SAN FRANCISCO BAY
BIRD OBSERVATORY

# California Least Tern Breeding at Eden Landing Ecological Reserve


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## METHODS

### Study Area

California Least Terns (*Sternula antillarum browni*; hereafter Least Tern) in the San Francisco Bay nest predominantly on constructed islands, abandoned naval airstrips, and former salt production ponds and associated levees and berms. In 2018, Least Terns nested at Eden Landing Ecological Reserve, a California Department of Fish and Wildlife property in Alameda County that includes approximately 6,400 acres of former salt ponds, tidal marsh and mudflat habitat. All Least Tern breeding activity was observed in pond E14, a former salt pond that has been enhanced and managed to provide high quality habitat for the federally threatened Western Snowy Plover (*Charadrius nivosus nivosus*).

### Least Tern Surveys

From March 5 to September 28, 2018, SFBBO biologists, interns, and volunteers surveyed pond E14 and adjacent ponds E12 and E13 by driving slowly on the levees or walking levees without vehicle access. We stopped approximately every 0.3 miles to scan for Least Terns with spotting scopes. We recorded the number and behavior of all Least Terns present, identified the age class of chicks and fledglings on the pond, and marked the approximate location of sightings on a geo-referenced map.

### Nest Monitoring

We located Least Tern nests by scanning for incubating adults during weekly surveys and/or observing mate food provisioning. We then searched for nests on foot and recorded nest locations with a hand-held tablet (Apple® iPad 2 or Apple® iPad Mini 2). We monitored nests weekly until we determined the fate of the nest. On each visit, we recorded whether the nest was still active (eggs present and adults incubating) and the number of eggs or chicks in the nest. Our Recovery Permit for Least Terns does not allow for egg handling, therefore the age of Least Tern nests could not be determined. When we observed an empty nest, we assigned each nest a fate (hatched, when chicks were confirmed in and around the nest; presumed hatched, when chicks were not seen in or around nest but the nest should have hatched by that point and no obvious signs of depredation were observed; and depredated, when the nest had not been incubated long enough to hatch and/or obvious signs of depredation were observed). In some instances, our inability to handle eggs and thus determine the age of the nest resulted in our being unable to definitively determine the final nest fate, resulting in a classification of unknown.

### Avian Predator Surveys

SFBBO biologists and interns conducted predator surveys on the same ponds surveyed weekly for Least Terns. Observers chose points throughout the survey that would allow the observer to fully scan all required ponds for predators. At each survey point, the location, start time, and stop time were recorded. Observers recorded the number, species, behavior, and habitat type at the time of sighting of any predators present. The approximate locations of the predators were marked on a map.

We defined avian predators as any species that could potentially prey on a Least Tern egg, chick, or adult. While mammalian predators and their signs (e.g., tracks) were also recorded opportunistically, these surveys were not designed to detect mammals, particularly since many are nocturnal. Among all

avian predators, we considered corvids, raptors, and gulls to be the most critical potential predators to Least Tern adults, eggs, and chicks.

## RESULTS

### Least Tern Surveys

Least Terns were first observed at Eden Landing on April 23, when four adults were recorded flying over and foraging within the ponds. An average of 60.0±58.7 adults and 0.5±1.3 fledglings were observed during surveys between April 23 and August 18. A maximum of 245 adults were observed on July 23, while a maximum of five fledglings from E14 were observed on August 6. Between July 18 and July 30, we observed a large influx of migrating adults, when a range of 105-245 adults were observed on the pond during each survey. Excluding these weeks, an average of 41.0±31.4 adults were observed on the pond.

### Volunteer and Docent Surveys

During the first portion of the breeding season (April 23-July 1), breeding Least Terns were observed in areas of E14 where the adjacent levees are seasonally closed to the public to protect breeding Snowy Plovers. A large amount of Snowy Plover nest buffers extended onto levees on both sides of the pond; therefore we were unable to send Least Tern volunteers out to survey during this timeframe. Snowy Plover nests are legally protected by a 600ft radius nest buffer because Snowy Plovers in the San Francisco Bay have been shown to flush off their nests when a perceived predator is at a distance of up to 500ft.

Between July 1 and August 18, six volunteers conducted a total of 20 surveys. During these surveys, an average of 67.1±71.5 adults and 0.2±0.6 fledglings were observed. Frequently sighted predators included Northern Harriers, White Tailed Kites, and California Gulls.

### Predator Surveys

The most abundant potential avian predators at E14 were California Gulls (13.6/survey) and unidentified gulls (3.7/survey). Northern Harriers were the most frequently observed raptor at Eden landing (0.6/ survey). Common Ravens (0.4/ survey) were observed often foraging along the pond bottom. Less frequently observed predators included Red-tailed Hawks (0.07/ survey), White-tailed Kites (0.07/ survey), Merlins (0.07/ survey), and Peregrine Falcons (0.07/ survey).

Red foxes were the only mammalian predator seen during surveys (0.07/survey). Based upon United States Department of Agriculture (USDA) Wildlife Service trapping efforts, other mammals present at Eden Landing Ecological Reserve include raccoons, feral cats, striped skunks, and Virginia opossums.

### Nest Abundance and Success

We determined the fates of 141 Least Tern nests at Eden Landing. Five nests hatched (3.5%), seven nests were presumed to have hatched (5.0%), 97 nests were depredated (68.5%), one nest was non-viable (1%), and the fates of remaining 31 nests were unknown (22%). The first nests on the pond were

found on May 14, while the last nests were found on July 23rd. The first nest confirmed to hatch was recorded on July 9, while the last nest confirmed to hatch was recorded on August 6.

**Chick Fledging Success**

Based upon our counts of Least Tern fledglings on the pond throughout the season, we estimate that 1 to 4 Fledglings were produced on pond E14 in 2018. Our estimate of fledglings was partly obscured by migrating fledglings. Between July 18 and July 30, a large number of fledglings were present on the pond, coinciding with an influx of adults. The lack of Least Tern chicks on the pond prior indicates that these fledglings were produced from nearby colonies rather than pond E14.

**DISCUSSION**

**Increased Breeding Effort**

In 2018 we observed a large increase in Least Tern breeding effort (141 nests) at Eden Landing compared to 2017 (21 nests). The main reason for the increased breeding effort was a larger colony, as we observed nearly double the number of Least Terns attempting to breed at E14 in 2018 (41.0±31.4 adults) compared to 2017 (23.8±11.9 adults). The increased breeding effort may have also been due in part to Least Terns arriving on site earlier in 2018 (April 23) compared to 2017 (May 29). This resulted in the first nests in 2018 (May 14) being initiated 2.5 weeks before the first nests were initiated in 2017 (June 1). Lastly, high nest depredation rates may have influenced Least Terns to renest multiple times. While Least Terns typically nest in two large waves corresponding to the first and second half of the breeding season, high nest depredation may have resulted in Least Terns renesting during either one or both waves.

**Low Reproductive Success**

In contrast to 2017, when only one Least Tern nest was confirmed as depredated and up to 21 fledglings were produced, Least Terns experienced extremely high rates of depredation in 2018. There are several different explanations for the low reproductive success observed. Evidence from wildlife cameras placed at nearby Snowy Plover nests on pond E14 indicate that the most likely culprit for the majority of Least Tern nest depredations were Red Foxes. Wildlife cameras confirmed that Red Foxes depredated 11 Snowy Plover nests throughout the course of the season. The majority of these Snowy Plover nests were located within 100m of active Least Tern nests, and were depredated around the same time frame that 45 Least Tern nests were depredated. Furthermore, one of the 45 depredated nests contained Red Fox scat, and as the nests were all located close by, it is likely that Red Foxes were responsible for the majority of the other depredations.

Avian predators likely also played a role in the reproductive success of Least Terns, but not to the extent as Red Foxes. Northern Harriers, which were the most frequently observed raptor on the pond, have been shown to be an especially critical predator of Least Tern eggs and chicks (Jenks-Jay 1980). While they were not recoded on camera or via direct observation depredating Least Tern adults, eggs, or chicks, it is likely that they had a negative effect upon Least Tern breeding success based on findings from previous research. Although Ravens were the third most frequently observed avian predator on

the pond, we have reason to believe that they played a minor role in the low reproductive success of Least Terns. Wildlife cameras confirmed that Common Ravens depredated two Snowy Plover nests on pond E14, however these nests were located greater than 100m from the nearest Least Tern nest. Anecdotal observations of Least Terns successfully mobbing and chasing off Ravens from the pond throughout the season indicate that Raven depredation of eggs and chicks may have been limited. Although California Gulls were the most frequently observed predator at pond E14, the majority were observed in transit over the pond, while the rest were observed foraging on the far east side of the pond, over 150m from the nearest Least Tern nests. Therefore, we believe that California Gulls had little to no effect upon the reproductive success of Least Terns at E14.

**Future Least Tern Breeding at E14**

Despite their poor reproductive success in 2018, there is reason to believe that Least Terns will experience more successful breeding at E14 in the future. Most importantly, USDA Wildlife Services will be conducting consistent predator trapping and removal throughout the 2019 season. Although predator trapping and removal occurred beginning in mid-April of 2018, it was the first year that consistent trapping and removal had occurred at Eden Landing since 2009. As a result, there were a large amount of mammalian predators, especially Red Foxes, present throughout Eden Landing before becoming gradually trapped and removed over the course of the season. Starting the breeding season with fewer mammalian predators, to which Least Terns are highly susceptible, will likely result in higher hatching and fledging success. Additionally, we plan to install chick shelters, an effective tool in reducing chick predation by avian predators (Jenks-Jay 1980), to aid in chick survival in 2019. While we had planned to use this method in 2018, we were stymied this year due to significant delays in the processing of our Federal Recovery permit amendment application.

**Photos**

All photos were taken by SFBBO biologists, interns, or volunteers and/or SFBBO wildlife cameras, and should be credited to SFBBO when used for outreach or publication.

Figure 1. Two 1-2 day old Least Tern chicks hiding in gravel along the public trail next to E14

Figure 2. 4-5 day old Least Tern chick hiding beneath a clump of pickleweed

Figure 3. Four Least Tern adults stand on the pond, while a fifth adult flies in fish to a nearby fledgling

Figure 4. Least Tern younger fledgling waiting to be fed fish by nearby adult from Figure 4

Figure 5. Incubating Snowy Plover and Least Tern briefly sitting side by side