THE STATUS OF THE CALIFORNIA LEAST TERN

AT SAN DIEGO UNIFIED PORT DISTRICT PROPERTIES

IN 2012

Prepared under Contract

For

San Diego Unified Port District

Photo by Matt Sadowski

By

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SUMMARY

From mid- to late March, San Diego Unified Port District personnel 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, 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. Monitoring was conducted mid-March through mid-August one to three days per week.

Least terns were first observed at the D Street Fill on 12 April 2012. They were observed each visit after that through 6 August. At least 114 nests were initiated by 78 to 93 estimated pairs between 5 May and 10 July. The maximum number of concurrently active nests was 75 with three broods of chicks on 29 May.

At least 65 chicks from 47 nests hatched successfully. It is estimated that only nine young fledged from the site. The outcome of 16 nests with 20 eggs was uncertain, but lack of evidence of hatching or chick presence indicates probable depredation. Harriers were observed preying on four eggs of two nests, their tracks were found with seven depredated eggs from six nests, and they were suspected in the depredation of nine eggs from five nests due to the disposition of remains of the eggs. Harrier tracks were also found associated with the depredation/scavenging of 14 previously abandoned eggs from 11 nests. One egg was found depredated with longitudinal crease outside of the nest and gull-billed tern was suspected responsible. Forty nests with 52 eggs were abandoned pre-term, and four eggs failed to hatch and were abandoned after the other egg in each clutch hatched successfully.

Fifteen chicks and one adult were found with no obvious cause of death. An additional chick was found dead being scavenged by ants, but whether ants contributed to its death could not be determined. Three other chicks appeared to have been depredated by ants. One chick was observed being taken by a northern harrier and prey being carried but not definitively identified was suspected to be two to three other chicks. One chick was observed being taken by gull-billed tern and at least one other was suspected of being taken. The band from another chick at D Street was recovered in a regurgitated pellet at the gull-billed tern nesting colony at South San Diego Bay saltworks. 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 30 to 31 chicks coincided with documented depredation and daily disturbances to the colony by northern harrier, and visits by Cooper's hawk, red-tailed hawk, American kestrel, peregrine falcon, gull-billed tern, barn owl, common raven, and feral cat. Other potential predator species observed in the area included great blue heron, great egret, night-heron, kite, gulls, crow, starling, meadowlark, opossum, rats, ground squirrel, skunk, raccoon, gray fox, coyote, and gopher snake. The majority of chick mortality and nest abandonment occurred through June and early July when mortality was reported at other colony sites and attributed to possible lack of prey fish availability, but also coincided with repeated hunting of the site by the aforementioned predators.

There were no western snowy plovers documented at D Street Fill during the peak of nesting season from mid-April to mid-August, and no nests were established by snowy plovers this season. Up to 86 plovers were observed foraging on adjacent mudflats during ebbing or low tides. Band combinations observed included origins at Naval Amphibious Base, NAS North Island, Fort Ord, and a captive-reared individual from Project Wildlife.

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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 2011 was estimated to be 4826 to 6108 pairs (Marschalek 2012).

This report addresses monitoring and management of the least tern colony site at the "D Street Fill" adjacent to San Diego Bay and the mouth of the Sweetwater River under contract with the San Diego Unified Port District (Port) during the 2012 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 District but recently turned over to 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 & Game (CDFG) 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",

adjacent to 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 San Diego Unified Port District and the U.S. Fish and Wildlife Service 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, predation and predator presence, and human disturbance. Appendix A summarizes annual least tern productivity at D Street Fill. The site was abandoned by nesting terns in 1981 and 1990 (Copper 1981, Obst and Johnston 1992), but the colony re-established with up to 135 nests in1992 (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 then, annual nest numbers have ranged from 100 in 2006 to 148 in 2008, with 116 established in 2011 (Patton 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011).

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. Vegetation is diminished by mechanical grading or dragging prior to each nesting season, ceramic tiles are laid out at grid intersections of 30 meter squares to assist in nest mapping and provide shade and shelter for chicks.

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. From mid- to late March, staff of the San Diego Unified Port District 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 iceplant (Carpobrotus), Baccharis, Astragalus, and mustard (Brassica) species. Vegetation around the periphery of the cleared area was pruned back by contract monitors to limit predator perches and reduce invasive non-native plant species.

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. Plastic and papier-mache decoys were placed in five 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).

Monitoring

The site was monitored one to three times per week by one to four 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-March. 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 into August until the terns departed. Monitoring was discontinued when no least terns had been observed for three consecutive visits. Final monitoring visits were on 21 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. Numbers were assigned by order of discovery.

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.

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) 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).

Abandoned egg, chick and adult carcass specimens were collected, frozen, and delivered per direction from USFWS to San Diego State University for isotope analysis. Management of avian

and mammalian predators was conducted by personnel of the U.S. Department of Agriculture, Wildlife Services under a separate contract. Sick or injured birds were taken to Project Wildlife for veterinary treatment and possible rehabilitation and release.

RESULTS AND DISCUSSION

Least terns were observed from 12 April through 13 September 2012 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, 308 nests were established from 5 May to 10 July (Appendix C). At least 63 to 65 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 12 April through 6 August. Approximately 78 to 93 pairs established 114 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 CDFG 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 CDFG method results in a maximum estimate of 110 breeding pairs this season. However, up to 47 nests and 30 broods were lost prior to 20 June. At least 21 nests could potentially have resulted from renesting by pairs that had lost earlier clutches. Only eight nests were established after 15 June. The maximum number of concurrently active nests was 75 with three broods of chicks on 29 May.

Figure 3 depicts graphically the chronology of nesting events at the D Street Fill in 2012. The numbers of active nests plotted in Figure 3 were those nests being tended by an adult. The majority of nests (85%) were initiated between 5 May and 5 June. Fifteen more nests were then established from 10 to 19 June. The remaining two nests were established 26 June to 10 July. The number of active nests plotted in Figure 3 diverged from the number of total nests in mid- to late May due to predation of two nests and abandonment of two others. Divergence increased in late May and through June with hatching of chicks, additional predation, and nest abandonments. Active nest numbers dropped from late May through June with chicks hatching, reduced nest initiation, and losses to predation and nest abandonment.

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 a cluster in the central western half of the site where substrate appeared softer and relatively richer in shell content, and vegetation was sparser. Other nests were established in areas of less dense vegetation radiating from this primary colony cluster. The densest nesting occurred in the southwest portion of this colony cluster. A secondary colony cluster extended 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).

Eleven nests this season were established farther east in the site than most nests of recent years. Reasons for this expansion in nest distribution likely include vegetation reducing available nesting area elsewhere in the site, predator disturbance in the main colony nest cluster, and proximity to the restored tidal channel habitat along the northeast edge of the site with its recently 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, 10 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 78 to 93 estimated pairs of least terns established 114 nests with 162 eggs at the D Street Fill in 2012. The average clutch size was 1.42 eggs per nest with 48 two-egg clutches and 66 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) and the second lowest recorded at this site over the ten previous years (Appendix C).

Hatching Success

Only 40 percent of the eggs at D Street Fill hatched successfully this season, resulting in an average of 0.57 chicks per nest and 1.38 chicks per nest that experienced hatching (Table 1). Nest abandonment and predation were the primary known limiting factors to hatching success, with 35 percent of nests abandoned pre-term and 12 percent documented depredated. Four additional eggs were abandoned after the other egg in each clutch hatched, and one was abandoned after the other egg was depredated. The outcome of 16 additional nests was unknown but predation likely, either of eggs or of recently hatched chicks. Undetermined nest outcomes coincided with documented predation of other nests. Nest abandonments were likely influenced by predator presence and/or depredation of one or both adults.

Chick Banding

In 2012, 41 chicks from at least 30 nests were banded at D Street Fill. Chicks were banded on the right leg with USFWS metal bands individually numbered 2411-17399 through -17400, 2411-18501 through -18537, 1841-96689 and -96694.

Fledging Success and Seasonal Production

Only nine young are estimated to have fledged from the colony this season. Productivity was thus 0.08 fledglings per nest, 0.10 to 0.11 per pair. 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 59 percent of the chicks from 29 May to 8 June, and 73 percent of chicks hatching within a two week period in late May to early June.

Predation and mortality limited the number of chicks reaching fledging age. Significant losses of the majority of the early hatchlings were indicated by lack of observations and recaptures of chicks and by observations of predation and recovery of carcasses. This is reflected in Figure 4 by the lack of large numbers of fledglings in late June and early July. It is striking that on 29 June there should have been up to 37 fledglings rather than the three that were observed. The variation in fledgling numbers on 6 July reflects increasing fledgling mobility and ability to follow adults to foraging areas, as well as disturbance to the colony by the presence of a northern harrier (Circus cyaneus). Fledgling numbers dropped in mid-July as the young gained flight experience and dispersed from the colony with the adults.

Chick recovery for band recapture and growth measurement data was difficult this season due to extensive vegetative cover. It was at times also complicated, and monitoring protocol adjusted, to accommodate weather fluctuations and predator presence. However the consistency of twice-weekly counts of numbers of chicks observed, the corresponding lack of chick observations, recaptures, and fledgling observations with predator presence, observed depredation, and recovery of carcasses supports the accuracy of this season's fledgling estimate. Only nine chicks were estimated to have survived to fledgling age but all appeared to survive to fledge from the site.

Mortality

Forty nests (35 percent) with 52 eggs were abandoned after one to 30 days of incubation

(Table 2). Eggs of four two-egg clutches failed to hatch and were abandoned after the other in each clutch hatched, and one was abandoned after the other was depredated. Fifteen chicks and one adult were found dead of undetermined causes, although some were found skeletonized so that it was possible that predator-inflicted wounds no longer visible may have caused death. An additional chick was found dead being scavenged by ants, but whether ants contributed to its death could not be determined.

The majority of chick mortality and nest abandonment occurred through June and early July when depredation and daily disturbances to the colony were documented by multiple predators. Some nest abandonment and chick mortality were possibly related to depredation of one or both adults. However, this relatively high number of chick and fledgling deaths also coincided with significant mortality at other colonies (B. Foster, K. Keane, J. Jackson, and V. Johnson, pers. comm.). Mortality at these other colonies was attributed to localized decreases in prey fish availability during this critical period of the season, possibly relating to shifting currents or sea surface temperatures. Without regular sampling of the appropriate size fish, such conclusions as to fluctuations in prey availability are only speculative.

Predation

Twenty-one eggs were found depredated this season (Tables 1 and 2). The outcome of 16 nests with 20 eggs was uncertain, but lack of evidence of hatching or chick presence indicates probable depredation. Northern harriers were observed preying on four eggs of two nests, their tracks were found with seven depredated eggs from six nests, and they were suspected in the depredation of nine eggs from five nests due to the disposition of remains of the eggs. Harrier tracks were also found associated with the depredation/scavenging of 14 previously abandoned eggs from 11 nests. One egg was found depredated with longitudinal crease outside of the nest and gull-billed tern (Gelochelidon nilotica) was suspected responsible.

The carcasses of three chicks appeared to have been depredated by ants. An additional chick was found dead being scavenged by ants, but whether ants contributed to its death could not be determined. One chick was observed being taken by a northern harrier and prey being carried but not definitively identified was suspected to be two to three other chicks. One chick was observed being taken by gull-billed tern and at least one other was suspected of being taken. The band from

another chick at D Street was recovered in a regurgitated pellet at the gull-billed tern nesting colony at South San Diego Bay saltworks.

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 30 to 31 chicks coincided with documented depredation and daily disturbances to the colony by northern harrier, and visits by Cooper's hawk (Accipiter cooperii), red-tailed hawk (Buteo jamaicensis), American kestrel (Falco sparverius), peregrine falcon (Falco peregrinus), gull-billed tern, barn owl (Tyto alba), common raven (Corvus corax), and feral cat (Felis catus). 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), white-tailed kite (Elanus leucurus), western gull (Larus occidentalis), other 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), striped skunk (Mephitis mephitis), gray fox (Urocyon cinereoargenteus), and coyote (Canis latrans).

Appendix F summarizes telemetry research this season that demonstrates the small percentage of times that a predator is detected versus the number of times it actually visits a site, as well as the limited number of predation events detected versus the actual number.

Snowy Plovers and Other Species

Up to 86 snowy plovers were observed foraging pre-season this year on mudflats west of the nesting site (Appendix E-1). None were observed during the peak of nesting season from late April to mid-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. However, the excavation of the northwest edge of the site to an unvegetated gentler slope adjacent to mudflats prior to last season increased the potential for plover numbers to increase and nesting to be re-established.

Observations of uniquely banded 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 with 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 majority of those roosting along Silver Strand. Band combinations observed included origins at Naval Amphibious Base, NAS North Island, Fort Ord, and a captive-reared individual from Project Wildlife (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). Killdeer (Charadrius vociferus) established at least three nests within the interior. Horned larks (Eremophila alpestris) appeared to nest throughout the site, and at least 16 nests were found within the tern colony. Presence and behavior of western meadowlarks, Belding's savannah sparrows (Passerculus sandwichensis beldingi) and their fledglings indicated nesting adjacent to the prepared colony site. Although breeding was not confirmed, a federally endangered light-footed clapper rail (Rallus longirostris levipes) was heard calling in the northeast restoration marsh. 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).

MANAGEMENT RECOMMENDATIONS

Site preparation, monitoring, and predator management efforts should continue as incorporated 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 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. Appropriate staff, equipment, and budget need to be secured prior to each season to ensure adequate site preparation. Plans need to 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.

Discussion of plans to continue mechanical scraping in the off-season to reduce vegetation should be pursued. The possibility of herbicide application should be considered, particularly in the southwestern site where Distichlis 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 be removed to reduce encroachment of these species on the site as well as to reduce potential predator perches. Iceplant, mustard, sea-rocket (Cakile maritima), cocklebur (Xanthium spinosum), pampas grass (Cortaderia sp.), garland chrysanthemum (Chrysanthemum coronarium), sweet fennel (Foeniculum vulgare), Russian thistle (Salsola iberica), Brazilian pepper tree (Schinus terebinthifolius), tamarisk (Tamarix sp.) and Acacia sp. are non-native invasive species that are present on-site and potentially spreading. Coordination is needed in removal of any piles of vegetation or soil generated by such projects. Previous seasons, piles of manually removed iceplant have 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.

The access points between upland nesting habitat and tidal flat foraging habitat for snowy plovers should 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 should be cleared through the saltmarsh to make the site again suitable for use by snowy plovers.

The signs installed in past seasons may have reduced human intrusion into nesting areas. Many signs have weathered significantly or been removed so that new and additional signs are now

needed. 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 Wildlife Services 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 Wildlife Services 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.

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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LITERATURE CITED

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.

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.

_____. 2012. California least tern breeding survey, 2011 season. CA Dep. Fish & Game, Wildl. Branch, Nongame Wildl. Program Rep., 2012-1. Sacramento, CA. 25 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.

_____. 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, 2012.

	nests*	eggs
Total	114	162
1 egg clutch	66	66
2 eggs	48	96
Known Hatch		
Total	47*	65
1 egg	24	24
2 eggs	23*	41
Uncertain Outcome		
Total	16*	20
1 egg	10	10
2 eggs	6*	10
Failed to Hatch		
Total	57*	77
1 egg	32	32
2 eggs	25*	45
Depredated		
Total	14*	21
1 egg	6	6
2 eggs	8*	15
Abandoned (pre-term)		
Total	40*	52
1 egg	26	26
2 eggs	14*	26
Abandoned post-term/nonviable		
Total	4*	4
1 egg	0	0
2 eggs	4*	4

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

Table 2. Documented causes of least tern mortality, D Street Fill, 2012.

Cause	Least Tern Age Class	Total Losses D Street Fill
Total:		
	egg	77*
	chick	22*
	fledgling	0
	adult	1
Predation*:		
Ant species		
	chick	3
Northern Harrier		
	egg	11
	egg (suspected)	9
	chick	1
	chick (suspected)	2-3
Gull-billed Tern		
	egg (suspected)	1
	chick	2
	chick (suspected)	1
Non-predation Mortality:		
Abandonment (pre-term)		
	egg	52
Unknown		
Abandoned post-term/nonviable		
	egg	4
No visible trauma		
	chick	16*
	adult	1

*daily-observed chick numbers and recapture data indicate additional losses of up to 30-31 chicks, species suspected as responsible for losses include northern harrier and gull-billed tern, with possible losses also to ant species, gopher snake, red-tailed hawk, Cooper's hawk, peregrine falcon, American kestrel, barn owl, and feral cat.

Gull-billed tern was observed taking a chick and the band of another was recovered in a regurgitated pellet; suspected in predation of an egg found with longitudinal crease and of a chick missing with freshly hatched shell present in nest.

Northern harrier was observed preying on a chick and carrying prey 2-3 times suspected to be chicks; observed preying on 4 eggs at 2 nests and tracks found at 6 nests with 7 depredated eggs, in addition to 11 previously abandoned nests with 14 eggs; 5 other nests with 9 depredated eggs but no clear tracks but corresponding time period.

3 chicks were found apparently depredated by ants, another appeared to have died previously and was being scavenged by ants.

FIGURES

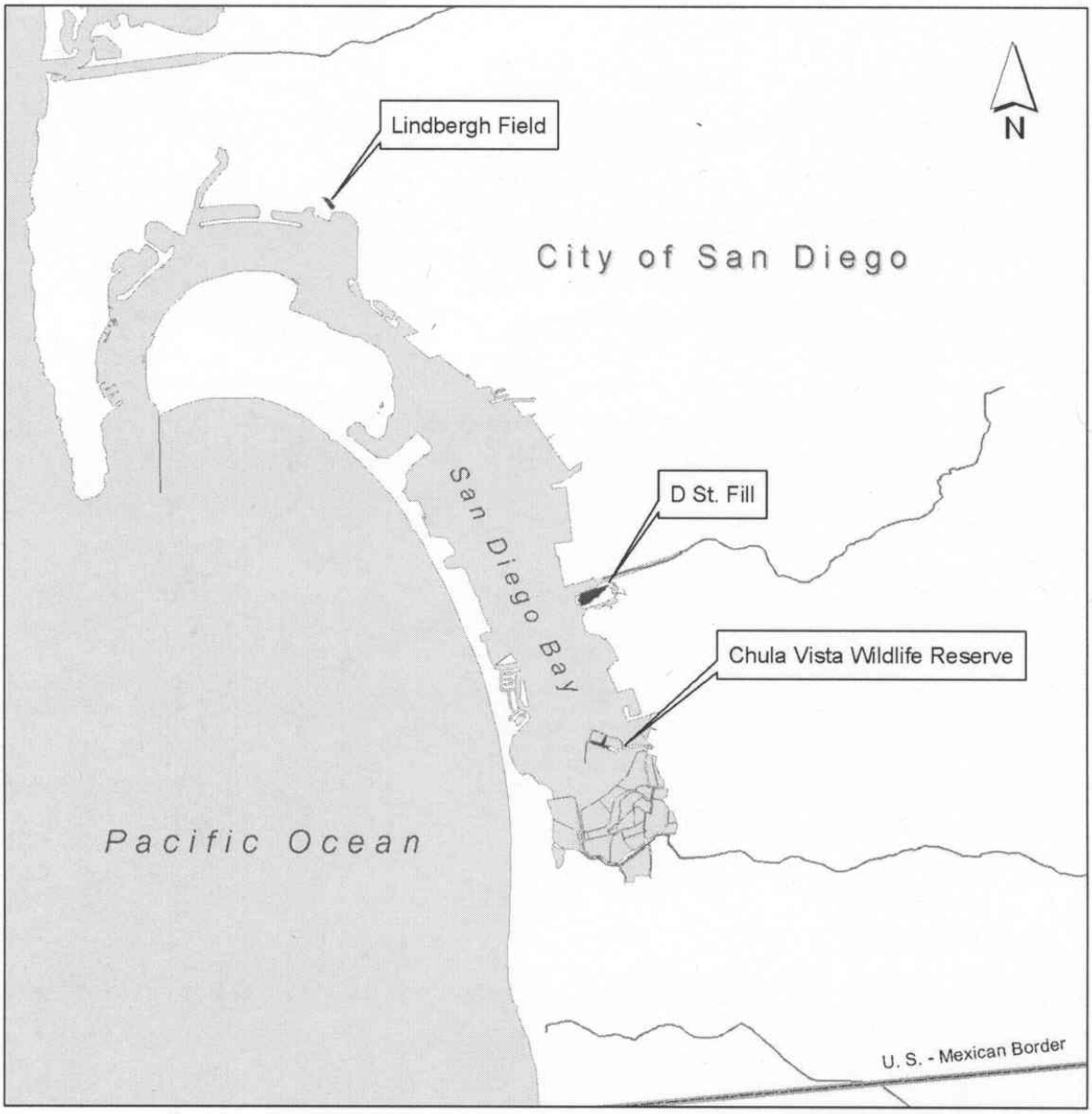


Figure 1. San Diego Unified Port District and San Diego County Regional Airport Authority least tern nesting sites, 2012.

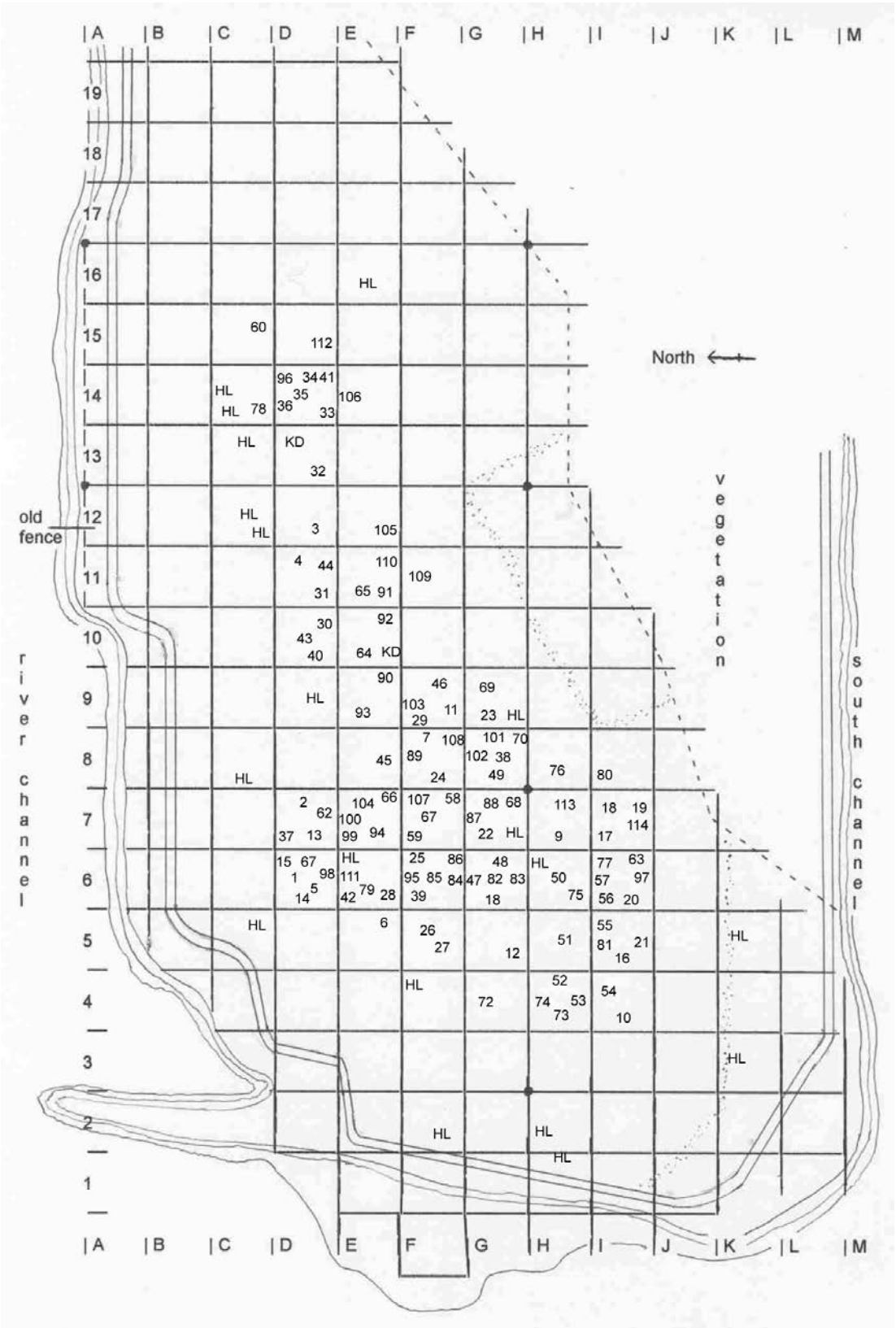


Figure 2. Least tern nest distribution, D Street Fill, 2012.

Figure 3. Least tern breeding chronology, D Street Fill, 2012.

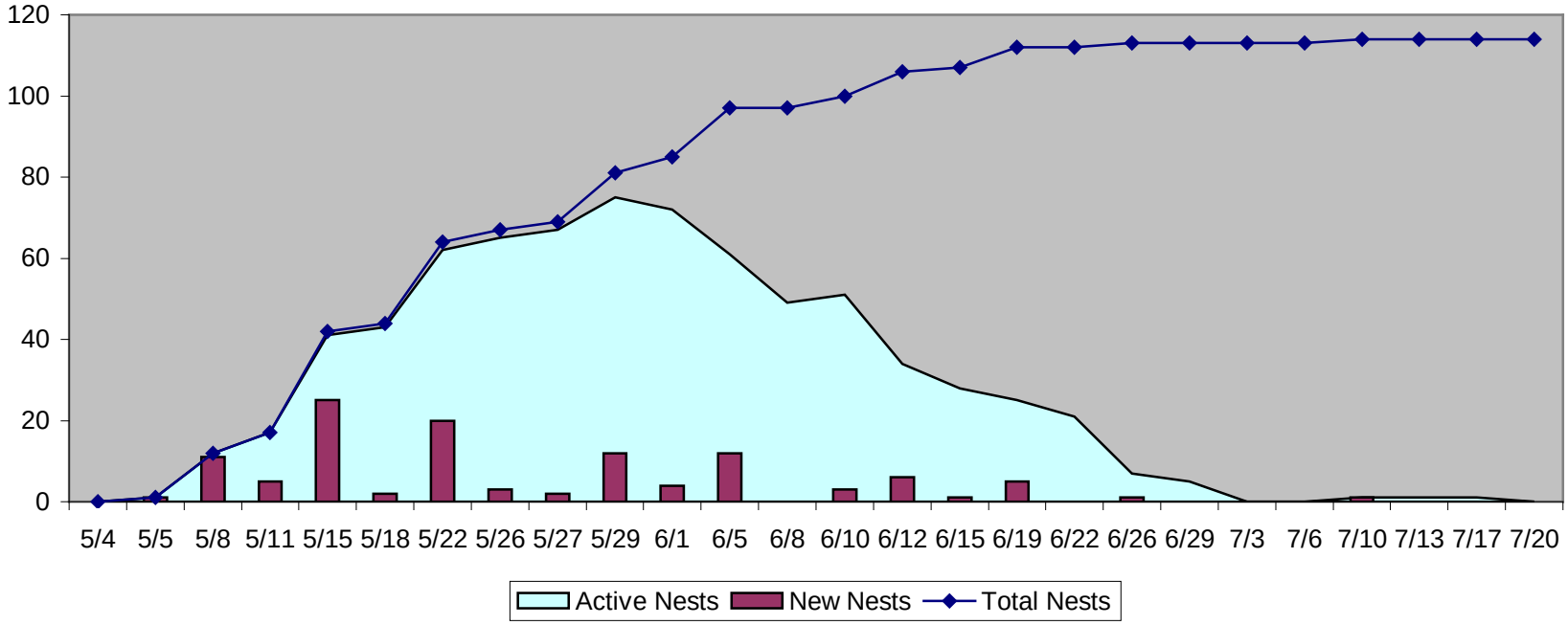
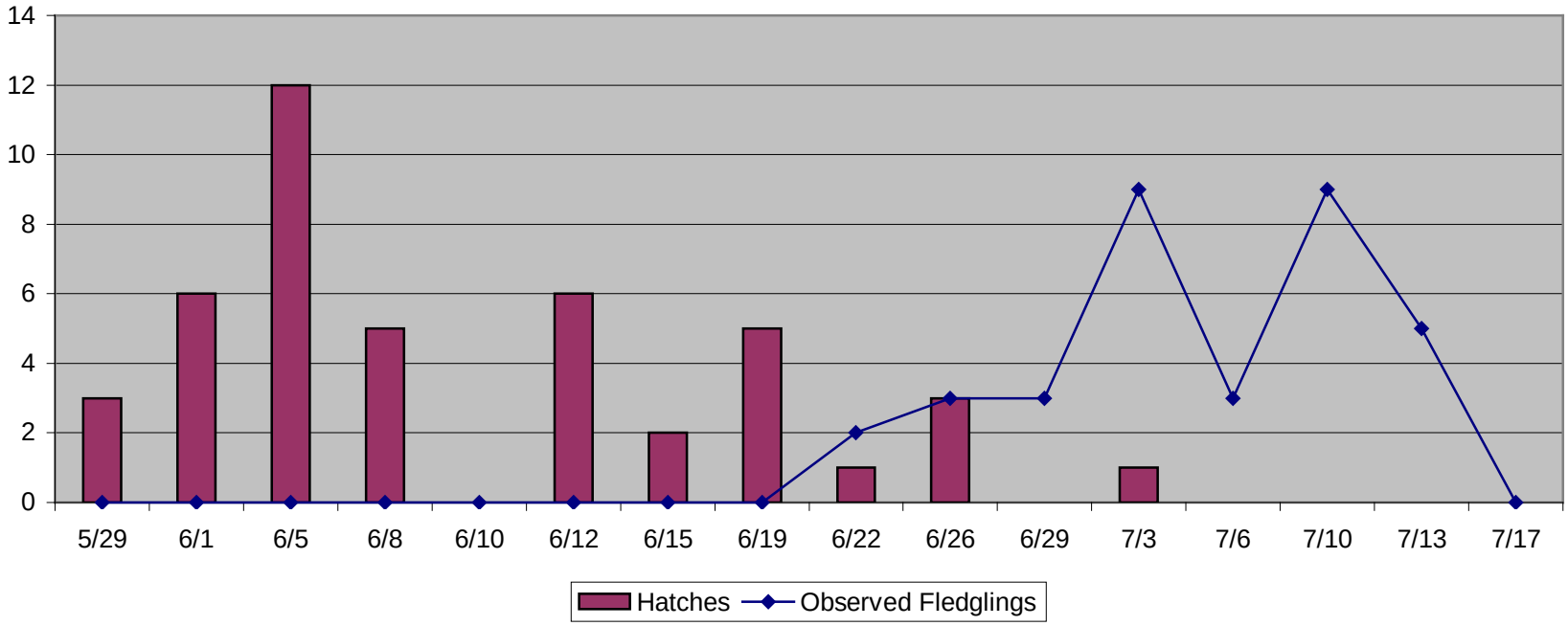


Figure 4. Least tern productivity chronology, D Street Fill, 2012.



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

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 2012.

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 mid-March through mid-September, 2012, by Robert Patton, Matt Sadowski, Jennifer Jackson, Lea Squires, Brian Foster, and Elizabeth Copper. 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 12 April through 13 September 2012 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, 308 nests were established from 5 May to 10 July. At least 63 to 65 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. Preliminary data statewide indicates a possible decline in breeding pairs of 20 to 34 percent over the past four years.

Snowy plovers were observed foraging adjacent to the D Street Fill from January through early April. A maximum number of 86 plovers were recorded foraging on the tidal flats, but there were no sightings near potential nesting habitat. Snowy plovers were recorded only once at CVWR this season with a group of three roosting in early July.

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 two ovals used in recent years by terns for nesting, and assisted in repairs to chick barriers. Monitoring was conducted April through mid-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 and in flight over the southeast end of Lindbergh Field on 16 April 2012. They were observed each visit after that through 7 August. At least 130 nests were initiated by 96 to 124 estimated pairs between 8 May and 3 July. The maximum number of concurrently active nests was 74 with 22 broods of chicks on 5 June. At least 103 nests were established in the main nesting oval 03-S east of the Ryan taxiway (2 BS), 20 nests in oval 03-S west of the Ryan taxiway (3BS), four nests in oval 04-S (3S), two nests in oval 02-S (1BS), and one nest between the perimeter road and taxiway bravo to the west of oval 03-S.

At least 135 chicks from 84 nests hatched successfully. It is estimated that 36 young fledged from the site. Three nests of four eggs were found depredated with raven tracks and two other nests were found depredated and raven suspected. The outcome of nine nest and eggs were uncertain, but lack of evidence of hatching or chick presence indicates probable depredation. Thirty-five nests with 42 eggs were abandoned pre-term, and one single-egg clutch failed to hatch and was abandoned after prolonged incubation of 37 days. One egg failed to hatch and was abandoned after the other egg in its clutch hatched successfully. The abandonment of seven to 20 of these nests coincided with the malfunctioning of the Fourth of July fireworks presentation and subsequent single large explosion over the adjacent bay.

On 7 July, a city-maintained water main ruptured under the Ryan taxiway and resulted in flooding approximately 90 percent of the 03-S nesting ovals. No nests were attributed as lost to the flooding since the last had appeared to have been abandoned by 5 July, however, carcasses of three chicks were recovered along the flotsam line. Band recovery data indicated that eight additional chicks had been lost to the flooding by being washed down stormdrains or through the airfield fence and across the highway to the bay. As a result of the flooding, one fledgling relocated to a taxiway and was crushed by an aircraft. On other dates and unrelated to the flooding, two other fledglings on taxiway and perimeter road adjacent to the nesting site were also hit by vehicles or aircraft.

One adult and 44 chicks were found with no obvious cause of death. Another adult was observed being taken from the site by a peregrine falcon. One chick was observed taken by an American kestrel, and two others suspected based on injuries to their carcasses and their location beneath the perch where the first was seen to be taken. Nest abandonment and chick mortality coincided with regular disturbance and documented predation by kestrel, peregrine, and

raven as well as sightings of Cooper's hawk and crows. Although no other definitive evidence of chick depredation was found, the lack of observations, recaptures, fledglings, and attentive adults indicates that up to 39 more chicks were likely preyed on. Other potential predators observed in the area included rats, great blue heron, black-crowned night-heron, and gulls.

D Street Fill & Sweetwater Marsh NWR

From mid- to late March, San Diego Unified Port District personnel 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, 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. Monitoring was conducted mid-March through mid-August one to three days per week.

Least terns were first observed at the D Street Fill on 12 April 2012. They were observed each visit after that through 6 August. At least 114 nests were initiated by 78 to 93 estimated pairs between 5 May and 10 July. The maximum number of concurrently active nests was 75 with three broods of chicks on 29 May.

At least 65 chicks from 47 nests hatched successfully. It is estimated that only nine young fledged from the site. The outcome of 16 nests with 20 eggs was uncertain, but lack of evidence of hatching or chick presence indicates probable depredation. Harriers were observed preying on four eggs of two nests, their tracks were found with seven depredated eggs from six nests, and they were suspected in the depredation of nine eggs from five nests due to the disposition of remains of the eggs. Harrier tracks were also found associated with the depredation/scavenging of 14 previously abandoned eggs from 11 nests. One egg was found depredated with longitudinal crease outside of the nest and gull-billed tern was suspected responsible. Forty nests with 52 eggs were abandoned pre-term, and four eggs failed to hatch and were abandoned after the other egg in each clutch hatched successfully.

Fifteen chicks and one adult were found with no obvious cause of death. An additional chick was found dead being scavenged by ants, but whether ants contributed to its death could not be determined. Three other chicks appeared to have been depredated by ants. One chick was observed being taken by a northern harrier and prey being carried but not definitively identified was suspected to be two to three other chicks. One chick was observed being taken by gull-billed tern and at least one other was suspected of being taken. The band from another chick at D Street was recovered in a regurgitated pellet at the gull-billed tern nesting colony at South San Diego Bay saltworks. 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 30 to 31 chicks coincided with documented depredation and daily disturbances to the colony by northern harrier, and visits by Cooper's hawk, red-tailed hawk, American kestrel, peregrine falcon, gull-billed tern, barn owl, common raven, and feral cat. Other potential predator species observed in the area included great blue heron, great egret, night-heron, kite, gulls, crow, starling, meadowlark, opossum, rats, ground squirrel, skunk, raccoon, gray fox, coyote, and gopher snake. The majority of chick mortality and nest abandonment occurred through June and early July when mortality was reported at other colony sites and attributed to possible lack of prey fish availability, but also coincided with repeated hunting of the site by the aforementioned predators.

There were no western snowy plovers documented at D Street Fill during the peak of nesting season from mid-April to mid-August, and no nests were established by snowy plovers this season. Up to 86 plovers were observed foraging on adjacent mudflats during ebbing or low tides. Band combinations observed included origins at Naval Amphibious Base, NAS North Island, Fort Ord, and a captive-reared individual from Project Wildlife.

Chula Vista Wildlife Reserve

Prior to early April 2012 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 mid-February through mid-September 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 12 April 2012, and on each visit through 9 September. A migrant group of two adults and two fledglings was observed foraging on 13 September. At least 64 nests

were initiated by 29 to 37 estimated pairs between 12 May and 10 July with distribution throughout but most in the southwestern portion of the site. This included one nest far to the east of the site, located in the road just west of the gate. The maximum number of concurrently active nests was 27 with two broods of chicks on 10 July.

At least 55 chicks from 36 nests hatched successfully. It is estimated that 18 to 20 young fledged from the site this season. The outcome of nine nests with 11 eggs was uncertain, but lack of evidence of hatching or chick presence indicates probable depredation. Nine eggs from six nests were documented to have been depredated, including one with longitudinal crease indicating having been hit by a gull-billed tern, two with harrier tracks, and others suspected of harrier predation. In addition, one previously abandoned egg was found depredated with harrier tracks. One depredated eggshell appeared to have been nibbled on by rodents, but it was unclear if that was a result of scavenging or from the initial predation. Fourteen nests were abandoned pre-term, one was abandoned after the other egg in its clutch was depredated, and two other nests were abandoned after one of two eggs in each clutch disappeared and were suspected of being depredated. One egg failed to hatch and was abandoned after the other egg in its clutch hatched successfully.

Three chicks were found dead of undetermined causes. Peregrine falcons were observed taking one adult and one fledgling, and feather piles led to suspicion of their responsibility in the depredation of one to two other adults and at least one fledgling. The two observed predation incidents occurred within four days of the return to CVWR by a previously trapped immature peregrine. It had been trapped at CVWR, released five days later in Alpine, and returned to CVWR within four hours. A harrier was removed while taking one chick and the remains of a second chick were found in necropsy. A gull-billed tern was observed picking up and dropping a hatching egg, although the chick appeared healthy at least the following day. A gull-billed tern was observed carrying prey that was possibly a tern chick but could not be definitively identified. The bands from three chicks at CVWR were recovered in pellets at gull-billed tern nests at South San Diego Bay saltworks. This represents seven percent of bands used this season. 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 25 to 27 chicks coincided with repeated hunting of the site by gull-billed terns, at least three peregrine falcons and five harriers, an American kestrel and red-tailed hawk, and up to six barn owls. Other potential predator species observed in the area included great blue heron, great egret, gulls, Caspian tern, osprey, striped skunk, feral cat, and rats. To the east of the site were opossum, ground squirrel, gray fox, coyote, American crow, and common raven.

Snowy plovers were recorded only once at CVWR this season with a group of three roosting on 6 July. Gull-billed terns were observed among the Forster's tern colony on the southwest jetty, but no gull-billed tern nests were found this season. Forster's terns established at least 110 to 114 nests, the majority of which were on the southwest jetty, with smaller sub-colonies on the northwest, central, and northeast dikes.

Appendix C. Summary of California least tern breeding at San Diego Unified Port District and San Diego County Regional Airport Authority sites, 2012.

	SDIA-LF	D St Fill	CVWR
Date terns first observed	4/16	4/12	4/12
Date terns last seen	8/7	8/6	9/13
Date of first nest	5/8	5/5	5/12
Date last nest found	7/3	7/10	7/10
Date last nest established	7/3	7/10	7/10
Date of first hatch	5/31	5/26	6/2
Date of last hatch	7/6	7/3	7/31
Date of first fledgling	6/21	6/22	6/29
Estimated number of pairs	96-124	78-93	29-37
Total number of nests	130	114	64
Total number of eggs	197	162	98
Clutch size:			
1 egg	63	66	30
2 egg	67	48	34
3 egg	0	0	0
Average clutch size	1.54	1.42	1.53
No. of nests hatching young*	84	47	36
Total number of eggs hatched	136	65	55
Estimated number of fledglings	36	9	18-20
Number of chicks banded	110	41	43
Number of adults banded	0	7	2
Uncertain outcome			
Nests*	9	16	9
Eggs	9	20	11
Documented Mortality			
Preyed upon			
Nests*	5	14	6
Eggs**	6	21	9
Chicks	3	6	5
Fledglings	0	0	2
Adults	1	0	2-3
Human disturbance			
Nests*	0	0	0
Eggs	0	0	0
Chicks	3	0	0
Fledglings	3	0	0
Adults	0	0	0
Other causes			
Nests*			
Abandoned (pre-term)	35	40	17
Failed to hatch (incubated to term)	2	4	1
Died hatching	1	0	0
Damaged	1	0	0
Flooded	0	0	0
Eggs			
Abandoned (pre-term)	42	52	22
Failed to hatch (incubated to term)	2	4	1
Died hatching	1	0	0
Damaged	1	0	0
Flooded	0	0	0
Chicks	44	16	3
Fledglings	0	0	0
Adults	1	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, 2003-2012.

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Date terns first observed	4/16	4/20	4/21	4/19	4/23	4/22	4/21	4/20	4/19	4/16
Date terns last seen	8/1 (8/12 bay)	8/18	8/3 (9/2 bay)	8/30	8/22	8/15	8/11	8/10	8/3	8/7
Date of first nest	5/8	5/11	5/4	5/15	5/15	5/16	5/10	5/4	5/10	5/8
Date last nest found	6/28	7/6	7/5	8/1	7/11	7/18	8/11	7/20	7/19	7/3
Date last nest established	6/28	7/6	7/5	7/18	7/11	7/18	7/2	7/2	6/24	7/3
Date of first hatch	5/29	6/1	5/31	6/13	6/10	6/6	6/2	6/2	5/31	5/31
Date of last hatch	7/9	7/1	7/19	8/1	7/18	7/21	7/7	7/15	7/5	7/6
Date of first fledgling	6/17	6/28	6/20	7/8	7/2	6/30	6/22	6/22	6/21	6/21
Estimated number of breeding pairs	45-50	65-70	121-150	114	120-127	122-124	136	110	66-76	96-124
Total number of nests	53	76	157	131	135	139	145	116	78	130
Total number of eggs	96	126	278	207	238	238	268	211	141	197
Clutch Size										
1 egg	10	27	39	55	33	43	26	23	15	63
2 egg	43	48	115	76	101	94	116	91	126	67
3 egg	0	1	3	0	1	1	2	2	0	0
4 egg	0	0	0	0	0	1	1	0	0	0
Average clutch size	1.83	1.66	1.77	1.53	1.76	1.71	1.85	1.82	1.81	1.54
No. of nests hatching young*	43	42	128	81	93	112	103	88	66	84
Total number of eggs hatched	80	78	221	124	156	193	183	161	118	136
Estimated number of fledglings	35-46	10-17	45-85	54-65	34-42	115-128	36-38	29-38	11-15	36
Number of chicks banded	71-72	62	183	120	116	167	138	144	93	110
Number of adults banded	0	0	0	0	0	12	3	12	7	0
Uncertain outcome										
Nests*	1	14	2	4	3	3	9	3	1	9
Eggs	1	19	4	7	5	3	16	4	2	9
Documented Mortality										
Preyed upon:										
Eggs**	0	5	3	56	24	14	11	11	0	6
Chicks	2	8	15	8	15	2	0	5	23	3
Fledglings	0	0	11	13-14	3-4	1	3	3	7	0
Adults	1	0	1	4-8	1-2	2	2	3	1	1
Other than preyed upon:										
Eggs										
Human Damaged	0	0	0	0	0	0	0	0	0	0
Failed to hatch (incubated to term)	3	1	15	8	13	20	12	10	9	2
Died hatching	0	0	0	0	1	0	0	1	0	1
Abandoned (pre-term)	9	23	16	12	40	9	46	23	12	42
Flooded	0	0	0	0	0	0	0	0	0	0
Chicks	7	15	21	1	12	19	46	36	10	47
Fledglings	6	0	10	1	3	5	2	6	0	3
Adults	3	0	1	0	1	0	0	2	1	1
Nests										
Human damaged*	0	0	0	0	0	0	0	0	0	0
Preyed upon*	0	5	2	37	18	11	7	8	0	5
Failed to hatch*	3	1	15	8	13	16	11	9	8	2
Abandoned (pre-term)*	7	16	16	10	26	8	31	18	9	35
Flooded	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-2. Summary of California least tern breeding at D Street Fill, 2003-2012.

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Date terns first observed	4/19	4/19	4/19	4/18	4/22	4/22	4/21	4/16	4/19	4/12
Date terns last seen	8/14	8/26	8/1	8/14	8/20	8/13	7/28	7/30	8/15	8/6
Date of first nest	5/8	5/18	5/10	5/16	5/15	5/10	5/8	5/4	5/6	5/5
Date last nest found	7/8	7/20	7/8	7/11	8/20	7/18	8/11	6/29	7/2	7/10
Date last nest established	7/8	7/20	7/8	7/11	7/17	7/16	6/27	6/29	7/2	7/10
Date of first hatch	6/3	6/8	6/4	6/9	6/8	6/3	5/29	5/25	5/27	5/26
Date of last hatch	7/8	7/13	6/28	7/25	7/24	7/22	7/14	7/2	7/8	7/3
Date of first fledgling	6/24	7/6	6/28	7/4	6/30	6/24	6/19	6/15	6/21	6/22
Estimated number of breeding pairs	62-85	77-94	77-97	88-94	100-115	133-135	129	117	100-113	78-93
Total number of nests	91	111	101	100	130	148	132	119	116	114
Total number of eggs	148	163	161	140	214	262	229	227	217	162
Clutch Size										
1 egg	34	59	42	60	47	34	35	11	15	66
2 egg	57	52	58	40	82	114	97	108	101	48
3 egg	0	0	1	0	1	0	0	0	0	0
Average clutch size	1.63	1.47	1.59	1.40	1.65	1.77	1.73	1.91	1.87	1.42
No. of nests hatching young*	58	71	79	74	91	124	110	83	97	47
Total number of eggs hatched	100	105	122	98	160	223	189	158	174	65
Estimated number of fledglings	12-19	4-17	9-17	18-29	25-28	17-24	19-29	15-27	25-32	9
Number of chicks banded	69	52	79	52	83	129	122	86	112	41
Number of adults banded	0	0	0	0	0	5	0	4	2	7
Uncertain outcome										
Nests*	3	19	3	5	5	6	11	27	2	16
Eggs	6	23	5	7	9	8	16	51	4	20
Documented Mortality										
Preyed upon:										
Eggs**	5	5	11	14	14	2	0	5	14	21
Chicks	1	7	8	2	9-12	11	8-11	14	4-7	6
Fledglings	2	0	1	1	4	0	1	1	1	0
Adults	5-6	0	1	1	2	0	5	1	3-4	0
Other than preyed upon:										
Eggs										
Human Damaged	0	0	0	0	0	0	0	0	0	0
Failed to hatch (incubated to term)	3	4	7	6	3	9	8	5	6	4
Died hatching	2	0	0	0	0	0	2	0	3	0
Abandoned (pre-term)	32	26	16	16	28	20	14	8	16	52
Flooded	0	0	0	0	0	0	0	0	0	0
Chicks	16	10	17	8	7	12	12	28	40	16
Fledglings	4	0	1	0	5	0	0	11	9	0
Adults	1	0	1	0	0	0	0	0	0	1
Nests										
Human damaged*	0	0	0	0	0	0	0	0	0	0
Preyed upon*	3	5	7	10	11	2	0	3	9	14
Failed to hatch*	3	4	7	6	3	6	8	4	6	4
Abandoned (pre-term)*	26	22	12	13	24	16	11	5	11	40
Flooded	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

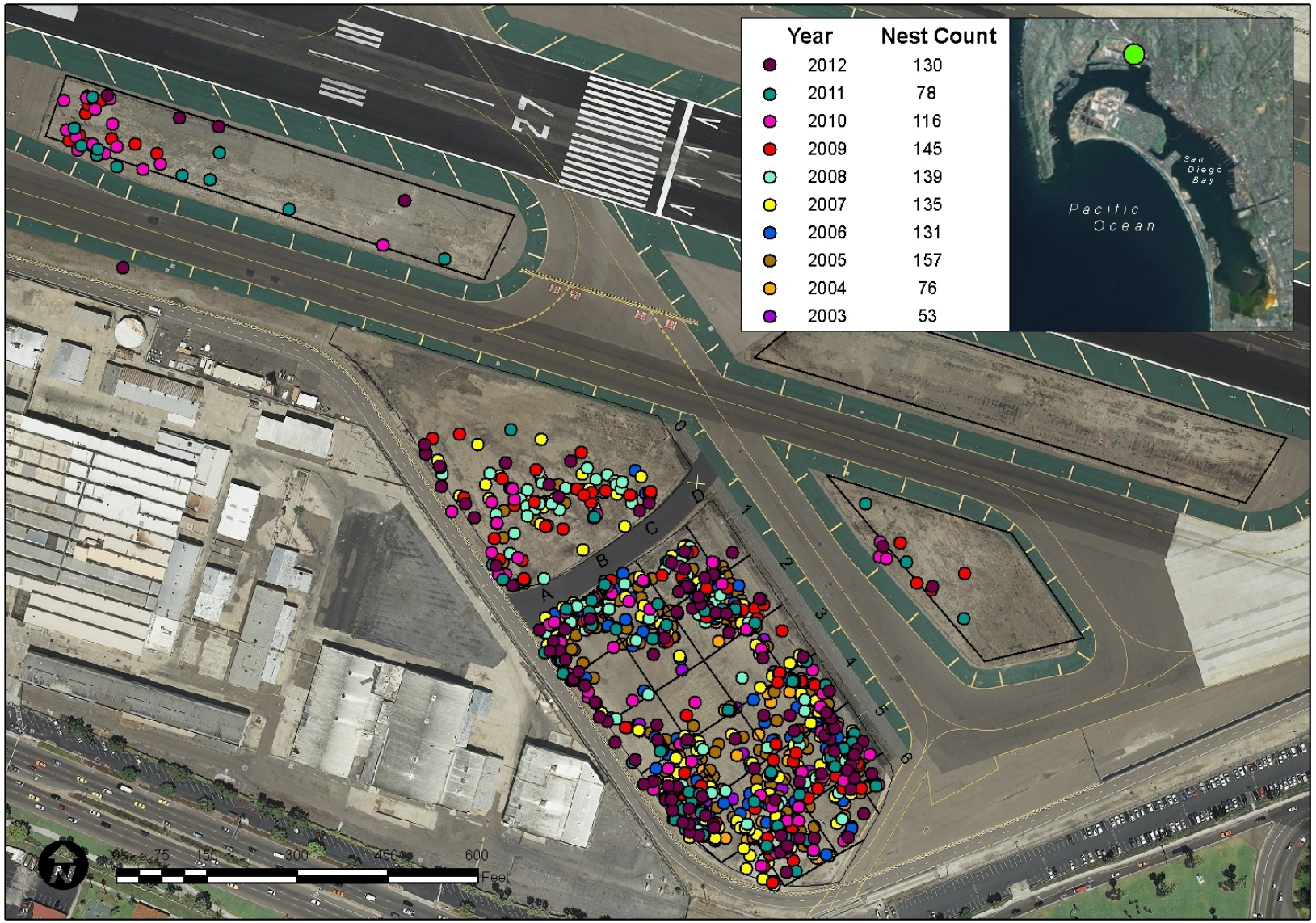
Appendix C-3. Summary of California least tern breeding at Chula Vista Wildlife Reserve, 2003-2012.

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Date terns first observed	4/24	4/20	4/26	4/21	4/23	4/9	4/24	4/22	4/19	4/12
Date terns last seen	8/14	9/5	7/29	8/14	8/15	8/29	8/4	8/2	8/24	9/13
Date of first nest	5/15	5/15	5/17	5/30	5/15	5/16	5/12	5/11	5/13	5/12
Date last nest found	7/1	7/13	7/1	7/4	7/10	7/8	7/10	6/29	7/19	7/10
Date last nest established	7/1	7/13	7/1	7/4	7/3	7/8	7/10	6/29	7/16	7/10
Date of first hatch	6/5	6/5	6/10	6/20	6/8	6/6	6/2	6/1	6/3	6/2
Date of last hatch	7/16	7/24	7/1	7/22	7/20	7/26	7/24	7/2	7/18	7/31
Date of first fledgling	6/24	7/13	7/5	8/4	7/17	8/15	6/23	6/29	6/21	6/29
Estimated number of breeding pairs	22-25	30-48	44-53	12-13	33-39	28	37	32	34-47	29-37
Total number of nests	31	66	57	15	46	33	48	40	53	64
Total number of eggs	52	103	101	25	81	60	86	76	100	98
Clutch Size										
1 egg	10	30	13	5	11	7	11	4	6	30
2 egg	21	35	44	10	35	25	36	36	47	34
3 egg	0	1	0	0	0	1	1	0	0	0
Average clutch size	1.68	1.56	1.77	1.66	1.76	1.82	1.79	1.9	1.89	1.53
No. of nests hatching young*	10	47	40	9	24	18	22	21	39	36
Total number of eggs hatched	18	73	74	17	42	32	40	41	75	55
Estimated number of fledglings	6-8	11-18	2	2	0	2	4-5	2	12-19	18-20
Number of chicks banded	15	44	46	10	23	16	18	16	40	43
Number of adults banded	0	0	0	0	0	7	5	7	1	2
Uncertain outcome										
Nests*	7	11	3	2	0	11	16	5	10	9
Eggs	11	13	5	3	0	17	28	10	15	11
Documented Mortality										
Preyed upon:										
Eggs**	11	0	9	3	36	6	8	21	4	9
Chicks	1	2	1	0	2	2	2	8-9	5-7	5
Fledglings	0	0	0	0	0	1	0	0	1	2
Adults	0	1-2	0	1	0	0	0	0	3	2-3
Other than preyed upon:										
Eggs										
Human Damaged	0	0	0	0	0	0	0	0	0	0
Failed to hatch (incubated to term)	2	3	5	0	1	4	3	0	1	1
Died hatching	0	1	0	0	0	1	2	0	0	0
Abandoned (pre-term)	10	13	8	2	2	0	5	2	5	22
Flooded	0	0	0	0	0	0	0	0	0	0
Chicks	0	1	5	0	0	0	2	1	2	3
Fledglings	0	0	0	0	0	0	0	1	0	0
Adults	0	0	0	0	0	0	0	0	0	0
Nests										
Human damaged*	0	0	0	0	0	0	0	0	0	0
Preyed upon*	8	0	6	3	21	4	7	11	2	6
Failed to hatch*	1	2	5	0	1	4	5	0	1	1
Abandoned (pre-term)*	7	9	7	2	2	0	4	2	4	17
Flooded	0	0	0	0	0	0	0	0	0	0

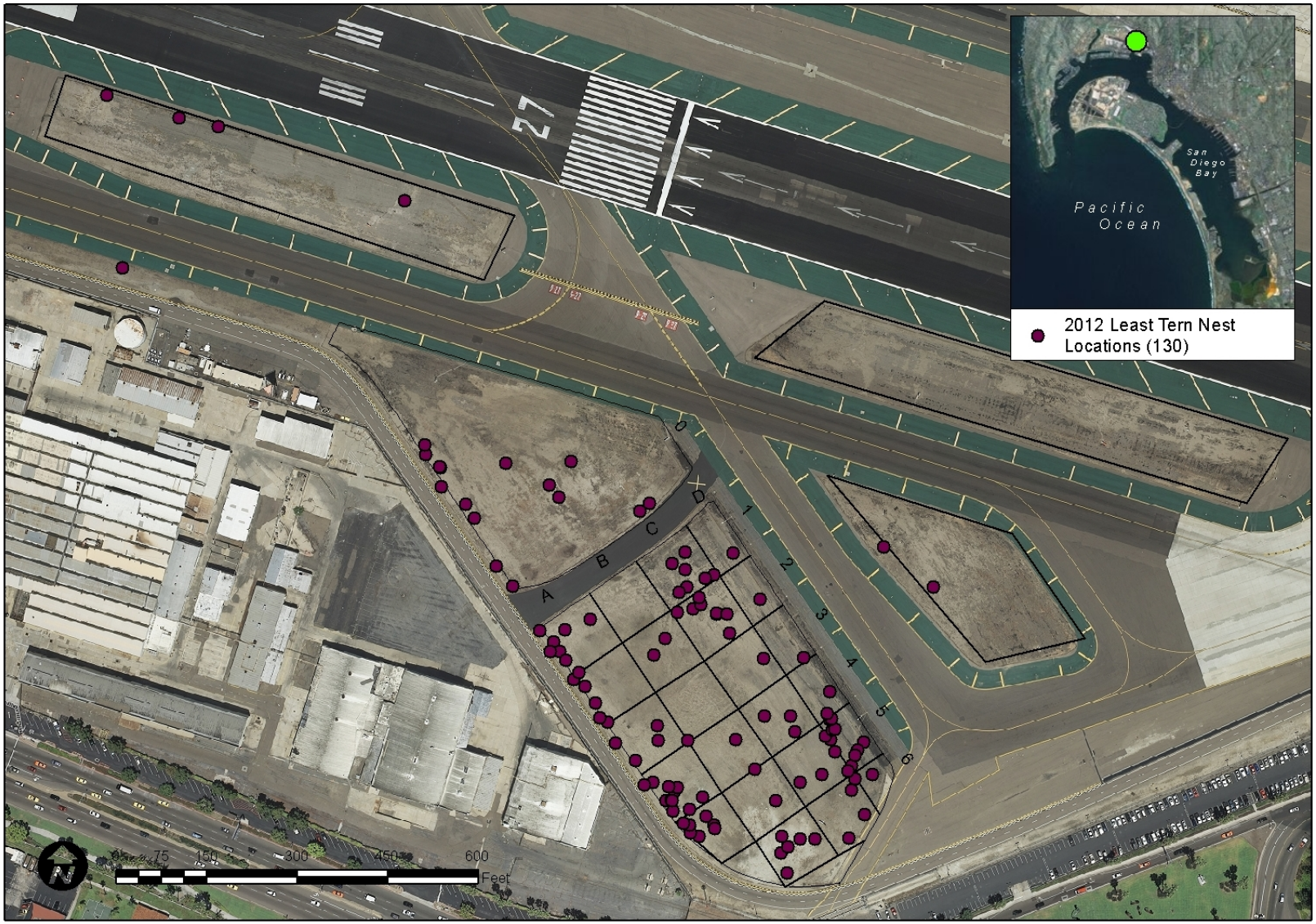
* included in more than one category

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

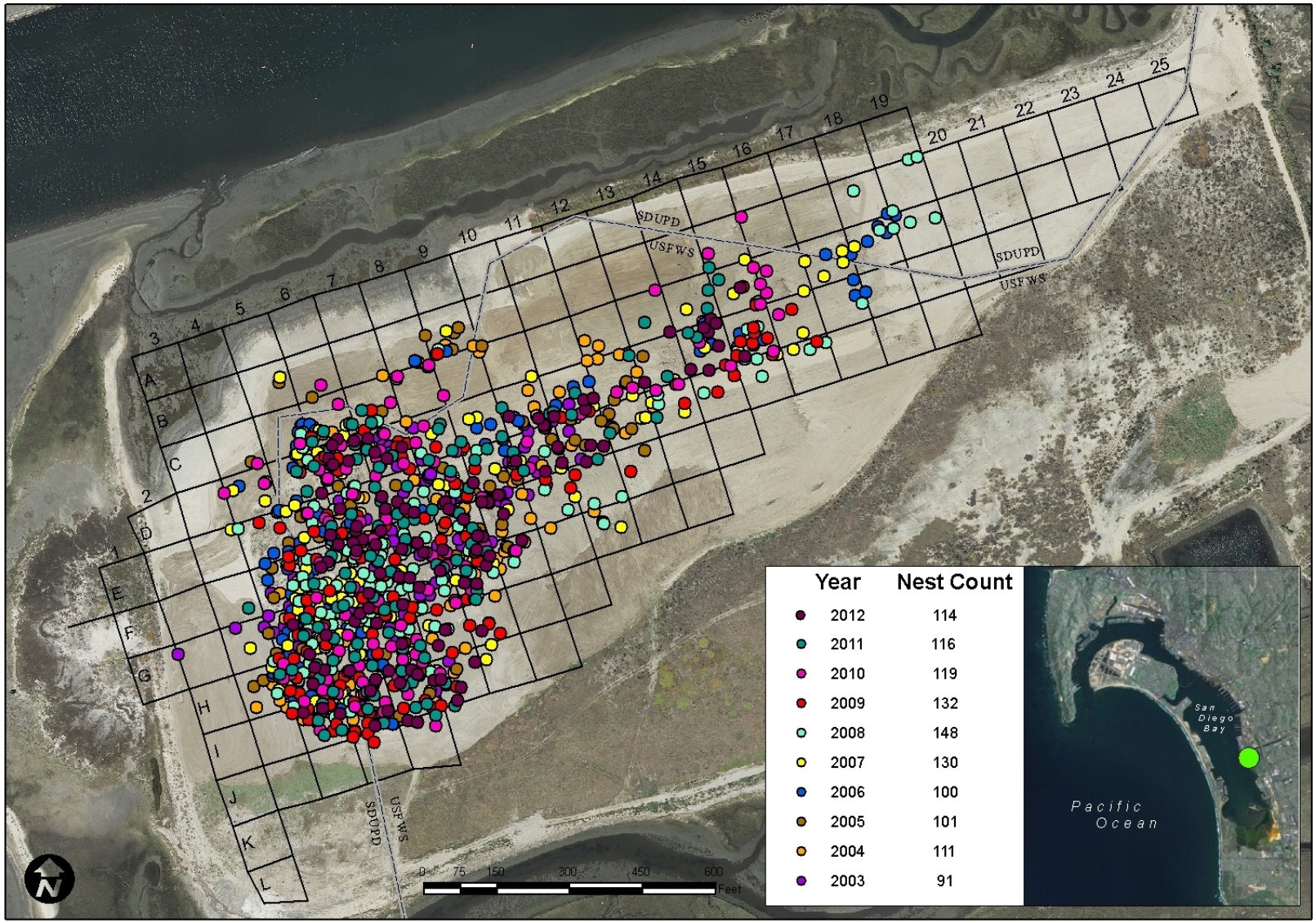
Least Tern Nests: San Diego International Airport 2003 - 2012



Least Tern Nests: San Diego International Airport 2012

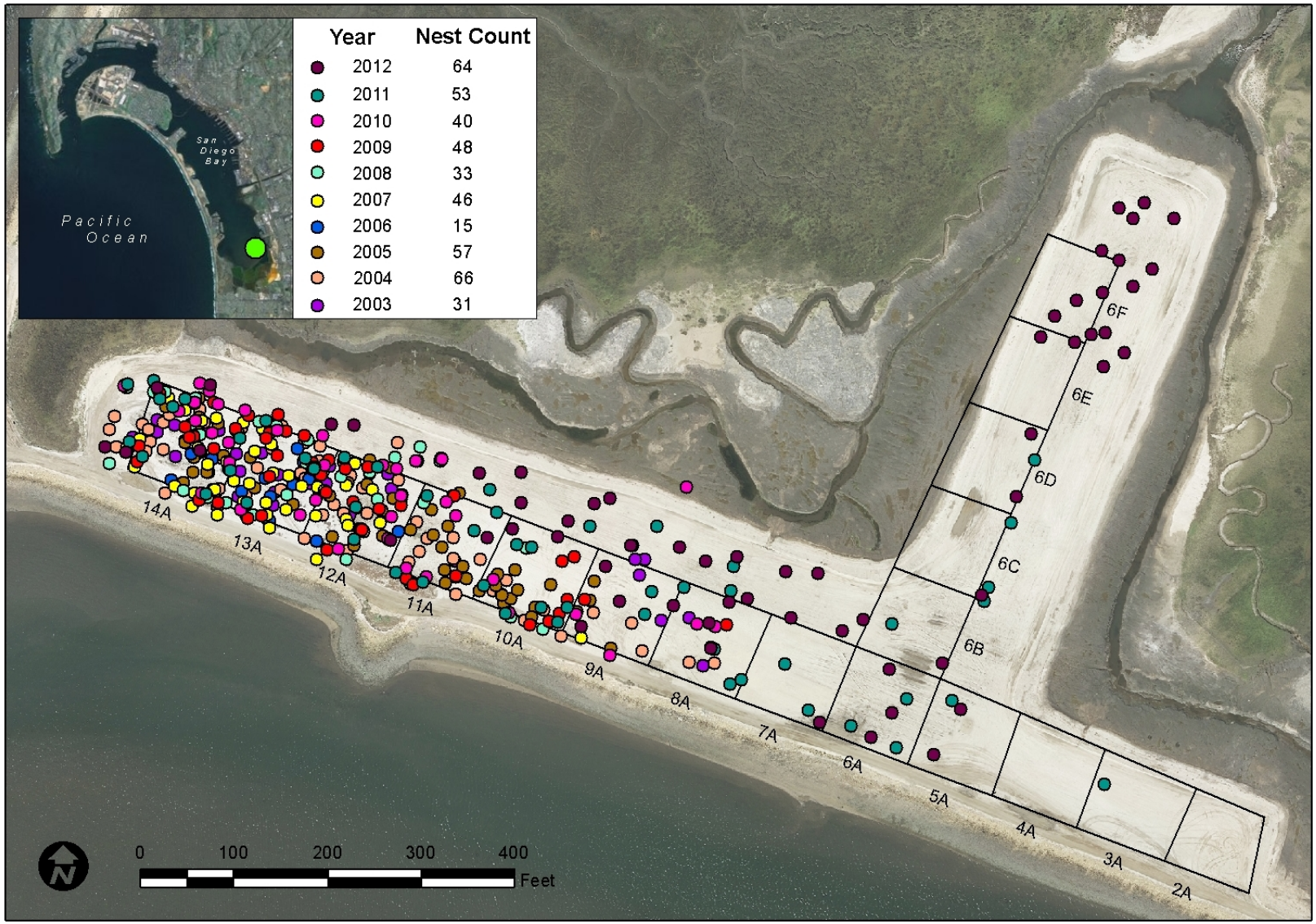


Least Tern Nests: D Street 2003 - 2012



Least Tern Nests: D Street 2012

Least Tern Nests: Chula Vista Wildlife Reserve 2003-2012



Least Tern Nests: Chula Vista Wildlife Reserve 2012

Appendix D. Distribution of nests of California least tern and western snowy plover at D Street Fill, 1997-2012.

	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

Appendix E-1. Numbers of western snowy plovers and band combinations observed at D Street Fill, 2012.
Color code: A=aqua, B=blue, F=fuchsia, G=green, K=black, L=lime, M=mauve, O=orange, P=pink, R=red, S=service, V=violet, W=white, Y=yellow.

Date	Number of	Bands
1/15	0	(high tide)
1/17	57	(ebbing tide) OO-RY, S-L/KW/K, S-A/K, SK-O/AB/P, S-X
1/20	86	S-X
3/13	0	
3/16	19	S-X
3/22	1	
3/26	0	
3/29	0	
4/3	17	S-X
4/10	0	
4/12	0	
4/24	0	
4/29	0	
5/1	0	
5/8	0	
5/15	0	
5/22	0	
5/29	0	
6/5	0	
6/12	0	
6/19	0	
6/26	0	
7/3	0	
7/10	0	
7/17	0	
7/24	0	
7/31	0	
8/6	0	
8/14	0	
8/21	0	

Appendix E-2. Western snowy plover band combinations observed at D Street Fill, 2012.
Color code: A=aqua, B=blue, F=fuchsia, G=green, K=black, L=lime, M=mauve, N=tan, O=orange, P=pink, R=red, S=service, V=violet, W=white, Y=yellow.

Date(s)	Bands	Origin
1/17	OO-RY	Fort Ord, 2005
1/17	S-A/K	Naval Air Station, North Island
1/17	SK-O/AB/P	Project Wildlife captive-reared, 2011
1/17	S-L/KW/K	Naval Amphibious Base - Ocean, adult 2009
1/17, 1/20, 3/16, 4/3	S-X	San Diego County

Appendix F. Detection of presence and predation by gull-billed terns.

Despite California least tern colonies being monitored two to three times per week, large time windows exist each day during which predator presence or predation may not be observed simply because of the absence of a monitor. Likewise, little sign of predators' presence may be left by those that carry prey from the site or devour prey intact (Patton 2000). Observations of predation events and recovery of bands in regurgitated pellets indicate that during some breeding seasons, gull-billed terns may depredate potentially significant numbers of least tern chicks (Patton 2009).

To assess detection of presence of gull-billed terns at least tern colonies during the 2012 breeding season, data from monitoring visits to the least tern colonies at Chula Vista Wildlife Reserve and D Street Fill (Patton, unpubl. data of San Diego County Regional Airport Authority and San Diego Unified Port District) were compared to data from radio receivers at each site that had recorded the presence of gull-billed terns that had been fit with radio transmitters (Goodenough, unpubl. data; see Goodenough 2013).

To assess detection of predation and levels of predation, data on predation observed during monitoring visits to least tern colonies around San Diego Bay and Tijuana Estuary were combined with band recovery data collected at South San Diego Bay National Wildlife Refuge saltworks (Patton, Sadowski, and Squires, unpubl. data). Advances in metal detector technology reducing interference from minerals and trace metals in the soil allowed more effective recovery of least tern bands from pellets regurgitated by gull-billed terns in their nesting colony at the saltworks this season.

Presence of gull-billed terns

Gull-billed terns were observed regularly foraging at Naval Air Station North Island, Naval Amphibious Base, Silver Strand State Beach, Naval Radio Receiving Facility, Tijuana Estuary, South San Diego Bay saltworks, Chula Vista Wildlife Reserve, and the D Street Fill. Sightings of gull-billed terns dispersing up the coast were reduced this season, but included reports near the mouth of the San Diego River/Dog Beach area, at Batiquitos Lagoon, Camp Pendleton, and in Orange County at Bolsa Chica (Patton 2012).

Stationary radio telemetry documented significantly higher frequency of gull-billed tern presence at least tern colonies than did traditional observational monitoring. These results indicate that presence of other individual predator species is also likely under-detected.

Chula Vista Wildlife Reserve

Stationary radio telemetry recorded 831 visits by three radio-tagged gull-billed terns to CVWR from 29 May to 15 August, 2012 (Goodenough, unpubl. data). Visits included every day except for two from 17 June to 15 August. Radio telemetry also documented that 252 of those visits were nocturnal. In contrast, monitoring visits recorded only 33 observations of gull-billed terns from 20 March to 10 July, 12 of which were after 29 May (Figure 1).

Monitoring visits and telemetry registering gull-billed tern presence coincided on 11 dates. Of those, the times of eight monitoring visits coincided with times of telemetry registering gull-billed tern presence. Gull-billed terns were detected by monitors on three of those eight incidents. Reasons for monitors not detecting gull-billed terns include focus of effort, size of site, and frequency of presence of other tern species. One of the five visits was not

a regular monitoring visit but rather a focused visit for trapping of least tern adults for recovery of band data, when monitors were within a blind and viewing one nest at a time. Unless the gull-billed tern called or flew low over the nest being focused on at the time, or least terns responded to its presence with alarm calls, monitors would have been unlikely to detect its presence while trapping. During regular monitoring visits, the site is generally traversed from one end to the other, and birds at the opposite end of the site may be undetected, particularly if not calling or least terns not responding to their presence. Similarly, a large number of Forster's and elegant terns fly over and adjacent to the site frequently (if not constantly during some visits), and due to their similar size, shape, and coloration, individual gull-billed terns may be missed among them if not actively hunting, calling, or least terns responding to them.

D Street Fill

Stationary radio telemetry recorded 56 visits by one radio-tagged gull-billed tern to the D Street Fill site from 9 June to 14 August, 2012 (Goodenough, unpubl. data). Radio telemetry also documented that 16 of those visits were nocturnal. In contrast, monitoring visits recorded only 29 observations of gull-billed terns from 22 May to 29 June (Figure 2). No dates of monitoring visits coincided with telemetry registering gull-billed tern presence.

Predation by gull-billed terns

The proportion of least tern and snowy plover bands recovered this season in the gull-billed tern colony was significantly higher than that of previous seasons due to the use of advanced technology pulse-induction above/underwater metal detectors (Patton, Sadowski, and Squires, unpubl. data). Band recovery efficiency was increased due to improved sensitivity, diminished interference from minerals and trace metals in the soil, and the ability to search in all substrates including moist shoreline and underwater. Fifteen bands had been recovered using traditional methods but an additional 49 were recovered using the improved metal detectors. Large numbers of additional bands from previous seasons were also recovered.

Of the 274 bands applied to least tern chicks at San Diego Bay colony sites this season, 48 were recovered at the saltworks gull-billed tern colony (17.5 percent). This is simply documentation confirming the relatively high proportion of chicks of this endangered species taken by a single predator species. Such band recovery is only possible due to that species' concentration at a single breeding site, although additional bands were undoubtedly expelled in pellets at foraging or roosting sites away from the colony site. Similar or higher proportions were likely taken by other more dispersed predator species, including but not limited to coyotes, harriers, kestrels, peregrines, gulls, and corvids.

Chula Vista Wildlife Reserve

One egg was found depredated but lack of tracks and patterns of damage could have been consistent with predation by either northern harrier or gull-billed tern. One egg was found damaged with a longitudinal crack and crease indicative of having been gripped by gull-billed tern. One hatching egg was observed to have been picked up and dropped by a gull-billed tern; although bleeding, the chick hatched and survived at least through the following day.

Of 43 bands applied to California least tern chicks at CVWR in 2012, three were recovered in regurgitated pellets of gull-billed terns at their nesting colony at South San Diego Bay saltworks (6.98 percent). None of these three chicks had been observed to have been taken.

The fact that the predation of these chicks would have been undocumented without the effort expended in band recovery at the gull-billed tern colony indicates the importance of this as a monitoring tool.

D Street Fill

Of 41 bands applied to California least tern chicks at D Street in 2012, one was recovered in regurgitated pellet of a gull-billed tern at their nesting colony at South San Diego Bay saltworks (2.44 percent). The predation of this chick had not been observed, but a second chick on a later date was observed taken from the site by a gull-billed tern. Predation of additional chicks was suspected based on their absence coinciding with sightings of gull-billed terns. One egg was found with damage consistent with having been hit by a gull-billed tern.

Literature cited

Goodenough, K.S. 2013. Tracking inter- and intra-annual variations of gull-billed tern (*Gelochelidon nilotica vanrossemi*) home range and diet in San Diego Bay and Tijuana River Estuary habitats: 2012 end of field season report. Unpubl. rept. to U.S Fish and Wildlife Service, San Diego County Regional Airport Authority, and Sonoran Joint Venture.

Patton, R.T. 2002. California least tern breeding survey, 2000 season. Calif. Dep. Fish and Game, Habitat Conservation and Planning Branch, Species Conservation and Recovery Program Report, 2002-03. Sacramento, CA.

Patton, R. 2009. The status of western gull-billed terns at South San Diego Bay National Wildlife Refuge in 2009. Final contract report to U.S. Fish and Wildlife Service, San Diego National Wildlife Refuge Complex, Carlsbad, CA.

Patton, R. 2012. The status of western snowy plovers, California least terns, western gull-billed terns, and breeding waterbirds at South San Diego Bay National Wildlife Refuge in 2012. Unpubl. draft to U.S. Fish and Wildlife Service, San Diego National Wildlife Refuge Complex, Chula Vista, CA.

Figure F-1. Frequencies of detection of gull-billed tern presence by stationary radio telemetry and traditional observational monitoring, Chula Vista Wildlife Reserve, 2012.

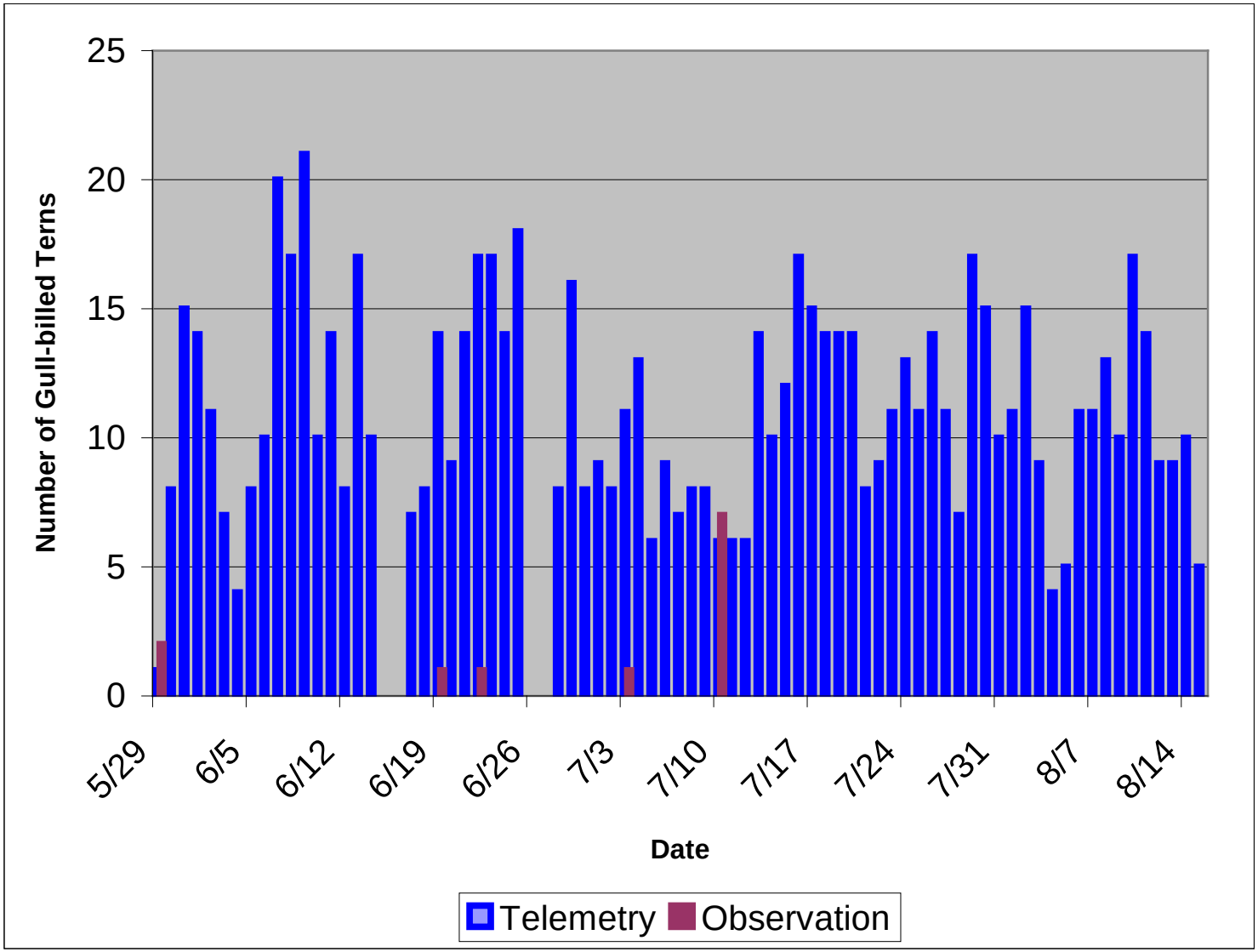


Figure F-2. Frequencies of detection of gull-billed tern presence by stationary radio telemetry and traditional observational monitoring, D Street Fill, 2012.