THE STATUS OF THE CALIFORNIA LEAST TERN

AT SAN DIEGO UNIFIED PORT DISTRICT PROPERTIES

IN 2015

Prepared under Contract

For

San Diego Unified Port District

Photo by Kate Goodenough

By

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SUMMARY

In preparation for the 2015 nesting season at D Street Fill, U.S. Fish and Wildlife Service staff applied herbicide to invasive plant species; and in mid- to late March, 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 March through mid-August one to three days per week.

Least terns were first observed at the D Street Fill on 17 April 2015. They were observed each visit after that through 25 July. At least 123 nests were initiated by 108 to 111 estimated pairs between 5 May and 7 July. The maximum number of concurrently active nests was 106 on 29 May, and the maximum number of concurrently active nests and broods was 91 nests with 17 to 18 broods of chicks on 2 June. At least 12 nests were suspected to have resulted from renesting by pairs that lost earlier clutches.

At least 184 chicks from 99 nests hatched successfully. It is estimated that 25 to 37 chicks reached fledgling age and 21 to 34 survived to fledge from the site. The outcome of four nests with seven eggs was uncertain, but lack of evidence of hatching or chick presence indicates probable depredation. At least two nests with two eggs were depredated, one by undetermined species and one suspected to have been taken by gull-billed terns. Nineteen nests with 24 eggs were abandoned pre-term, and five eggs failed to hatch and were abandoned after the other egg in each clutch hatched successfully.

One fledgling and 29 chicks were found with no obvious cause of death. Two additional chicks were found dead being scavenged by ants, but whether ants contributed to their mortality could not be determined. One fledgling banded at D Street was later found hit by a vehicle at Border Field State Park. One adult was observed being taken by a peregrine falcon, another prey item observed being carried from the site by a peregrine was suspected to be a least tern adult, and piles of feathers of an additional adult and a fledgling suggested predation by peregrine. The depredated carcass of another adult was found following observation of a barn owl on-site. Two chicks were observed being taken by an American kestrel and remains of two more recovered upon necropsy. Two chick carcasses were found with trauma to the head and either kestrel or northern harrier were suspected to be responsible. 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 109 to 122 chicks coincided with documented depredation and/or daily disturbances to the colony by northern harrier, American kestrel, and peregrine falcon, and visits by gull-billed tern and barn owl. Other potential predator species observed in the area included great blue heron, great egret, black-crowned night-heron, Cooper's hawk, red-tailed hawk, gulls, common raven, American crow, European starling, western meadowlark, 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 May to mid-August, and no nests were established by snowy plovers this season. However, a male observed chasing other plovers from the vicinity of a pre-nest scrape in March was the first breeding behavior documented at this site since 2000. From 31 to 39 plovers were observed foraging on adjacent mudflats during ebbing or low tides prior to nesting season, and nine following nesting season. The only band combinations observed included origins in San Diego County.

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

The California least tern (Sternula antillarum browni) 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 2014 was estimated to be 4232 to 5786 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 2015 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 previously managed by 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 the site being abandoned by nesting terns in 1981 and 1990, but the colony being re-established with up to 135 nests in 1992 (Copper 1981, Obst and Johnston 1992, Caffrey 1993). Following significant losses to predation in 1997, colony size dropped from 41 nests to only seven nests in 1998 (Patton 1998a, 1998b). Numbers remained relatively low through 2002 (24 to 36 nests) but increased significantly in 2003 (Patton 1999, 2000, 2001, 2002, 2003). Since then, 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 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014). 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.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Nests	101	100	130	148	132	119	116	114	144	148
Fledglings	9-17	18-29	25-28	17-24	19-29	15-27	25-32	9	23-32	28-36

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 any site preparation efforts, the site was surveyed for the presence, courting or nesting of western snowy plovers, and for nests of other species. Prior to April 2015, staff and contractors of the San Diego National Wildlife Refuge Complex applied herbicide in limited areas to reduce invasive plant species, particularly iceplant (Carpobrotus and Mesembryanthemum sp.), tamarisk (Tamarix sp.), and Bermuda grass (Cynodon dactylon). From March 16 to 20, USFWS staff conducted mechanical scraping of the site to reduce vegetation and further enhance it for use by least terns and snowy plovers. New growth of vegetation in some areas was reduced by manual weeding, most notably Baccharis and Astragalus species, and to reduce invasive non-native garland chrysanthemum (Glebionis coronaria), iceplant, and mustard (Brassica) species. Vegetation around the periphery of the cleared area was pruned back by contract monitors to limit predator perches and cover.

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 the status of the site were repaired or replaced. Plastic and papier-mache decoys were placed in three 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 group was

arranged to simulate single birds (spaced 1.0 to 2.0 m apart) and the remainder of each group set as pairs of birds (spaced approximately 15.0 cm apart) according to Burger (1988).

Mechanical scraping of vegetation to enhance the site for least tern nesting.

Monitoring

The site was monitored one to three times per week by one to five 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 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 at each site 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 during hot weather, 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 mid-August until the terns departed. Monitoring was discontinued when no least terns had been observed for three consecutive visits. The final monitoring visit for 2015 was on 18 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 and stored on-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. When known, the nest from which the chick originated was noted. 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 possible 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.

Banding 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 as an 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, frozen, and delivered per direction from USFWS to San Diego State University for isotope and/or contaminant analysis.

RESULTS AND DISCUSSION

Least terns were observed from 15 April through 18 August 2015 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, 220 nests were established from 5 May to 3 July (Appendix C). At least 62 to 80 young are estimated to have fledged from San Diego International Airport - Lindbergh Field, D Street Fill, and Chula Vista Wildlife Reserve.

Least tern nest with eggs. Photo by Kate Goodenough

Breeding Chronology

California least terns were observed at the D Street Fill nesting site from 17 April through 25 July. Approximately 108 to 111 pairs established 123 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).

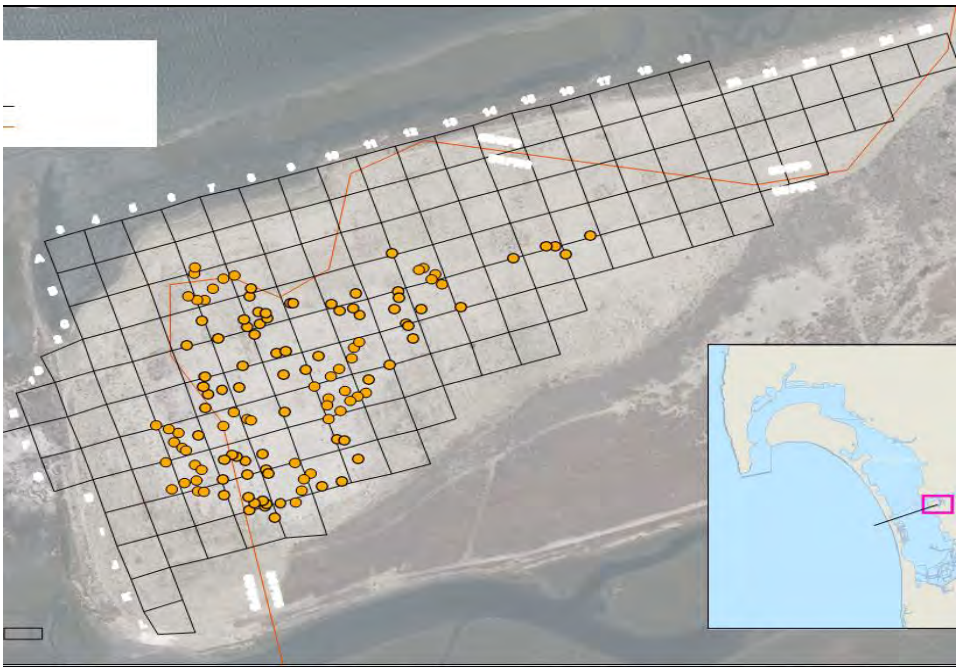
However, given the lack of productivity in recent seasons, particularly with significant predation around San Diego Bay, the question has been raised as to whether the maximum number of concurrently active nests may be a more accurate measure of the number of breeding pairs. The CDFW method results in a maximum index estimate of 119 breeding pairs this season. However, up to 12 nests and at least 14 broods 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 111 breeding pairs. The maximum number of concurrently active nests was 91 on 2 June, but the maximum number of concurrently active nests and broods was 108 to 109 with 91 nests and 17 to 18 broods.

Figure 3 depicts graphically the chronology of nesting events at the D Street Fill in 2015. The numbers of active nests plotted in Figure 3 were those nests being tended by an adult. The majority of nests (93%) were initiated between 5 May and 2 June. Three more nests were then established from 9 to 18 June. Four nests were established on 23 June, then one more on 30 June. The remaining nest was found on 7 July, but had been previously abandoned and suspected initiated no later than 3 July. The number of active nests plotted in Figure 3 diverged from the number of total nests in mid- to late May due to abandonment of four nests. Divergence increased through June with hatching of chicks, additional nest abandonments, and predation. Active nest numbers dropped from early June through 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 where substrate appeared softer and relatively richer in shell content, and vegetation was sparser. The densest nesting occurred in the southwest portion of this concentration of nests. Other nests were established in areas of less dense vegetation 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 locations at D Street Fill in 2015.

Six nests this season were established farther east in the site than most nests of recent 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. From 1997 through 2003, no nests were documented east of grid row 12 (see Figure 2). 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. (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 some years it has not been extended beyond row 19). Prior to the 2004 breeding season, a portion of the northeastern fill north of rows

18 through 24 was excavated for saltmarsh and tidal channel restoration. Prior to the 2011 breeding season, a portion of the northwestern fill that had included grid rows 1 through 10, A through E, was excavated for the L-ditch mitigation project. Least terns have been observed foraging in the channels of both these areas and roosting with their fledglings on adjacent shoreline.

Clutch Size

Approximately 108 to 111 estimated pairs of least terns established 123 nests with 224 eggs at the D Street Fill in 2015. The average clutch size was 1.82 eggs per nest with 101 two-egg clutches and 22 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 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 82 percent of the eggs at D Street Fill hatched successfully this season, resulting in an average of 1.50 chicks per nest and 1.86 chicks per nest that experienced hatching (Table 1). This was an increase over that of the previous two seasons and a substantial increase over that of the 2012 season when nest predation and abandonment severely limited hatching success (Patton 2012, 2013, 2014). Nest abandonment was still the primary known limiting factor to hatching success, with 15 percent of nests abandoned pre-term (19 nests). Five additional eggs were abandoned after the other egg in each clutch hatched. Although only two nests were documented to have been depredated, the outcome of four 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.

Chick Banding

In 2015, 128 chicks from at least 86 nests were banded at D Street Fill. Chicks were banded on the right leg with USFWS metal bands individually numbered 2421-51025, 2421-51201 through -51220, 2421-52501 through -52600, and 2421-52983, -52994 through -53000.

Fledging Success and Seasonal Production

From 25 to 37 chicks are estimated to have reached fledging age this season but carcasses of three to four were recovered, resulting in 21 to 34 young being estimated to have survived to fledge from the colony. The wide range in the fledgling estimate is due to the estimation method being complicated by an influx of fledglings from other sites and the inability of monitors to discern bands or exact numbers of which were local and which were migrants. Productivity was thus 0.17 to 0.28 fledglings per nest, 0.19 to 0.31 per pair. Although relatively low, this was among the higher number of fledglings produced at this site over the past 10 years and 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 98 percent of the chicks from 2 to 16 June. This is in turn reflected in numbers of fledglings three weeks later. However, the contrast between the two curves is notable, with daily numbers of observed fledglings reduced from earlier corresponding hatching numbers due to mortality and predation limiting the number of chicks reaching fledging age. The sharp peak and abrupt decline of observed fledgling numbers indicate lack of survival of later chicks and fledglings. Fledglings generally remain at the colony site for two weeks post-fledging, but the lack of sightings indicates lack of survival and/or early departure and dispersal.

Chick recovery for band recapture and growth measurement data at times was complicated by and monitoring protocol adjusted to accommodate 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, as well as 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. At least 29 chicks were found dead of undetermined causes, at least seven were depredated, and it was unclear whether two more had been depredated or had been scavenged post mortem. One fledgling was found dead of undetermined causes and at least two was depredated. A fourth fledged from the site but later was found crushed in tire tracks at Border Field State Park.

Least tern chick. Photo by Kate Goodenough

Mortality

Fifteen percent of nests (19 nests) with 24 eggs were abandoned after one to 37 days of incubation (Table 2). Eggs of five two-egg clutches failed to hatch and were abandoned after the other in each clutch hatched, another was abandoned after uncertain outcome of the other egg in its clutch. Twenty-nine chicks and one fledgling were found dead of undetermined causes (16 percent of those hatched). Two additional chicks were found dead being scavenged by ants, but whether ants contributed to their deaths could not be determined.

	Hatched	Abandoned Pre-term	Abandoned Post-term (Failed to Hatch)	Uncertain Outcome	Predation	Possible Non-predation Mortality	Non-predation Mortality
Nests	99	19	5	4	2		
Eggs	184	24	5	7	4		
Chicks					7	2	29
Fledglings					2		1
Adults					4		0

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. However, the relatively high number of chick and fledgling deaths also coincided with mortality reported at other colonies (J. Jackson and V. Johnson, pers. comm.). 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

Only four eggs were reported as having been depredated this season (Tables 1 and 2). The remains of a two-egg clutch were found being scavenged by ants, but it was unclear whether ants were responsible or just scavenging after predation by another species. The disappearance of two eggs only five days old coincided with observed foraging of a gull-billed tern (Gelochelidon nilotica) in the vicinity of the nest. The outcomes of four other nests with seven eggs were uncertain, but lack of evidence of hatching or chick presence indicated probable depredation. Early in the season, nests of killdeer (Charadrius vociferus) and horned lark (Eremophila alpestris) were depredated by common raven (Corvus corax) or American crow (Corvus brachyrhynchos), but neither species had been seen at the site during the dates of tern nest losses. Northern harriers (Circus cyaneus) had been observed hunting within the colony during the period of egg and chick loss.

One adult least tern was observed being taken by a peregrine falcon (Falco peregrinus), another prey item suspected of being an adult tern was observed being carried from the site, and peregrines were suspected as being responsible for the piles of plucked feathers of another adult and a fledgling. The depredated carcass of another adult was found after observations of a barn owl (Tyto alba) on site.

As previously mentioned, the carcasses of two chicks were found being scavenged by ants, but whether ants were the cause of death could not be determined. One chick was found freshly dead being consumed by ants. Two chicks were observed being taken by an American kestrel (Falco sparverius), and the remains of two others were recovered by necropsy following its removal. Additional chicks were suspected of being taken by each of these species. Two chicks and one fledgling were found dead with head trauma suspected inflicted by kestrel or harrier.

	Harrier or Kestrel	American Kestrel	Peregrine Falcon	Gull-billed Tern	Barn Owl	Ant sp.
Nests				1		1
Eggs				2		2
Chicks	2	4				1-3
Fledglings	1		1			
Adults			3		1	

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 109 to 122 chicks coincided with documented depredation and daily disturbances to the colony by northern harrier, American kestrel, and peregrine falcon, and visits by gull-billed tern and barn owl. Other potential predator species observed in the area included gopher snake (Pituophis catenifer), great blue heron (Ardea herodias), great egret (Ardea alba), black-crowned night-heron (Nycticorax nycticorax), Cooper's hawk (Accipiter cooperii), red-tailed hawk (Buteo jamaicensis), gull species (Larus spp.), European starling (Sturnus vulgaris), western meadowlark (Sturnella neglecta), 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 31 to 39 which were observed foraging pre-season on mudflats west of the nesting site (Appendix E-1). At least nine were observed foraging post-season. In March and April, one male plover was observed chasing other plovers from the vicinity of a pre-nest scrape on the southwest edge of the fill and repeatedly roosting in the area. However, none were observed during the peak of nesting season from May to 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 had 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 been filling 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 Silver Strand. Band combinations observed this season included origins elsewhere in San Diego County (specific sites undetermined) (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 least terns and snowy plovers were marked, mapped, and contents recorded (Figure 2). Mallard (Anas platyrhinos) initiated at least one nest along the north perimeter and killdeer established at least nine nests within the interior and on the northwest slope. Horned larks appeared to nest throughout the site, and at least 12 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).

Snowy plover on southwest D Street Fill in 2015. 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 the southwestern site where Bermuda grass and salt grass (Distichlis spicata) regrowth precluded nesting again this season, in the south central site where extensive stands of iceplant prevent nesting, and in the northern site where locoweed and mustard have become a problem. 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 by such projects. 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 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.

ACKNOWLEDGEMENTS

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LITERATURE CITED

Atwood, J.L., and P.R. Kelly. 1984. Fish dropped on breeding colonies as indicators of least tern food habits. Wilson Bull. 96:34-47.

Burger, J. 1988. Social attraction in nesting least terns: effects of numbers, spacing, and pairbonds. Condor 90:575-582.

Caffrey, C. 1993. California least tern breeding survey, 1992 season. CA Dep. Fish & Game, Wildl. Manag. Div., Nongame Bird & Mammal Section Rep. 93-11, Sacramento, CA. 35 pp.

_____. 1994. California least tern breeding survey, 1993 season. CA Dep. Fish & Game, Wildl. Manag. Div., Nongame Bird & Mammal Section Rep. 94-07, Sacramento, CA. 39 pp.

_____. 1995. California least tern breeding survey, 1994 season. CA Dep. Fish & Game, Wildl. Manag. Div., Bird & Mammal Conservation Program Rep. 94-3, Sacramento, CA. 49 pp.

_____. 1998. California least tern breeding survey, 1996 season. CA Dep. Fish & Game, Wildl. Manag. Div., Bird & Mammal Conservation Program Rep. 98-2, Sacramento, CA. 57 pp.

California Department of Fish and Game. 1972. At the crossroads: a report on California's endangered and rare fish and wildlife. 99 pp.

California Least Tern Recovery Team. 1977. California least tern recovery plan. Unpublished draft.

Copper, E. 1980. Least tern breeding season in San Diego County, 1980. Unpublished report.

_____. 1981. Least tern breeding season in San Diego County, 1981. Unpublished report.

_____. 1987. Final report on least tern nesting in San Diego County, 1987. Unpublished report.

_____. and R. Patton. 1985. California least tern nesting, San Diego County, 1985. Unpublished report.

Coulson, J.C. 1968. Differences in the quality of birds nesting in the centre and on the edges of a colony. Nature 217:478-479.

Foster, B., K.M. Hyde, and R. Patton. 1982. 1982 observation and management of the California Least Tern site, Naval Air Station, North Island, San Diego, CA. Unpublished report.

Frost, N. 2015. California least tern breeding survey, 2014 season. CA Dep. Fish & Wildlife, Wildl. Branch, Nongame Wildl. Program Rep., 2015-01. Sacramento, CA. 23 pp. + app.

Marschalek, D.A. 2009. California least tern breeding survey, 2009 season. CA Dep. Fish & Game, Wildl. Branch, Nongame Wildl. Program Rep., 2009-02. Sacramento, CA. 23 pp. + app.

Massey, B.W. 1974. Breeding biology of the California least tern. Proc. Linnaean Soc. N.Y. 72:1-24.

_____. 1989. California least tern fledgling study, Venice, California, 1989. CA Dep. Fish & Game, Wildl. Manag. Div., Nongame Bird & Mammal Section Rep. (1989), Sacramento, CA. 8 pp.

_____. and J.L. Atwood. 1981. Second-wave nesting of the California least tern: age composition and reproductive success. Auk 98:596-605.

Obst, B.S. and S.M. Johnston. 1992. California least tern breeding survey, 1990 season. CA Dep. Fish & Game, Wildl. Manag. Div., Nongame Bird & Mammal Section Rep. 92-05, Sacramento, CA. 13 pp.

Patton, R. 1998a. The status of the California least tern at San Diego Unified Port District properties in 1997. Unpublished report.

_____. 1998b. The status of the California least tern at San Diego Unified Port District properties in 1998. Unpublished report.

_____. 1999. The status of the California least tern at San Diego Unified Port District properties in 1999. Unpublished report.

_____. 2000. The status of the California least tern at San Diego Unified Port District properties in 2000. Unpublished report.

_____. 2001. The status of the California least tern at San Diego Unified Port District properties in 2001. Unpublished report.

_____. 2002. The status of the California least tern at San Diego Unified Port District properties in 2002. Unpublished report.

_____. 2003. The status of the California least tern at San Diego Unified Port District properties in 2003. Unpublished report.

_____. 2004. The status of the California least tern at properties of the San Diego Unified Port District and San Diego County Regional Airport Authority in 2004. Unpublished report.

_____. 2005. The status of the California least tern at San Diego Unified Port District properties in 2005. Unpublished report.

_____. 2006. The status of the California least tern at San Diego Unified Port District properties in

2006. Unpublished report.

_____. 2007. The status of the California least tern at San Diego Unified Port District properties in 2007. Unpublished report.

_____. 2008. The status of the California least tern at San Diego Unified Port District properties in 2008. Unpublished report.

_____. 2009. The status of the California least tern at San Diego Unified Port District properties in 2009. Unpublished report.

_____. 2010. The status of the California least tern at San Diego Unified Port District properties in 2010. Unpublished report.

_____. 2011. The status of the California least tern at San Diego Unified Port District properties in 2011. Unpublished report.

_____. 2012. The status of the California least tern at San Diego Unified Port District properties in 2012. Unpublished report.

_____. 2013. The status of the California least tern at San Diego Unified Port District properties in 2013. Unpublished report.

_____. 2014. The status of the California least tern at San Diego Unified Port District properties in 2014. Unpublished report.

_____. and B. Foster. 1984. 1984 observation and management of the California least tern site, Naval Air Station, North Island, San Diego, Ca. Unpublished report.

Siegel-Causey, D. and G.L. Hunt, Jr. 1986. Breeding site selection and colony formation in double-crested and pelagic cormorants. Auk 103:230-234.

Thompson, B.C., and R.D. Slack. 1984. Post-fledging departure from colonies by juvenile least terns in Texas: implications for estimating production. Wilson Bull. 96:309-313.

U.S. Bureau of Sport Fisheries and Wildlife. 1973. Threatened wildlife of the United States. Resource Publ. 114. 289 pp.

WESTEC Services, Inc. 1981. Biological report on the California least tern (Sterna albifrons brownii) at Naval Air Station, North Island. Unpublished report.

TABLES

Table 1. Least tern nest and egg data, D Street Fill, 2015.

	nests*	eggs
Total	123	224
1 egg clutch	22	22
2 eggs	101	202
Known Hatch		
Total	99*	184
1 egg	9	9
2 eggs	90*	175
Uncertain Outcome		
Total	4*	7
1 egg	0	0
2 eggs	4*	7
Failed to Hatch		
Total	26*	33
1 egg	13	13
2 eggs	13*	20
Depredated		
Total	2	4
1 egg	0	0
2 eggs	2	4
Abandoned (pre-term)		
Total	19	24
1 egg	13	13
2 eggs	6	11
Abandoned post-term/nonviable		
Total	5*	5
1 egg	0	0
2 eggs	5*	5

* inclusion in more than one category: one egg each of five 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.

Table 2. Documented causes of least tern mortality, D Street Fill, 2015.

Cause	Least Tern Age Class	Total Losses D Street Fill
Total:		
	egg	33
	chick	38*
	fledgling	3
	adult	4
Predation*:		
Ant species		
	egg (possibly depredated previously)	2
	chick	1
	chick (possibly died previously)	2
American Kestrel or Northern Harrier		
	chick	2
	fledgling	1
American Kestrel		
	chick	4
Peregrine Falcon		
	fledgling	1
	adult	3
Gull-billed Tern		
	egg	2
Barn Owl		
	adult	1
Non-predation Mortality:		
Abandonment (pre-term)		
	egg	24
Unknown		
Abandoned post-term/nonviable		
	egg	5
No visible trauma		
	chick	29*
	fledgling	1

*daily-observed chick numbers and recapture data indicate additional losses of up to 109-112 chicks, species suspected as responsible for losses include northern harrier, American kestrel, and peregrine falcon, with possible losses also to ant species, gull-billed tern, and barn owl. American kestrel was observed preying on two chicks and carcasses of two others were recovered upon necropsy. Carcasses of two chick and one fledgling were found with trauma to the head and either kestrel or harrier suspected responsible. Peregrine falcon was observed preying on one adult, carrying prey suspected to be another, and suspected responsible for feather piles of another adult and one fledgling. The depredated carcass of one adult was found following barn owl observations. One chick was found being depredated by ants; and two others being scavenged by ants, but it was unclear whether they had been depredated by ants or had died previously and subsequently scavenged. Predation of two eggs at one nest was suspected to have been from gull-billed tern. Ants were scavenging remains of two eggs at one nest, but it was unclear if another species had depredated the eggs prior to ant activity.

FIGURES

Figure 1. San Diego Unified Port District and San Diego County Regional Airport Authority least tern nesting sites, 2015.

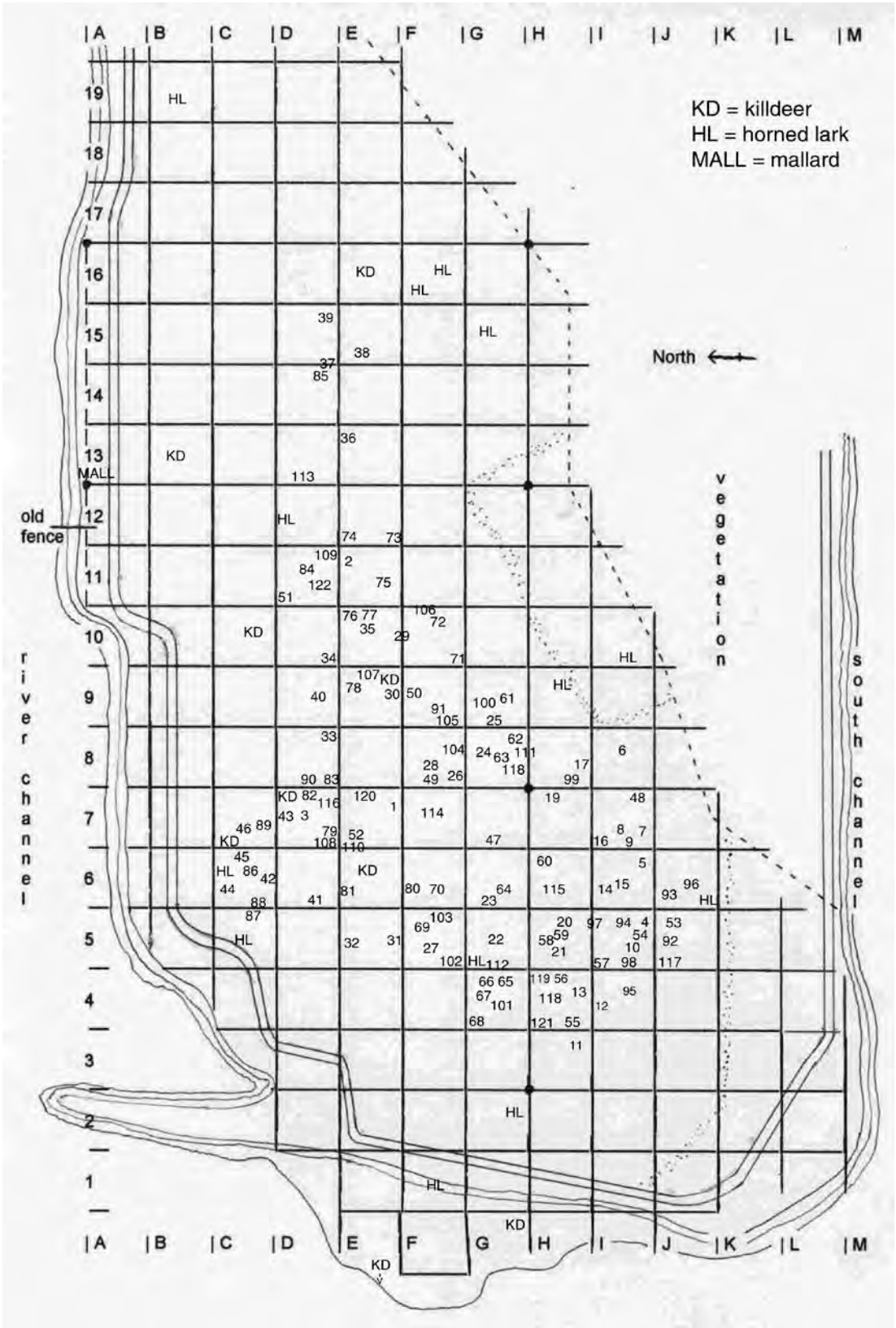


Figure 2. Least tern nest distribution, D Street Fill, 2015.

Figure 3. Least tern breeding chronology, D Street Fill, 2015.

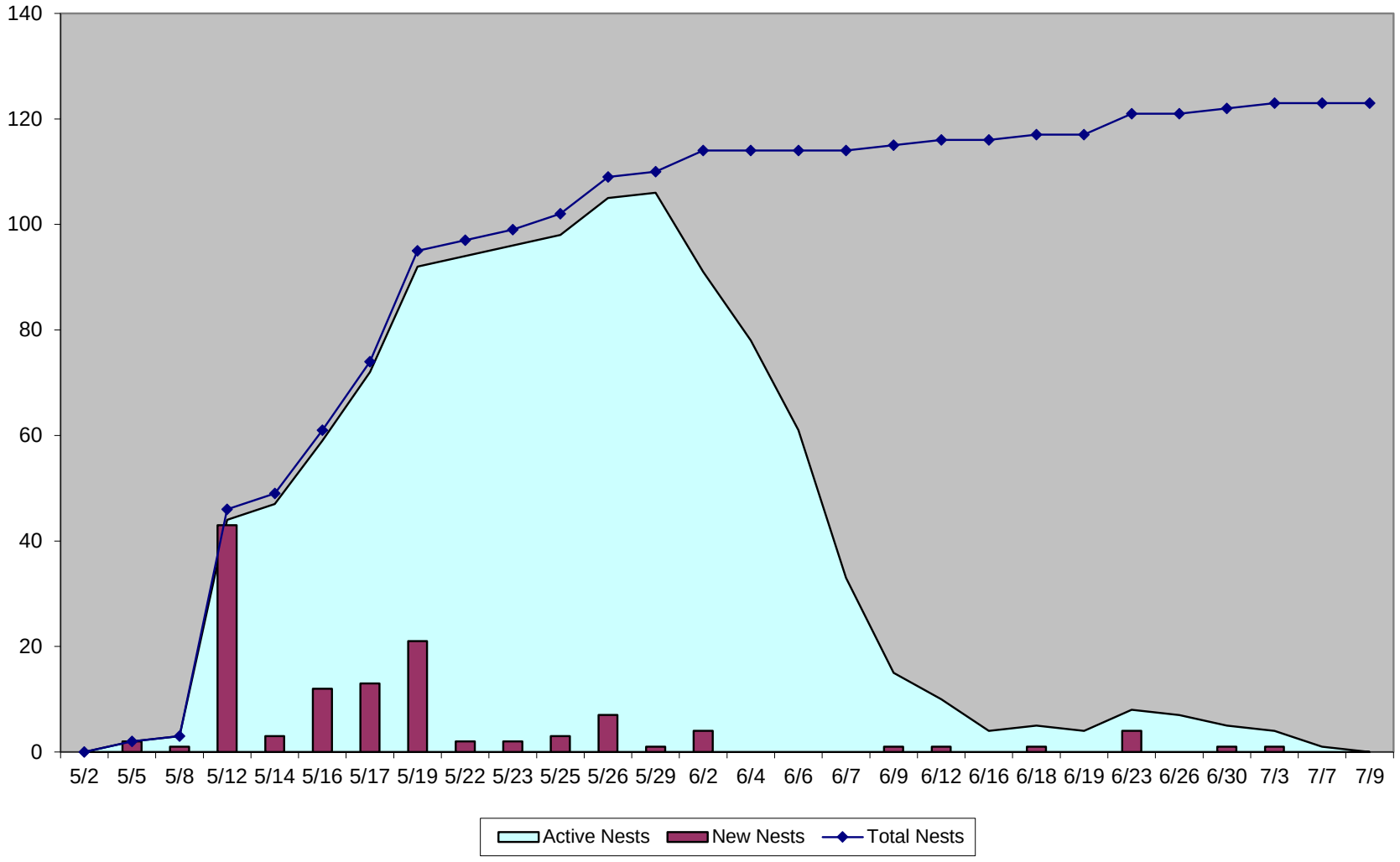
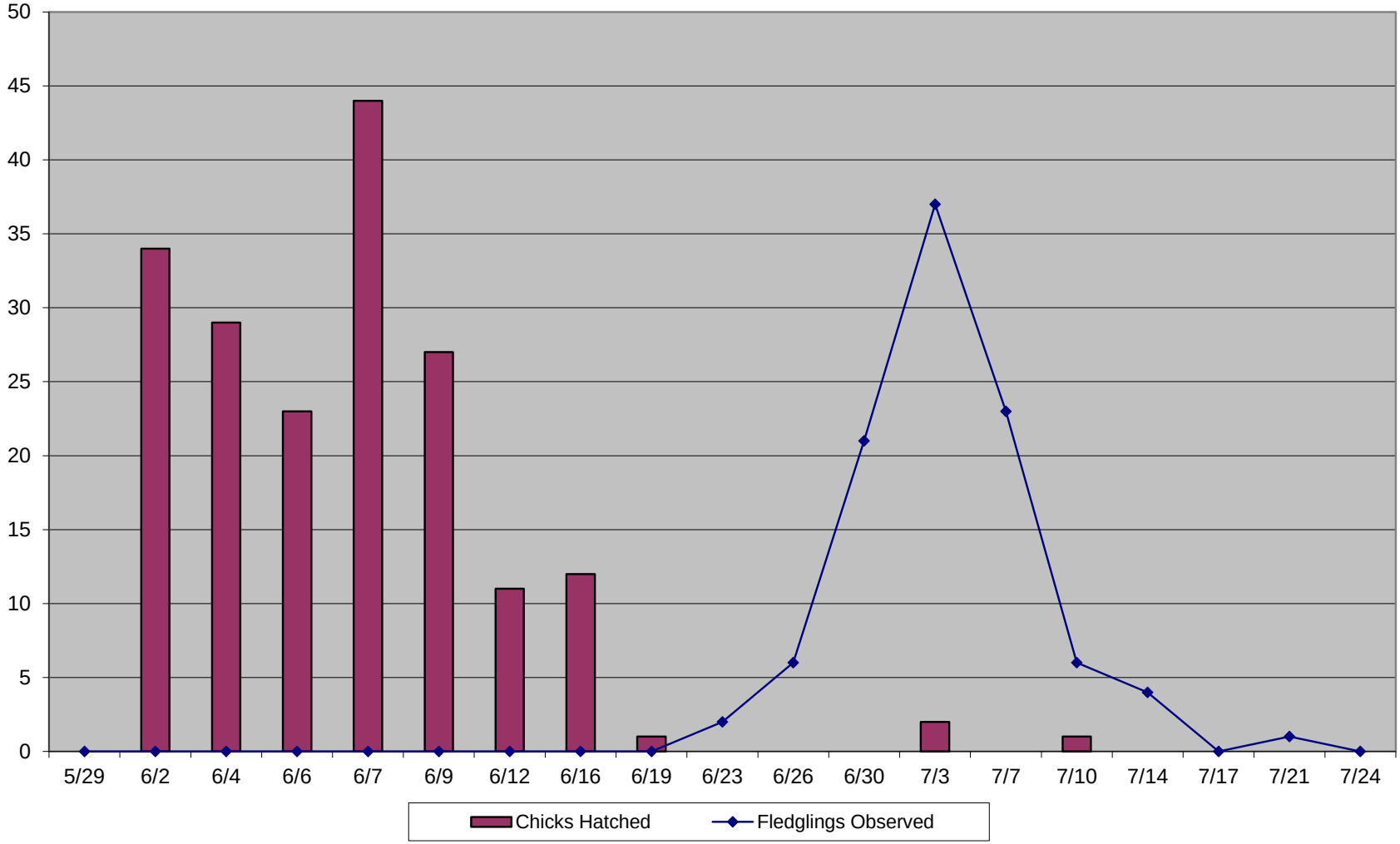


Figure 4. Least tern productivity chronology, D Street Fill, 2015.



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

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 2015.

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, and prior to mid-March at D Street Fill and Chula Vista Wildlife Reserve; and monitored from late February through August, 2015, by Robert Patton, Lea Squires, Jennifer Jackson, Kate Goodenough, Brian Foster, Elizabeth Copper and Matt Sadowski. Each also conducted additional monitoring of construction activity near the colony site at Lindbergh Field, as did Monica Alfaro, Rossy Mendez, and Thomas Myers. Mayra Garcia and staff of SDIA Environmental Affairs assisted at Lindbergh Field, and Brian Collins of Sweetwater Marsh NWR also monitored at D Street Fill.

Least terns were observed from 15 April through 18 August 2015 at and adjacent to properties and facilities of the San Diego Unified Port District. At the three Port District and San Diego County Regional Airport Authority sites, 220 nests were established from 5 May to 7 July. At least 62 to 80 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. The Terminal Link Road construction project resulted in closure of the adjacent perimeter road and relocation of the perimeter fence to closer to the colony site along the southern edge of oval 03-S, construction of an electronic gate and guard shack, and installation of visual barrier fabric on the perimeter fence adjacent to the southwestern edge of the site. Although these were completed prior to the nesting season, construction activity continued on the opposite side of the fence and construction traffic passed along the edge of the site and through the gate throughout the season. 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 August one to three days per week. Additional monitoring was conducted associated with adjacent construction activities. Predator management was conducted by personnel from USDA Wildlife Services.

Least terns were first observed foraging over the bay and in flight over the southeast end of Lindbergh Field on 15 April 2015. They were observed each visit after that through 14 July. There was an 82 percent reduction in nest numbers from 2014 to 2015 thought to be influenced by disturbance from construction activity, predators, and nest predation during the early formative period of colony establishment, as well as by possibly limited prey fish availability due to above average water temperatures, and by the long-term overall decline of the tern population in Southern California. At least 18 nests were initiated by nine to ten estimated pairs between 9 May and 3 June. The maximum number of concurrently active nests was nine from 21 May to 1 June, and six nests with three broods of chicks on 2 June. Up to eight nests possibly appeared to be renesting of pairs that had lost their initial clutches. At least 17 nests were established in the main nesting oval 03-S and one nest in oval 02-S.

Fifteen chicks from eight nests hatched successfully. It is estimated that nine to 10 chicks

reached fledgling age and eight to nine young survived to fledge from the site. Four nests with four eggs were abandoned pre-term, including one that had been washed out of its nest scrape by record rainfall. One egg was found abandoned with thin and only partially developed eggshell, and one two-egg clutch failed to hatch and was abandoned after prolonged incubation of 44 to 46 days. Five eggs from four nests were depredated, two to three by common ravens and one suspected by western gull.

One chick was depredated by ants and three to four others are suspected to have been depredated, with raven, American kestrel, and peregrine falcon each seen leaving the site with prey suspected to be possible tern chicks. One fledgling was crushed by an aircraft on the taxiway but was suspected to have been flushed from the site by a peregrine falcon. Feathers of one adult were found beneath the beacon where a peregrine falcon had been perched. Nest abandonment and chick predation coincided with regular disturbance by peregrine falcon, as well as disturbance and possible predation by Cooper's hawk, gulls, common raven, and American crows. Other potential predators observed in the area included rats, great blue heron, black-crowned night-heron, and European starling.

D Street Fill & Sweetwater Marsh NWR

Through mid-March, U.S. Fish and Wildlife Service staff and contractors applied herbicide to invasive plant species and 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 March through mid-August one to three days per week.

Least terns were first observed at the D Street Fill on 17 April 2015. They were observed each visit after that through 25 July. At least 123 nests were initiated by 108 to 111 estimated pairs between 5 May and 7 July. The maximum number of concurrently active nests was 106 on 29 May, and the maximum number of concurrently active nests and broods was 91 nests with 17 to 18 broods of chicks on 2 June. At least 12 nests were suspected to have resulted from renesting by pairs that lost earlier clutches.

At least 184 chicks from 99 nests hatched successfully. It is estimated that 25 to 37 chicks reached fledgling age and 21 to 34 survived to fledge from the site. The outcome of four nests with seven eggs was uncertain, but lack of evidence of hatching or chick presence indicates probable depredation. At least two nests with two eggs were depredated, one by undetermined species and one suspected to have been taken by gull-billed terns. Nineteen nests with 24 eggs were abandoned pre-term, and five eggs failed to hatch and were abandoned after the other egg in each clutch hatched successfully.

One fledgling and 29 chicks were found with no obvious cause of death. Two additional chicks were found dead being scavenged by ants, but whether ants contributed to their mortality could not be determined. One fledgling banded at D Street was later found hit by a vehicle at Border Field State Park. One adult was observed being taken by a peregrine falcon, another prey item observed being carried from the site by a peregrine was suspected to be a least tern adult, and

piles of feathers of an additional adult and a fledgling suggested predation by peregrine. The depredated carcass of another adult was found following observation of a barn owl on-site. Two chicks were observed being taken by an American kestrel and remains of two more recovered upon necropsy. Two chick carcasses were found with trauma to the head and either kestrel or northern harrier were suspected to be responsible. 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 109 to 122 chicks coincided with documented depredation and/or daily disturbances to the colony by northern harrier, American kestrel, and peregrine falcon, and visits by gull-billed tern and barn owl. Other potential predator species observed in the area included great blue heron, great egret, black-crowned night-heron, Cooper's hawk, red-tailed hawk, gulls, common raven, American crow, European starling, western meadowlark, 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 May to mid-August, and no nests were established by snowy plovers this season. However, a male observed chasing other plovers from the vicinity of a pre-nest scrape in March was the first breeding behavior documented at this site since 2000. From 31 to 39 plovers were observed foraging on adjacent mudflats during ebbing or low tides prior to nesting season, and nine following nesting season. The only band combinations observed included origins in San Diego County.

Chula Vista Wildlife Reserve

Prior to early April 2015 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 late February through August one to three days per week. Predator management was conducted by USDA Wildlife Services staff.

Least terns were first observed at Chula Vista Wildlife Reserve on 20 April 2015, and on each visit through 4 August. One adult and fledgling were observed on 18 August. At least 79 nests were initiated by 65 to 71 estimated pairs between 10 May and 30 June 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 was 80 on 27 May, and maximum number of concurrently active nests was 65 on 31 May, and maximum number of concurrently active nests and broods was 55 nests and 10 broods on 5 June.

At least 127 chicks from 70 nests hatched successfully. It is estimated that 40 to 44 chicks reached fledgling age and 33 to 37 young survived to fledge from the site this season. Four eggs from two nests were depredated and northern harrier suspected responsible, two eggs from one nest were depredated and gull-billed tern suspected responsible, two eggs from one nest and a previously abandoned egg from another nest were depredated but species responsible could not be determined. Seven nests were abandoned pre-term, and three were abandoned after the other egg in each clutch hatched successfully. One of the abandoned nests was found following record rainfall and may have been flooded prior to abandonment.

Four fledglings and 16 chicks were found dead of undetermined causes. One chick was observed being depredated by a great blue heron, and the bands and remains of 12 additional chicks were recovered upon necropsy. One chick was apparently depredated by ants, and

carcasses of others apparently previously deceased were scavenged. An owl pellet was found containing adult least tern feathers and bones. One adult and one fledgling were observed being taken by peregrine falcons, the remains of five to nine adults and one fledgling were suspected to have resulted from peregrine predation, those of two adults and one fledgling were suspected of being depredated by either owl or peregrine, and that of one large chick/fledgling depredated by undetermined species. 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 71 to 75 chicks coincided with repeated hunting of the site by peregrine falcons and great blue heron, and visits by northern harrier, American kestrel, and gull-billed tern. Other potential predator species observed in the area included great egret, osprey, red-tailed hawk, gulls, Caspian tern, common raven, American crow, coyote, gray fox, raccoon, striped skunk, feral cat, California ground squirrel, and rats.

Snowy plovers were recorded only twice at CVWR this season with one dispersing fledgling briefly flying in in July, and an adult and fledgling roosting during high tide in August. Forster's terns established at least 81 nests, the majority of which were on the southwest jetty, with smaller sub-colonies on the northeast and northwest central dikes. Black skimmers nested for the third 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, 2015.

	SDIA-LF	D St Fill	CVWR
Date terns first observed	4/15	4/17	4/20
Date terns last seen	7/14	7/25	8/18
Date of first nest	5/9	5/5	5/10
Date last nest found	6/6	7/7	6/30
Date last nest established	6/3	7/3	6/30
Date of first hatch	6/2	6/2	5/31
Date of last hatch	6/26	7/9	7/6
Date of first fledgling	6/23	6/23	6/20
Estimated number of pairs	9-10	108-111	65-71
Total number of nests	18	123	79
Total number of eggs	27	224	146
Clutch size:			
1 egg	9	22	13
2 egg	9	101	65
3 egg	0	0	1
4 egg	0	0	0
unknown (min. 1 egg)	0	0	0
Average clutch size	1.50	1.82	1.85
No. of nests hatching young*	8	99	70
Total number of eggs hatched	15	184	127
Estimated number of fledglings	8-9	21-34	33-37
Number of chicks banded	15	128	99
Number of adults banded	0	0	0
Uncertain outcome			
Nests*	0	4	0
Eggs	0	7	0
Documented Mortality			
Preyed upon			
Nests*	4	2	4
Eggs**	5	4	6
Chicks	1-4	7	15
Fledglings	0	2	3
Adults	1	4	8-13
Human disturbance			
Nests*	0	0	0
Eggs	0	0	0
Chicks	0	0	0
Fledglings	1	1	0
Adults	0	0	0
Other causes			
Nests*			
Abandoned (pre-term)	3	19	7
Failed to hatch (incubated to term)	1	5	3
Died hatching	0	0	0
Damaged (eggshell thinning)	1	0	0
Flooded	1	0	0
Eggs			
Abandoned (pre-term)	3	24	10
Failed to hatch (incubated to term)	2	5	3
Died hatching	0	0	0
Damaged (eggshell thinning)	1	0	0
Flooded	1	0	0
Chicks	0	31	16
Fledglings	0	1	4
Adults	0	0	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, 2004-2015.

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
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
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
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
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
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
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
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
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
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
Total number of nests	76	157	131	135	139	145	116	78	130	114	100	18
Total number of eggs	126	278	207	238	238	268	211	141	197	159-166	180	27
Clutch Size												
1 egg	27	39	55	33	43	26	23	15	63	64-71	20	9
2 egg	48	115	76	101	94	116	91	126	67	42-49	80	9
3 egg	1	3	0	1	1	2	2	0	0	0	0	0
4 egg	0	0	0	0	1	1	0	0	0	1	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
No. of nests hatching young*	42	128	81	93	112	103	88	66	84	80	65	8
Total number of eggs hatched	78	221	124	156	193	183	161	118	136	109	113	15
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
Number of chicks banded	62	183	120	116	167	138	144	93	110	85	99	15
Number of adults banded	0	0	0	0	12	3	12	7	0	1	2	0
Uncertain outcome												
Nests*	14	2	4	3	3	9	3	1	9	3	10	0
Eggs	19	4	7	5	3	16	4	2	9	3-7	14	0
Documented Mortality												
Preyed upon:												
Eggs**	5	3	56	24	14	11	11	0	6	5	8	5
Chicks	8	15	8	15	2	0	5	23	3	8	9-10	1-4
Fledglings	0	11	13-14	3-4	1	3	3	7	0	1	3-4	0
Adults	0	1	4-8	1-2	2	2	3	1	1	6	2	1
Other than preyed upon:												
Eggs												
Human Damaged	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
Died hatching	0	0	0	1	0	0	1	0	1	0	3	0
Abandoned (pre-term)	23	16	12	40	9	46	23	12	42	38	24	3
Flooded	0	0	0	0	0	0	0	0	0	0	0	1
Chicks	15	21	1	12	19	46	36	10	47	13	18	0
Fledglings	0	10	1	3	5	2	6	0	3	4	1	1
Adults	0	1	0	1	0	0	2	1	1	0	0	0
Nests												
Human damaged*	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
Failed to hatch*	1	15	8	13	16	11	9	8	2	4	15	1
Abandoned (pre-term)*	16	16	10	26	8	31	18	9	35	27	17	3
Flooded	0	0	0	0	0	0	0	0	0	0	0	1

* 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, 2004-2015.

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
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
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
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
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
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
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
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
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
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
Total number of nests	111	101	100	130	148	132	119	116	114	144	148	123
Total number of eggs	163	161	140	214	262	229	227	217	162	215	260	224
Clutch Size												
1 egg	59	42	60	47	34	35	11	15	66	73	36	22
2 egg	52	58	40	82	114	97	108	101	48	71	112	101
3 egg	0	1	0	1	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
No. of nests hatching young*	71	79	74	91	124	110	83	97	47	114	126	99
Total number of eggs hatched	105	122	98	160	223	189	158	174	65	174	224	184
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
Number of chicks banded	52	79	52	83	129	122	86	112	41	108	145	128
Number of adults banded	0	0	0	0	5	0	4	2	7	1	3	0
Uncertain outcome												
Nests*	19	3	5	5	6	11	27	2	16	5	2	4
Eggs	23	5	7	9	8	16	51	4	20	7	2	7
Documented Mortality												
Preyed upon:												
Eggs**	5	11	14	14	2	0	5	14	21	1	3	4
Chicks	7	8	2	9-12	11	8-11	14	4-7	6	4-8	4-7	7
Fledglings	0	1	1	4	0	1	1	1	0	3	1	2
Adults	0	1	1	2	0	5	1	3-4	0	0	7-11	4
Other than preyed upon:												
Eggs												
Human Damaged	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
Died hatching	0	0	0	0	0	2	0	3	0	3	0	0
Abandoned (pre-term)	26	16	16	28	20	14	8	16	52	27	23	24
Flooded	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
Fledglings	0	1	0	5	0	0	11	9	0	11	7	11
Adults	0	1	0	0	0	0	0	0	1	0	0	0
Nests												
Human damaged*	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
Failed to hatch*	4	7	6	3	6	8	4	6	4	3	7	5
Abandoned (pre-term)*	22	12	13	24	16	11	5	11	40	22	16	19
Flooded	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, 2004-2015.

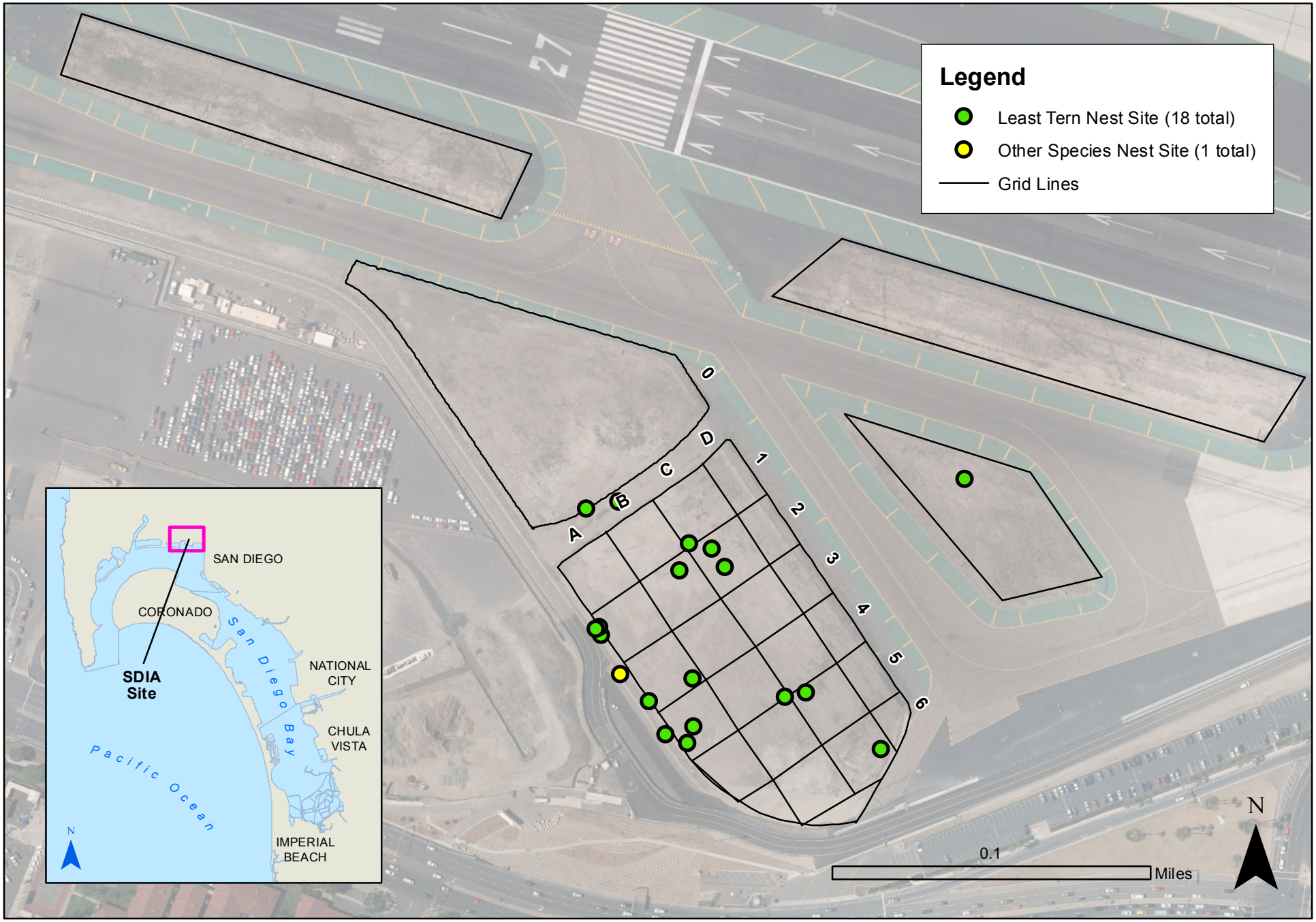
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Date terns first observed	4/20	4/26	4/21	4/23	4/9	4/24	4/22	4/19	4/12	4/13	4/15	4/20
Date terns last seen	9/5	7/29	8/14	8/15	8/29	8/4	8/2	8/24	9/13	8/19	8/12	8/18
Date of first nest	5/15	5/17	5/30	5/15	5/16	5/12	5/11	5/13	5/12	5/13	5/10	5/10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

* included in more than one category

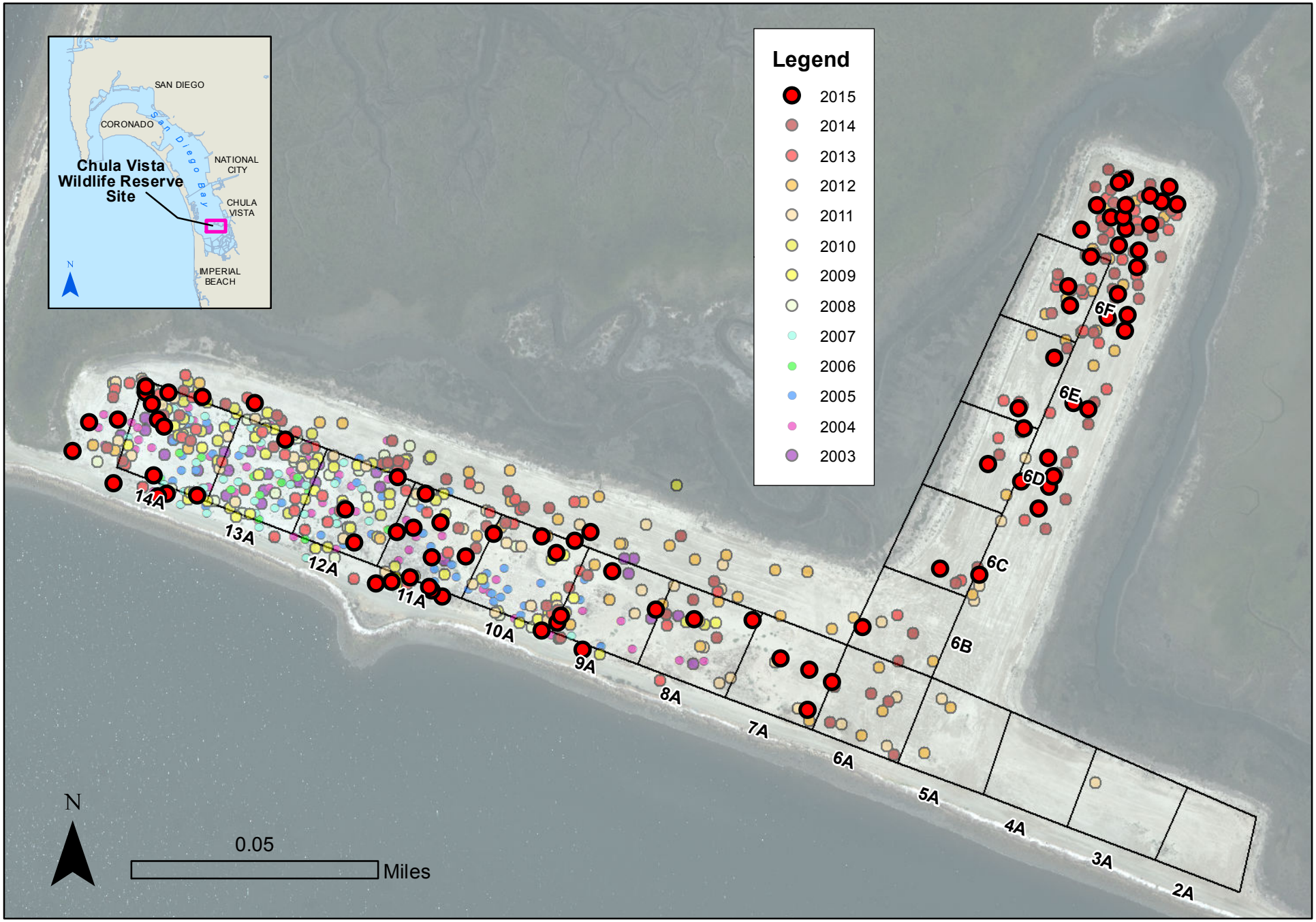
** not including previously abandoned eggs that were depredated/scavenged

Least Tern Nests: San Diego International Airport 2003-15

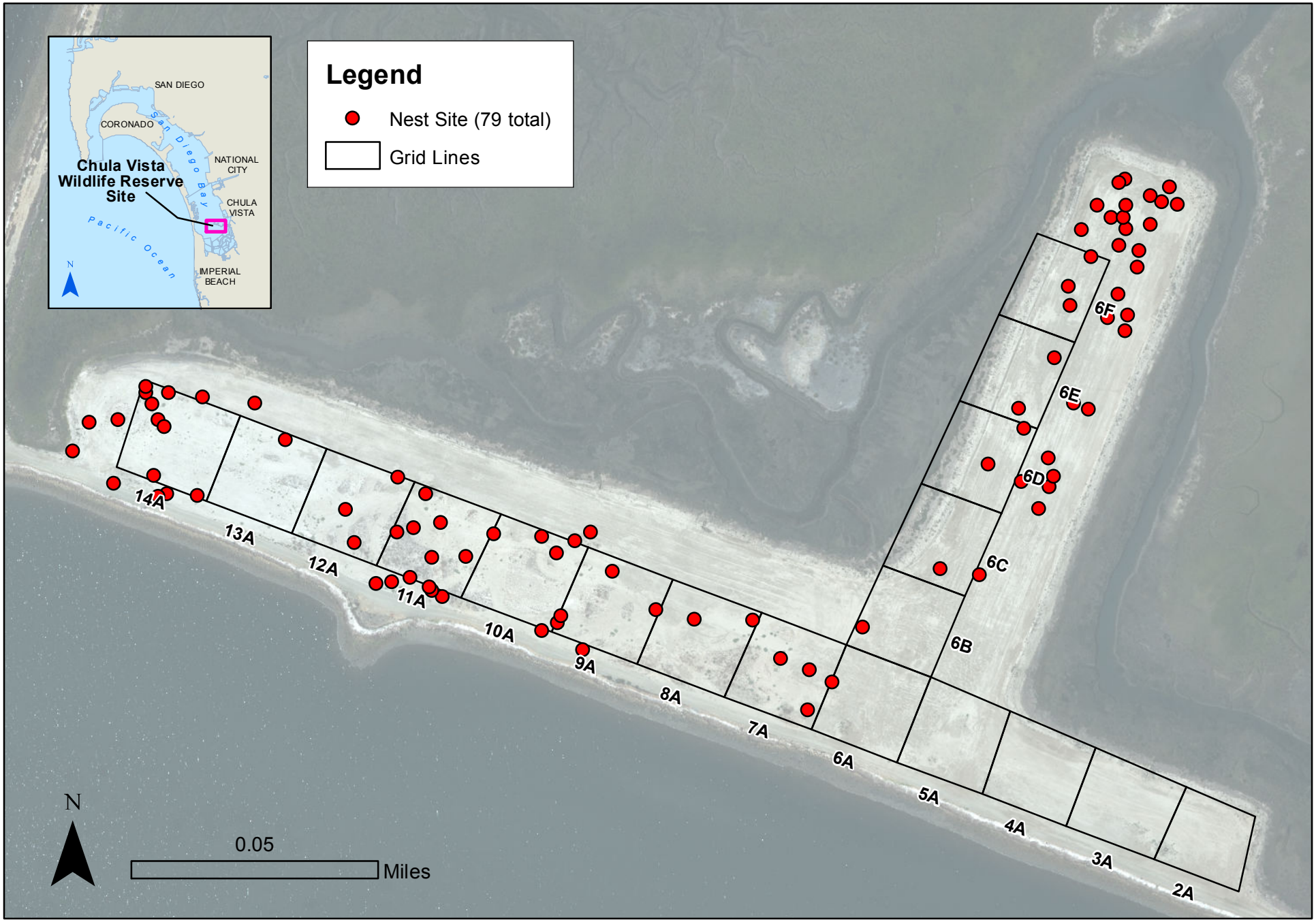
Least Tern Nests: San Diego International Airport 2015



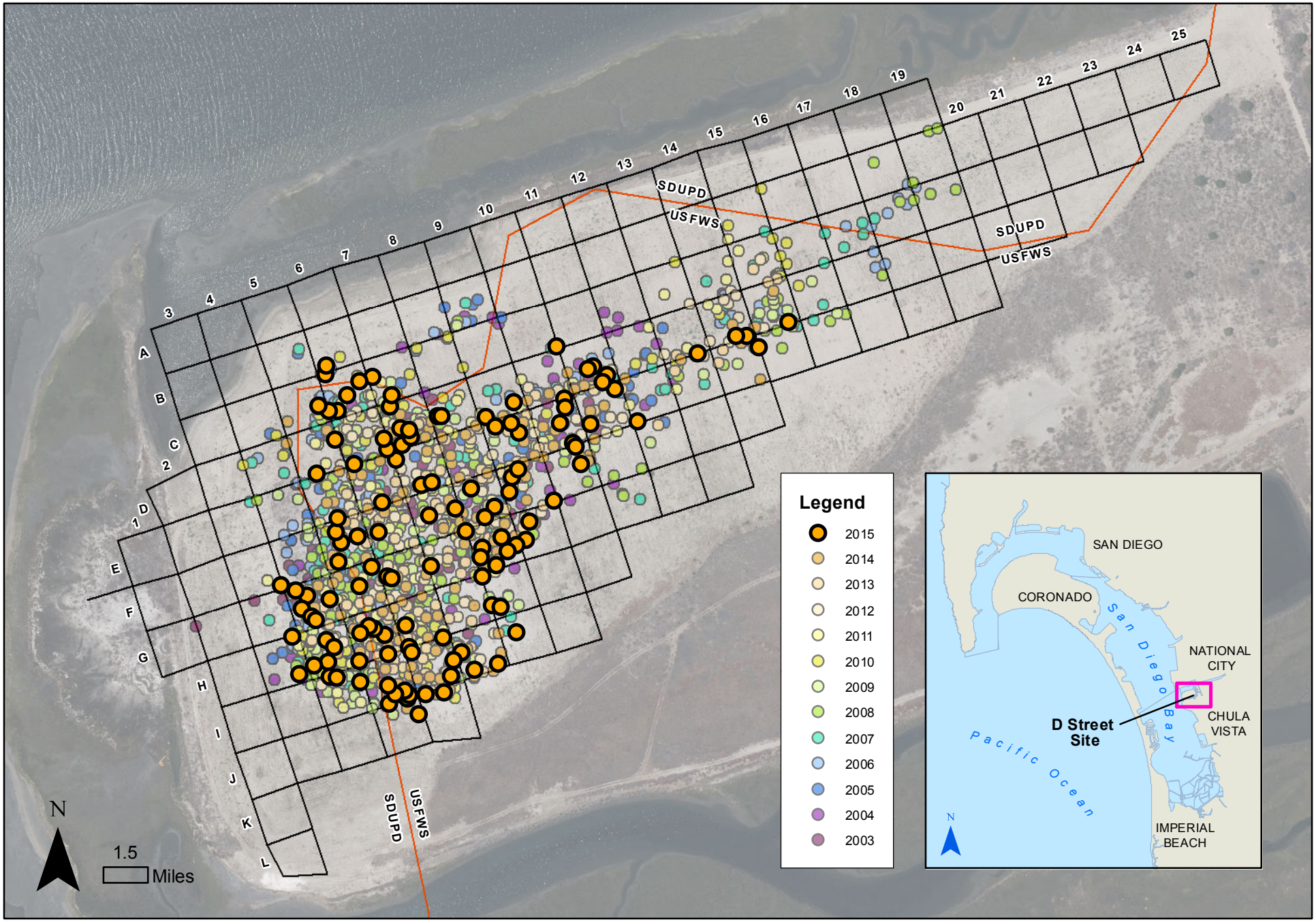
Least Tern Nests: Chula Vista Wildlife Reserve 2003-2015



Least Tern Nests: Chula Vista Wildlife Reserve 2015



Least Tern Nests: D Street 2003-2015



Least Tern Nests: D Street 2015

Appendix D. Distribution of nests of California least tern ar
western snowy plover at D Street Fill, 1997-2015.

	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

Appendix E-1. Numbers of western snowy plovers and band combinations observed at D Street Fill, 2015.
Color code: S=service, X=no band.

Date	Number of Plovers	Bands
1/21	0	(high tide)
1/21	31-39	(ebbing tide)
2/7	0	(high tide)
2/19	0	(high tide)
3/14	15	S-X
3/16	5	
3/17	5	
3/30	0	(high tide)
4/7	2	
4/17	3	
4/18	2	
4/27	1	
4/28	1	
5/5	0	
5/12	0	
5/19	0	
5/26	0	
6/2	0	
6/9	0	
6/16	0	
6/23	0	
6/30	0	
7/7	0	
7/14	0	
7/21	0	
7/28	0	
8/4	0	
8/13	0	
8/20	0	
9/1	0	
9/10	2	S-X
9/24	5	
9/28	9	
10/7	1	

Appendix E-2. Western snowy plover band combinations observed at D Street Fill, 2015.
Color code: S=service, X=no band.

Date(s)	Bands	Origin
3/14, 9/10	S-X	San Diego County