presence indicates probable depredation.

One adult, one fledgling, and 58 chicks were found with no obvious causes of death. Remains of one adult were found below a perched peregrine falcon, and piles of feathers or parts of an additional five adults, one fledgling, and one chick suggested predation by peregrine. Two chicks were observed being taken by a northern harrier. The carcass of one partially hatched chick was found away from the nest and suspected of having been dropped by a harrier or gull-billed tern. No other definitive evidence of chick depredation was found, but lack of observations, recaptures, fledglings, and attentive adults indicates that others were likely preyed on. The disappearance of up to 63 to 65 chicks coincided with documented depredation and/or daily disturbances to the colony by northern harrier, American kestrel, and peregrine falcon, and visits by common raven. Other potential predator species observed in the area included ant species, great blue heron, great egret, Cooper's hawk, red-tailed hawk, gulls, American crow, European starling, western meadowlark, opossum, rats, California ground squirrel, coyote, feral cat, and striped skunk.

There were no western snowy plovers documented at D Street Fill during the peak of nesting season from mid-March through August, and no nests were established by snowy plovers this season. However, 64 plovers were observed foraging on adjacent mudflats during ebbing or low tides prior to nesting season, and 29 to 44 following nesting season. Band combinations

observed included origins in San Diego County, Baja California, and Oregon.

Chula Vista Wildlife Reserve

Prior to early April 2016 and the terns' arrival, Zoological Society of San Diego subcontract personnel coordinated herbicide application, mechanical scraping and dragging of the site, and weeded invasive non-native vegetation, surveyed the grid system, and placed ceramic tiles for chick shelters, decoys, and new signs. Monitoring was conducted from mid-March through mid-August one to three days per week. Predator management was conducted by USDA Wildlife Services staff.

Least terns were first observed adjacent to Chula Vista Wildlife Reserve on 16 April and at the Reserve on 21 April 2016. They were seen on each visit through 27 July, and one to two were observed on 2 August. At least 76 nests were initiated by 56 to 63 estimated pairs between 9 May and 12 July with distribution throughout but concentrated in two clusters in the southwestern portion of the site and in the north-central site. The maximum number of concurrently active nests and broods was 54 nests and two broods of chicks on 31 May. At least 13 nests were suspected to have resulted from renesting by pairs that lost earlier clutches.

At least 103 chicks from 63 nests hatched successfully. It is estimated that 16 to 19 chicks reached fledgling age and 15 to 18 young survived to fledge from the site this season. Eleven nests with 14 eggs were abandoned pre-term, and two other eggs were abandoned after the other egg in each clutch hatched successfully. One single-egg nest was depredated with northern harrier suspected responsible, and another was depredated with gull-billed tern suspected responsible. Harriers were also responsible for depredation of previously abandoned eggs. The outcome of one nest was uncertain, but lack of evidence of hatching or chick presence indicates probable depredation.

One fledgling and 26 chicks were found dead of undetermined causes. Four chicks were apparently depredated by ants; and one was found dead being scavenged by ants, but whether they contributed to cause of death was uncertain. One chick was observed being depredated by a northern harrier. A pellet suspected of being regurgitated by a peregrine falcon was found containing adult least tern feathers and bones; and one adult with wing injuries was suspected of being hit by a peregrine. No other definitive evidence of chick depredation was found, but lack of observations, recaptures, fledglings, and attentive adults indicates that others were likely preyed on. The disappearance of up to 51 to 54 chicks coincided with repeated hunting of the site by peregrine falcons, and visits by northern harrier, American kestrel, great blue heron, and possibly barn owl. Other potential predator species observed in the area included great egret, osprey, red-tailed hawk, Cooper’s hawk, gulls, gull-billed tern, common raven, American crow, opossum, coyote, gray fox, and rats.

Snowy plovers were recorded only twice at CVWR this season with one adult in March, and a roosting group of six during high tide in April. Forster’s terns established at least 67 nests, the majority of which were on the northwest central dike, with smaller sub-colonies on the southwest jetty and northeast dike. Black skimmers nested for the fourth time at CVWR this season with one nest established on the northwest central dike. Osprey successfully fledged young from the nesting platform adjacent to the east dike again this season, and a second pair continued nest construction on the north end of the southwest jetty.

Appendix C. Summary of California least tern breeding at San Diego Unified Port District and San Diego County Regional Airport Authority sites, 2016.

	SDIA-LF	D St Fill	CVWR
Date terns first observed	4/13	4/11	4/16
Date terns last seen	7/26	7/26	8/2
Date of first nest	5/4	4/29	5/9
Date last nest found	6/20	7/12	7/26
Date last nest established	6/20	7/11	7/12
Date of first hatch	5/26	5/27	5/31
Date of last hatch	6/25	7/5	7/16
Date of first fledgling	6/14	6/17	6/21
Estimated number of pairs	31	91-106	56-63
Total number of nests	37	118	76
Total number of eggs	61	196	122
Clutch size:			
1 egg	13	40	30
2 egg	24	78	46
3 egg	0	0	0
4 egg	0	0	0
unknown (min. 1 egg)	0	0	0
Average clutch size	1.65	1.66	1.60
No. of nests hatching young*	25	89	63
Total number of eggs hatched	38	149	103
Estimated number of fledglings	10-17	21-22	15-18
Number of chicks banded	32	80	78
Number of adults banded	0	0	0
Uncertain outcome			
Nests*	2	5	1
Eggs	2	7	1
Documented Mortality			
Preyed upon			
Nests*	7	5	2
Eggs**	9	7	2
Chicks	4-5	4	5-6
Fledglings	1	1	0
Adults	0	5	2
Human disturbance			
Nests*	0	0	0
Eggs	0	0	0
Chicks	0	0	0
Fledglings	0	0	0
Adults	0	0	0
Other causes			
Nests*			
Abandoned (pre-term)	5	21	11
Failed to hatch (incubated to term)	5	6	2
Died hatching	0	0	0
Damaged (eggshell thinning)	0	0	0
Flooded	0	0	0
Eggs			
Abandoned (pre-term)	7	27	14
Failed to hatch (incubated to term)	5	6	2
Died hatching	0	0	0
Damaged (eggshell thinning)	0	0	0
Flooded	0	0	0
Chicks	5-6	58	26-27
Fledglings	1	1	1
Adults	0	1	0

* may be included in more than one category

** not including previously abandoned eggs that were depredated/scavenged

Appendix C-1. Summary of California least tern breeding at San Diego International Airport - Lindbergh Field, 2004-2016.

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Date terns first observed	4/20	4/21	4/19	4/23	4/22	4/21	4/20	4/19	4/16	4/22	4/15	4/15	4/13
Date terns last seen	8/18	8/3 (9/2 bay)	8/30	8/22	8/15	8/11	8/10	8/3	8/7	8/19	7/23	7/14	7/26
Date of first nest	5/11	5/4	5/15	5/15	5/16	5/10	5/4	5/10	5/8	5/13	5/6	5/9	5/4
Date last nest found	7/6	7/5	8/1	7/11	7/18	8/11	7/20	7/19	7/3	8/6	6/17	6/6	6/20
Date last nest established	7/6	7/5	7/18	7/11	7/18	7/2	7/2	6/24	7/3	7/16?	6/17	6/3	6/20
Date of first hatch	6/1	5/31	6/13	6/10	6/6	6/2	6/2	5/31	5/31	6/7	5/29	6/2	5/26
Date of last hatch	7/1	7/19	8/1	7/18	7/21	7/7	7/15	7/5	7/6	7/16	6/24	6/26	6/25
Date of first fledgling	6/28	6/20	7/8	7/2	6/30	6/22	6/22	6/21	6/21	7/2	6/17	6/23	6/14
Estimated number of breeding pairs	65-70	121-150	114	120-127	122-124	136	110	66-76	96-124	90-95	90-99	9-10	31
Total number of nests	76	157	131	135	139	145	116	78	130	114	100	18	37
Total number of eggs	126	278	207	238	238	268	211	141	197	159-166	180	27	61
Clutch Size													
1 egg	27	39	55	33	43	26	23	15	63	64-71	20	9	13
2 egg	48	115	76	101	94	116	91	126	67	42-49	80	9	24
3 egg	1	3	0	1	1	2	2	0	0	0	0	0	0
4 egg	0	0	0	0	1	1	0	0	0	1	0	0	0
Average clutch size	1.66	1.77	1.53	1.76	1.71	1.85	1.82	1.81	1.54	1.42-1.46	1.80	1.50	1.65
No. of nests hatching young*	42	128	81	93	112	103	88	66	84	80	65	8	25
Total number of eggs hatched	78	221	124	156	193	183	161	118	136	109	113	15	38
Estimated number of fledglings	10-17	45-85	54-65	34-42	115-128	36-38	29-38	11-15	36	34	34-46	8-9	10-17
Number of chicks banded	62	183	120	116	167	138	144	93	110	85	99	15	32
Number of adults banded	0	0	0	0	12	3	12	7	0	1	2	0	0
Uncertain outcome													
Nests*	14	2	4	3	3	9	3	1	9	3	10	0	2
Eggs	19	4	7	5	3	16	4	2	9	3-7	14	0	2
Documented Mortality													
Preyed upon:													
Eggs**	5	3	56	24	14	11	11	0	6	5	8	5	9
Chicks	8	15	8	15	2	0	5	23	3	8	9-10	1-4	4-5
Fledglings	0	11	13-14	3-4	1	3	3	7	0	1	3-4	0	1
Adults	0	1	4-8	1-2	2	2	3	1	1	6	2	1	0
Other than preyed upon:													
Eggs													
Human Damaged	0	0	0	0	0	0	0	0	0	0	0	0	0
Failed to hatch (incubated to term)	1	15	8	13	20	12	10	9	2	4	18	2	5
Died hatching	0	0	0	1	0	0	1	0	1	0	3	0	0
Abandoned (pre-term)	23	16	12	40	9	46	23	12	42	38	24	3	7
Flooded	0	0	0	0	0	0	0	0	0	0	0	1	0
Chicks	15	21	1	12	19	46	36	10	47	13	18	0	5-6
Fledglings	0	10	1	3	5	2	6	0	3	4	1	1	1
Adults	0	1	0	1	0	0	2	1	1	0	0	0	0
Nests													
Human damaged*	0	0	0	0	0	0	0	0	0	0	0	0	0
Preyed upon*	5	2	37	18	11	7	8	0	5	5	7	4	7
Failed to hatch*	1	15	8	13	16	11	9	8	2	4	15	1	5
Abandoned (pre-term)*	16	16	10	26	8	31	18	9	35	27	17	3	5
Flooded	0	0	0	0	0	0	0	0	0	0	0	1	0

* included in more than one category

** not including previously abandoned eggs that were depredated/scavenged

Appendix C-2. Summary of California least tern breeding at D Street Fill, 2004-2016.

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Date terns first observed	4/19	4/19	4/18	4/22	4/22	4/21	4/16	4/19	4/12	4/16	4/15	4/17	4/11
Date terns last seen	8/26	8/1	8/14	8/20	8/13	7/28	7/30	8/15	8/6	8/13	8/12	7/25	7/26
Date of first nest	5/18	5/10	5/16	5/15	5/10	5/8	5/4	5/6	5/5	5/7	5/6	5/5	4/29
Date last nest found	7/20	7/8	7/11	8/20	7/18	8/11	6/29	7/2	7/10	7/23	8/15	7/7	7/12
Date last nest established	7/20	7/8	7/11	7/17	7/16	6/27	6/29	7/2	7/10	7/22	7/8	7/3	7/11
Date of first hatch	6/8	6/4	6/9	6/8	6/3	5/29	5/25	5/27	5/26	6/1	5/27	6/2	5/27
Date of last hatch	7/13	6/28	7/25	7/24	7/22	7/14	7/2	7/8	7/3	7/19	7/12	7/9	7/5
Date of first fledgling	7/6	6/28	7/4	6/30	6/24	6/19	6/15	6/21	6/22	6/25	6/17	6/23	6/17
Estimated number of breeding pairs	77-94	77-97	88-94	100-115	133-135	129	117	100-113	78-93	96-113	125-129	108-111	91-106
Total number of nests	111	101	100	130	148	132	119	116	114	144	148	123	118
Total number of eggs	163	161	140	214	262	229	227	217	162	215	260	224	196
Clutch Size													
1 egg	59	42	60	47	34	35	11	15	66	73	36	22	40
2 egg	52	58	40	82	114	97	108	101	48	71	112	101	78
3 egg	0	1	0	1	0	0	0	0	0	0	0	0	0
Average clutch size	1.47	1.59	1.40	1.65	1.77	1.73	1.91	1.87	1.42	1.49	1.76	1.82	1.66
No. of nests hatching young*	71	79	74	91	124	110	83	97	47	114	126	99	89
Total number of eggs hatched	105	122	98	160	223	189	158	174	65	174	224	184	149
Estimated number of fledglings	4-17	9-17	18-29	25-28	17-24	19-29	15-27	25-32	9	23-32	28-36	21-34	21-22
Number of chicks banded	52	79	52	83	129	122	86	112	41	108	145	128	80
Number of adults banded	0	0	0	0	5	0	4	2	7	1	3	0	0
Uncertain outcome													
Nests*	19	3	5	5	6	11	27	2	16	5	2	4	5
Eggs	23	5	7	9	8	16	51	4	20	7	2	7	7
Documented Mortality													
Preyed upon:													
Eggs**	5	11	14	14	2	0	5	14	21	1	3	4	7
Chicks	7	8	2	9-12	11	8-11	14	4-7	6	4-8	4-7	7	4
Fledglings	0	1	1	4	0	1	1	1	0	3	1	2	1
Adults	0	1	1	2	0	5	1	3-4	0	0	7-11	4	5
Other than preyed upon:													
Eggs													
Human Damaged	0	0	0	0	0	0	0	0	0	0	0	0	0
Failed to hatch (incubated to term)	4	7	6	3	9	8	5	6	4	3	8	5	6
Died hatching	0	0	0	0	0	2	0	3	0	3	0	0	0
Abandoned (pre-term)	26	16	16	28	20	14	8	16	52	27	23	24	27
Flooded	0	0	0	0	0	0	0	0	0	0	0	0	0
Chicks	10	17	8	7	12	12	28	40	16	54-58	59-62	31	58
Fledglings	0	1	0	5	0	0	11	9	0	11	7	11	1
Adults	0	1	0	0	0	0	0	0	1	0	0	0	1
Nests													
Human damaged*	0	0	0	0	0	0	0	0	0	0	0	0	0
Preyed upon*	5	7	10	11	2	0	3	9	14	1	3	2	5
Failed to hatch*	4	7	6	3	6	8	4	6	4	3	7	5	6
Abandoned (pre-term)*	22	12	13	24	16	11	5	11	40	22	16	19	21
Flooded	0	0	0	0	0	0	0	0	0	0	0	0	0

* included in more than one category

** not including previously abandoned eggs that were depredated/scavenged

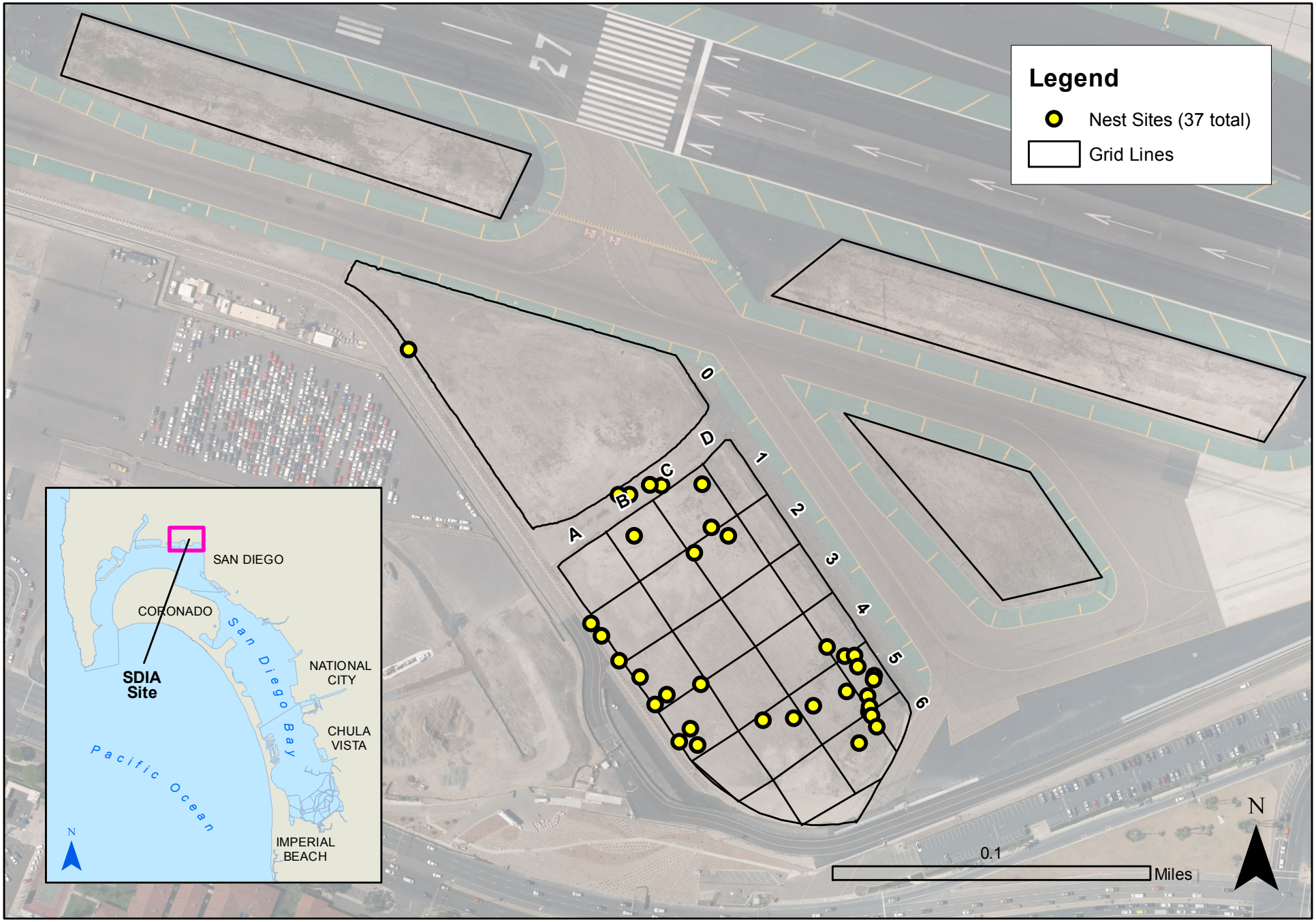
Appendix C-3. Summary of California least tern breeding at Chula Vista Wildlife Reserve, 2004-2016.

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Date terns first observed	4/20	4/26	4/21	4/23	4/9	4/24	4/22	4/19	4/12	4/13	4/15	4/20	4/16
Date terns last seen	9/5	7/29	8/14	8/15	8/29	8/4	8/2	8/24	9/13	8/19	8/12	8/18	8/2
Date of first nest	5/15	5/17	5/30	5/15	5/16	5/12	5/11	5/13	5/12	5/13	5/10	5/10	5/9
Date last nest found	7/13	7/1	7/4	7/10	7/8	7/10	6/29	7/19	7/10	7/2	6/20	6/30	7/26
Date last nest established	7/13	7/1	7/4	7/3	7/8	7/10	6/29	7/16	7/10	7/2	6/20	6/30	7/12
Date of first hatch	6/5	6/10	6/20	6/8	6/6	6/2	6/1	6/3	6/2	6/4	5/31	5/31	5/31
Date of last hatch	7/24	7/1	7/22	7/20	7/26	7/24	7/2	7/18	7/31	7/16	6/28	7/6	7/16
Date of first fledgling	7/13	7/5	8/4	7/17	8/15	6/23	6/29	6/21	6/29	6/25	6/20	6/20	6/21
Estimated number of breeding pairs	30-48	44-53	12-13	33-39	28	37	32	34-47	29-37	58-66	80-86	65-71	56-63
Total number of nests	66	57	15	46	33	48	40	53	64	79	87	79	76
Total number of eggs	103	101	25	81	60	86	76	100	98	129	166	146	122
Clutch Size													
1 egg	30	13	5	11	7	11	4	6	30	29	8	13	30
2 egg	35	44	10	35	25	36	36	47	34	50	79	65	46
3 egg	1	0	0	0	1	1	0	0	0	0	0	1	0
Average clutch size	1.56	1.77	1.66	1.76	1.82	1.79	1.9	1.89	1.53	1.63	1.91	1.85	1.60
No. of nests hatching young*	47	40	9	24	18	22	21	39	36	66	75	70	63
Total number of eggs hatched	73	74	17	42	32	40	41	75	55	106	142	127	103
Estimated number of fledglings	11-18	2	2	0	2	4-5	2	12-19	18-20	32-39	23-27	33-37	15-18
Number of chicks banded	44	46	10	23	16	18	16	40	43	94	107	99	78
Number of adults banded	0	0	0	0	7	5	7	1	2	4	1	0	0
Uncertain outcome													
Nests*	11	3	2	0	11	16	5	10	9	0	1	0	1
Eggs	13	5	3	0	17	28	10	15	11	0	2	0	1
Documented Mortality													
Preyed upon:													
Eggs**	0	9	3	36	6	8	21	4	9	2	6	6	2
Chicks	2	1	0	2	2	2	8-9	5-7	5	1-2	2	15	5-6
Fledglings	0	0	0	0	1	0	0	1	2	2	9	3	0
Adults	1-2	0	1	0	0	0	0	3	2-3	3	6	8-13	2
Other than preyed upon:													
Eggs													
Human Damaged	0	0	0	0	0	0	0	0	0	0	0	0	0
Failed to hatch (incubated to term)	3	5	0	1	4	3	0	1	1	9	3	3	2
Died hatching	1	0	0	0	1	2	0	0	0	0	0	0	0
Abandoned (pre-term)	13	8	2	2	0	5	2	5	22	12	13	10	14
Flooded	0	0	0	0	0	0	0	0	0	0	0	0	0
Chicks	1	5	0	0	0	2	1	2	3	28-29	35	16	26-27
Fledglings	0	0	0	0	0	0	1	0	0	3	2	4	1
Adults	0	0	0	0	0	0	0	0	0	0	0	0	0
Nests													
Human damaged*	0	0	0	0	0	0	0	0	0	0	0	0	0
Preyed upon*	0	6	3	21	4	7	11	2	6	1	4	4	2
Failed to hatch*	2	5	0	1	4	5	0	1	1	8	3	3	2
Abandoned (pre-term)*	9	7	2	2	0	4	2	4	17	10	9	7	11
Flooded	0	0	0	0	0	0	0	0	0	0	0	0	0

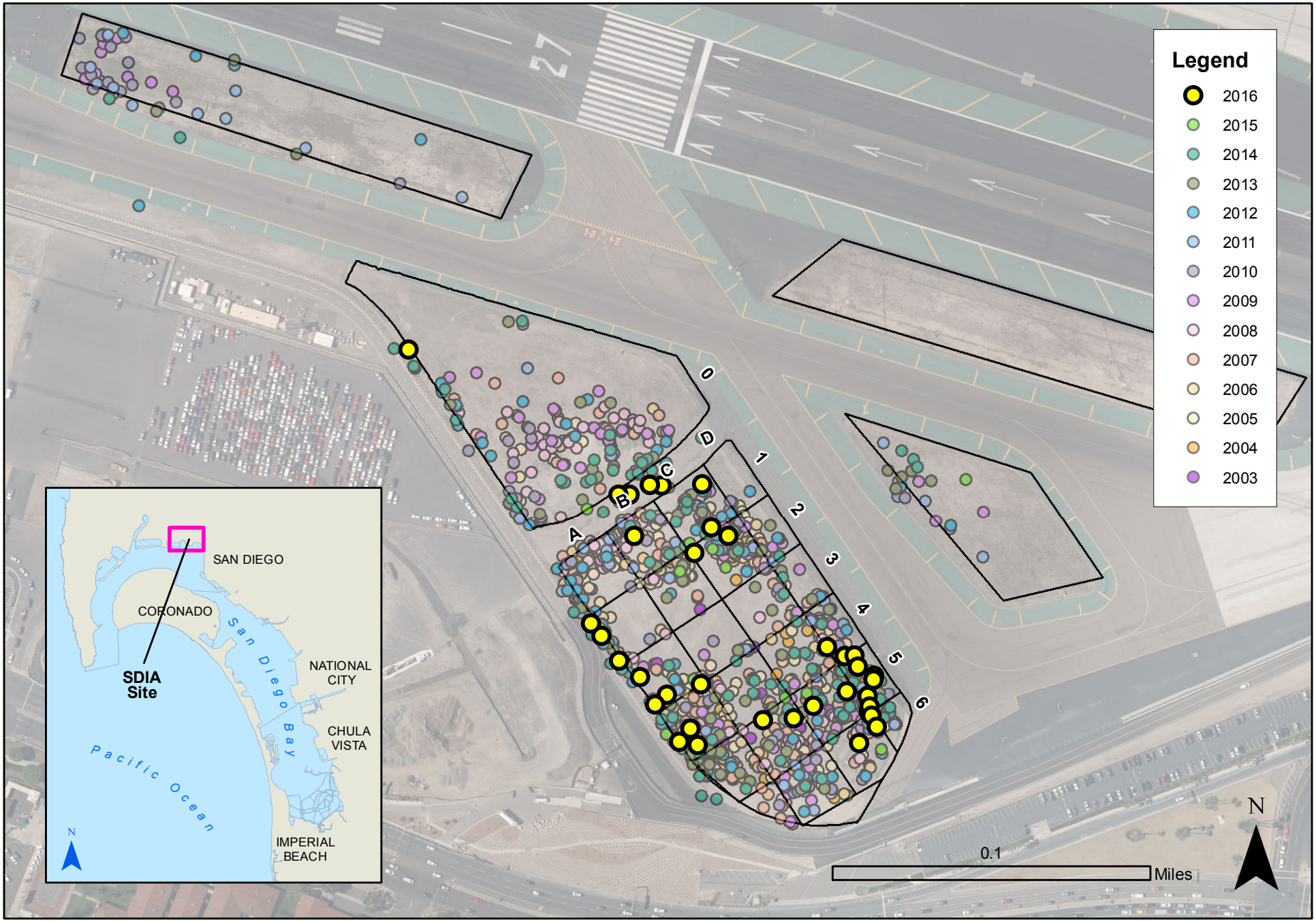
* included in more than one category

** not including previously abandoned eggs that were depredated/scavenged

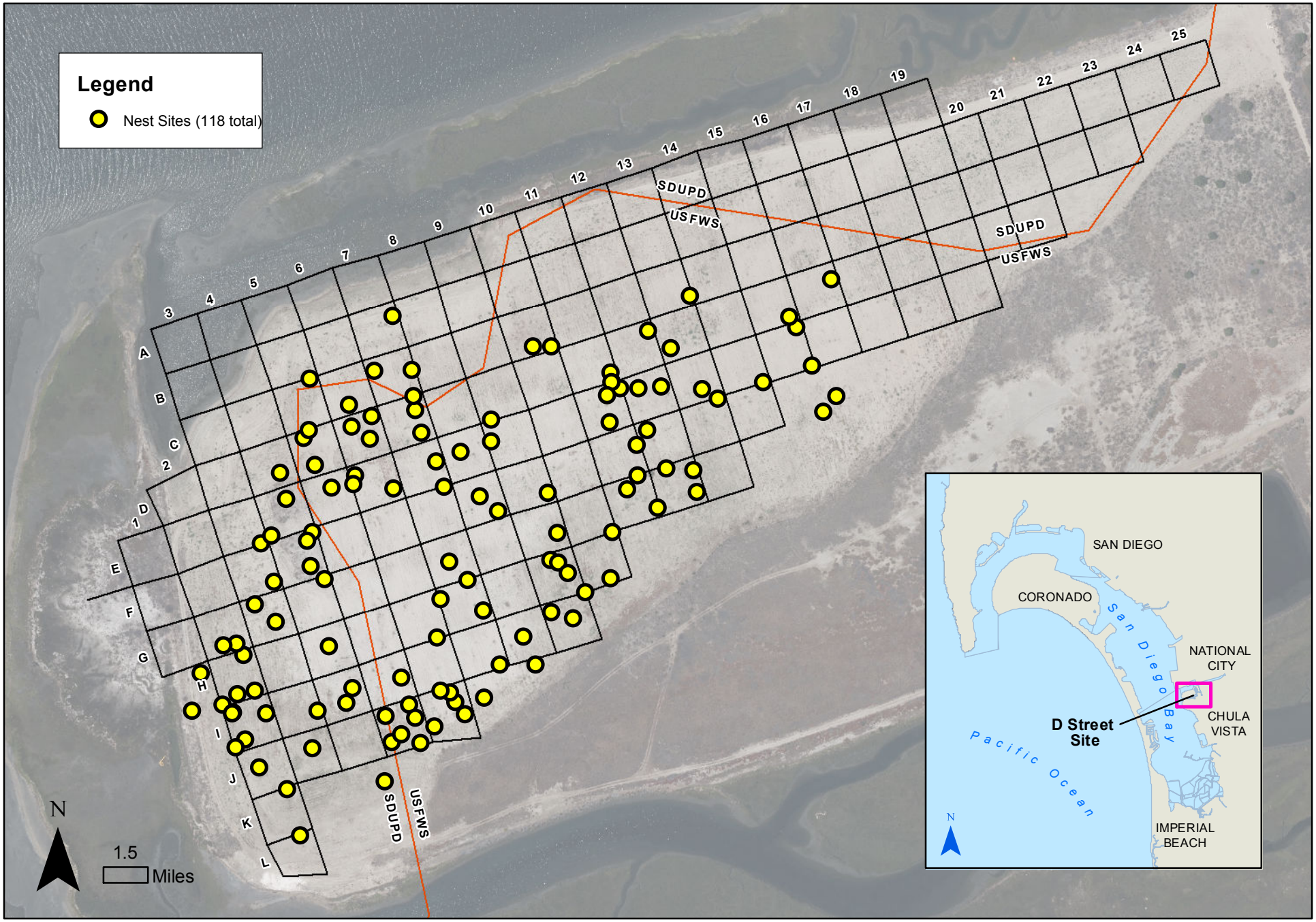
Least Tern Nests: San Diego International Airport 2016



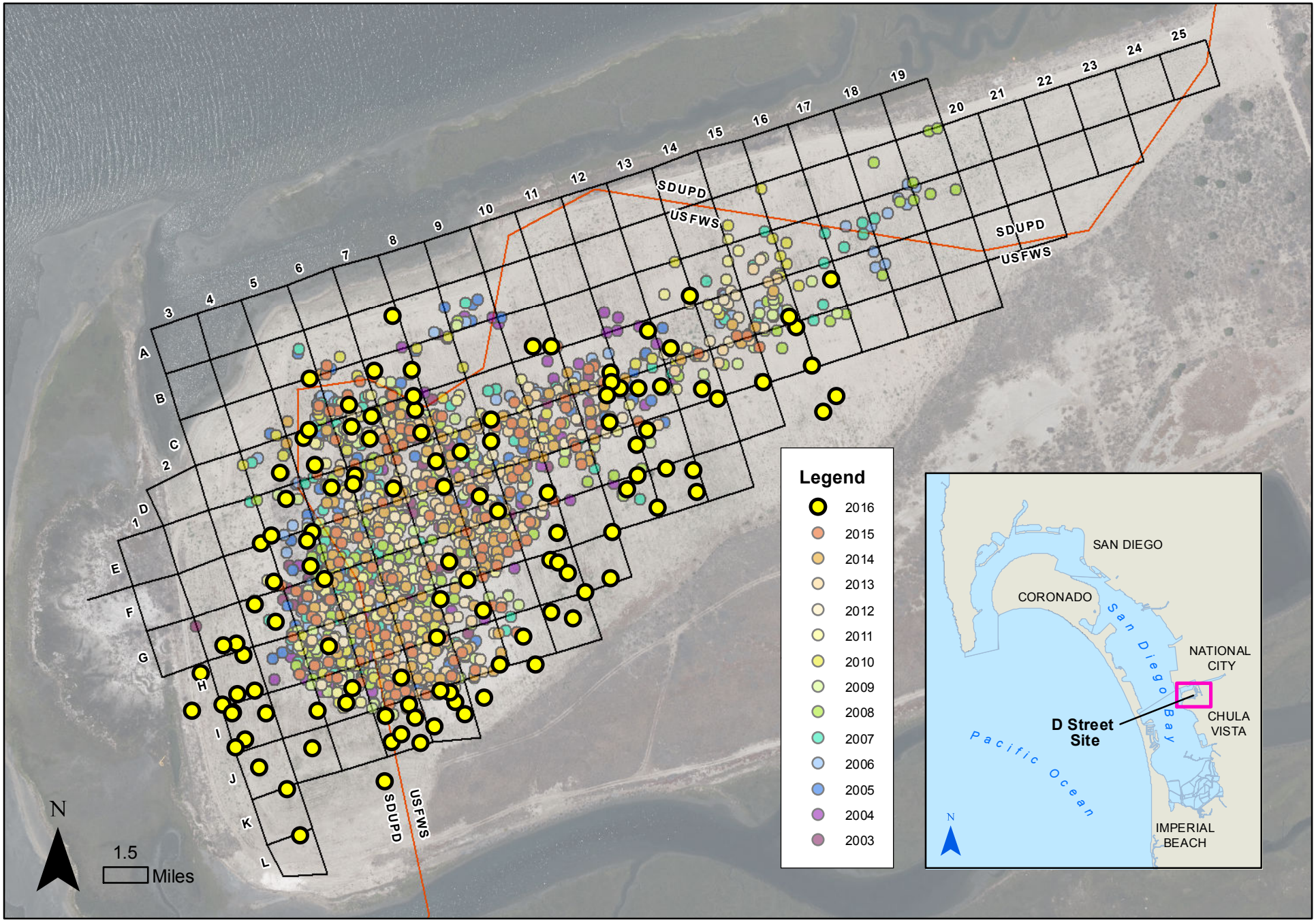
Least Tern Nests: San Diego International Airport 2003-2016



Least Tern Nests: D Street 2016

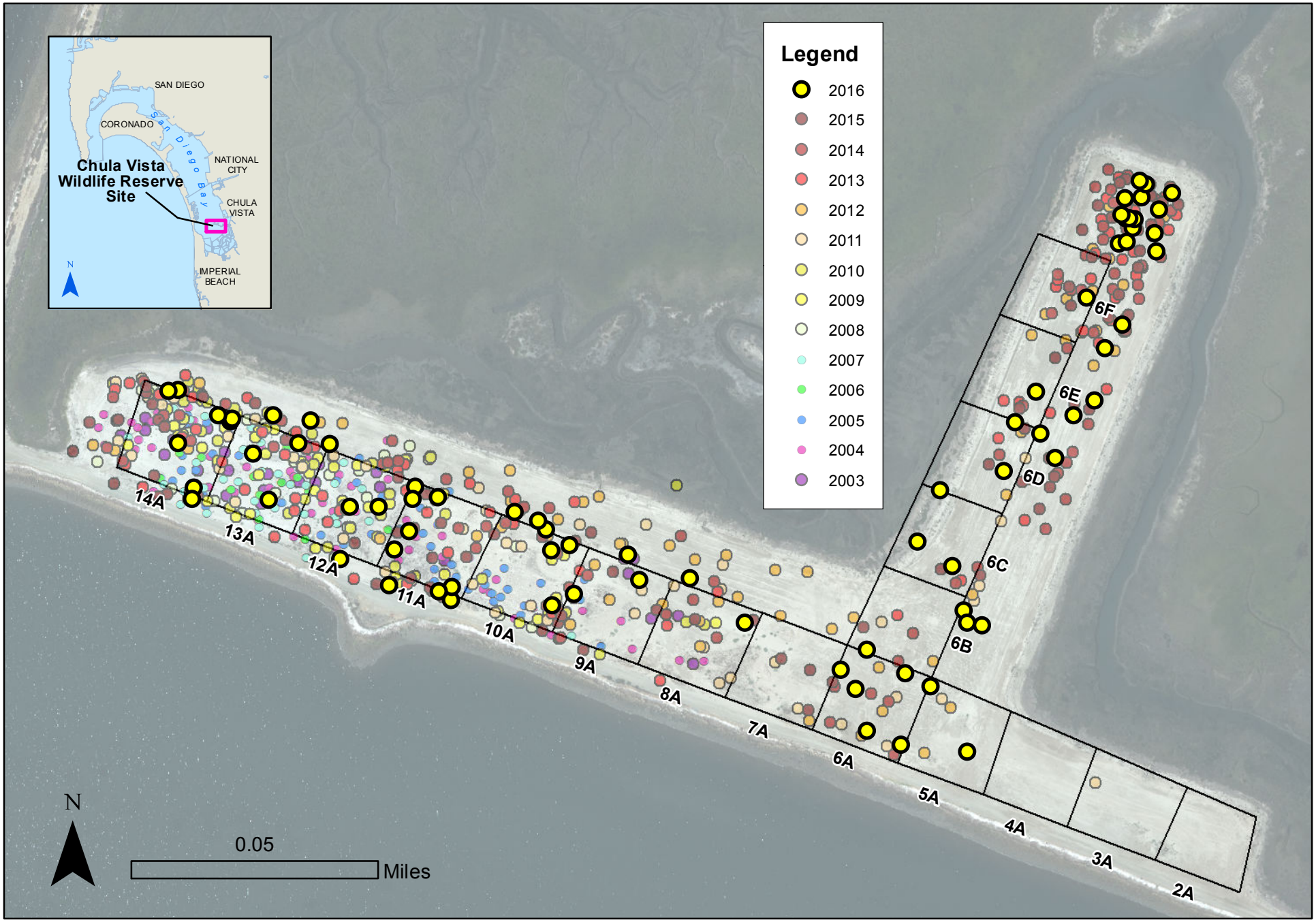


Least Tern Nests: D Street 2003-2016



Least Tern Nests: Chula Vista Wildlife Reserve 2016

Least Tern Nests: Chula Vista Wildlife Reserve 2003-2016



Appendix D. Distribution of nests of California least tern and western snowy plover at D Street Fill, 1997-2016.

	Number of Nests			
Year	CLT	WSP	W-E Row	N-S Column
1997	41	10-12	3-12	C-I
1998	7	2	4-11	D-F
1999	36	2	4-11	D-H
2000	34	1	4-10	D-H
2001	32	0	4-12	D-H
2002	24	0	4-11	E-H
2003	91	0	2-12	C-I
2004	111	0	3-14	B-I
2005	101	0	3-13	B-I
2006	100	0	3-19	B-I
2007	130	0	3-18	B-I
2008	148	0	3-20	B-I
2009	132	0	4-16	B-J
2010	119	0	4-16	B-J
2011	116	0	3-15	B-J
2012	114	0	4-15	C-I
2013	144	0	4-15	C-J
2014	148	0	4-15	C-J
2015	123	0	3-15	C-J
2016	118	0	2-17	B-K

Appendix E-1. Numbers of western snowy plovers and band combinations observed at D Street Fill, 2016.
Orientation code: colon divides upper and lower leg, dash divides left and right legs.
Color code: A=aqua, B=blue, G=green, K=black, L=lime, R=red, S=service, W=white, X= no band, Y=yellow.

Date	Number of Plovers	Bands
1/19	0	(high tide)
1/19	64	(ebbing tide); GW-YL, S-X (3), W:SA-R:B
2/9	39	(ebbing tide); GW-YL, KK-X, S-X (3)
2/17	38	(ebbing tide); GW-YL, S-X (2)
2/22	22	(ebbing tide)
2/24	0	(high tide)
3/1	12	(ebbing tide)
3/10	3	(ebbing tide)
3/15	0	
3/22	0	
3/28	0	
4/1	0	
4/11	0	
4/19	0	
4/26	0	
5/3	0	
5/10	0	
5/17	0	
5/24	0	
5/31	0	
6/7	0	
6/14	0	
6/21	0	
6/28	0	
7/5	0	
7/12	0	
7/19	0	
7/26	0	
8/2	0	
8/9	0	
8/28	0	
9/8	0	
9/14	3-4	
10/26	15	
11/16	4	
12/10	29-44	

Appendix E-2. Western snowy plover band combinations observed at D Street Fill, 2016.
Orientation code: colon divides upper and lower leg, dash divides left and right legs.
Color code: A=aqua, B=blue, G=green, K=black, L=lime, R=red, S=service, W=white, X= no band, Y=yellow.

Date(s)	Bands	Origin
1/19, 2/9, 2/17	GW-YL	South Ten Mile Beach, OR, adult 2010
2/9	KK-X	Project Wildlife captive-reared, 2012 or 2013; originally KK-W/KB/P or KK-R/YB/P but lost bands
1/19, 2/9, 2/17	S-X (up to 3 individuals at one time)	San Diego County (multiple individuals, multiple sites, multiple years)
1/19	W:SA-R:B	Salinas San Martin, N of San Quentin, BC, MX, adult 2012