SAN FRANCISCO BAY
BIRD OBSERVATORY

California Least Tern Breeding at Eden Landing Ecological Reserve 2019 Report

Prepared by:

Benjamin Pearl, Plover and Tern Program Director

Yiwei Wang, Executive Director

Lead Field Biologist: Alex Rinkert, Biologist

San Francisco Bay Bird Observatory

524 Valley way, Milpitas, CA 95035

For:

Alameda County Fish and Game Commission

December 23, 2019

METHODS

Study Area

California Least Terns (*Sternula antillarum browni*; 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 2019, 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 (Figure 1). Least Tern breeding activity was observed at two ponds, E14 (Figures 2-3), a former salt pond that was previously enhanced with large scale oyster shell plots and managed to breeding, foraging, and roosting habitat for the federally threatened Western Snowy Plover (*Charadrius nivosus nivosus;* Snowy Plover), and E12 (Figure 2), a former salt pond that has been reconfigured as part of the South Bay Salt Pond Restoration Project to provide breeding and foraging habitat for multiple species.

Least Tern Surveys

From March 4 to September 27, 2019, SFBBO biologists, interns, and volunteers surveyed ponds E12, E13, and E14 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. In other cases, we chose not to enter high density breeding areas on islands due to the presence of many Least Tern and Snowy Plover chicks, and instead obtained nest information via observation. Both situations resulted in some nests with a final classification of unknown fate.

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 route that allowed them to visually 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 of the predator 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, gulls, herons, egrets, and raptors to be the most critical potential predators to Least Tern adults, eggs, and/or chicks.

RESULTS

Least Tern Surveys

Least Terns were first observed at E14 on April 22, and the last observation of breeding Least Tern adults or hatched chicks was on August 5. During this timeframe, an average of 36.3±47.5 adult Least Terns were observed over 17 surveys at E14 (Table 1). A maximum of 155 adults were observed on June 24 (Table 2), while a minimum of two adults were observed on August 12 (Table 3).

At E12, Least Terns were first observed on June 3. Between June 3 and July 15, the last date when Least Tern adults breeding or chicks hatched at E12 were observed, an average of 35.3±20.1 adult Least Terns were observed over seven surveys Table 1. A maximum of 68 adults were observed on July 15 (Table 2), while a minimum of 6 adults were observed on June 3 (Table 3).

Volunteer Surveys

Between June 2 and August 1, seven volunteers conducted 16 surveys at E14 and four surveys at E12. An average of 29.3±25.2 Least Tern adults were observed at E14, while an average of 17.0±8.5 adults were observed at E12 (Table 4).

Predator Surveys

The most abundant potential avian predators at E14 were Snowy Egrets (4.3/survey), unidentified gulls (1.8/survey; likely mostly California Gulls based upon time of year), California Gulls (1.6/survey) and Great Egrets (1.4/survey; Table 6). Northern Harriers were the most frequently observed raptor at E14 (0.7/ survey), followed by Peregrine Falcons (0.5/survey). Common Ravens (0.2/ survey) were occasionally observed foraging along the pond bottom. Less frequently observed predators included White-tailed Kites (0.2/ survey), Red-tailed Hawks (0.1/ survey), Western Gulls (0.1/ survey), and Great Blue Herons (0.1/ survey).

The most abundant potential avian predators at E12 were California Gulls (14.6/survey), unidentified gulls (10.5/survey; likely mostly California Gulls based upon time of year), Snowy Egrets (5.8/survey), and Great Egrets (4.4/survey; Table 6). American Crows were frequently observed foraging in the grass along the public trail in the medium salinity cell (0.8/survey), while Red-tailed Hawks were the most frequently observed raptors (0.1/survey). Other observed predators included Western Gulls (0.6/ survey), Great Blue Herons (0.2/ survey), Ring-billed Gulls (0.2/ survey), and Black-crowned Night-Herons (0.1/ survey).

Red foxes were the only mammalian predator seen during surveys at ponds E12 and E14 (0.03/survey; Table 6). Nest cameras and tail tracks (Figure 4-6) identified striped skunks as a significant nest predator of Least Terns. Based upon United States Department of Agriculture (USDA) Wildlife Service trapping efforts, other mammalian potential predators present at Eden Landing Ecological Reserve include raccoons, feral cats, and Virginia opossums.

Nest Abundance and Success

Between May 27 and July 22, at least 48 pairs established at least 101 nests at E14 that were confirmed and monitored. The first nest confirmed to hatch was on July 1, 2019, and the last nest confirmed to hatch was on August 5, 2019. At least thirteen nests hatched at least one chick, twenty nests were presumed to have hatched, 36 nests were confirmed as depredated, and the fate of 32 nests could not be determined (Table 5).

Between May 27 and July 8, 41 pairs established at least 41 nests at E12, of which twenty were located and monitored. The first nest confirmed to hatch was on June 24, 2019, and the last nest confirmed to hatch was on July 15, 2019. Of the monitored nests, two nests hatched at least one chick, two nests were presumed to have hatched, six nests were confirmed as depredated, and the fates of ten nests were unknown (Table 5). An additional 21 nests were not located, and thus their fate is marked as unknown. These nests were established between June 24 and July 15, and although some may have hatched, all eggs and/or chicks were depredated by July 15, when all but one known nest were found depredated.

Chick Fledging Success

At the E14 colony, an estimate of 5-8 fledglings were produced, resulting in 0.12-0.20 fledglings per pair (Table 7).

At the E12 colony, an estimate of five fledglings were produced, resulting in 0.05-0.10 fledglings per pair (Table 7).

DISCUSSION

High Breeding Effort

For the second consecutive year, we observed a high amount of breeding effort at Eden Landing. At E14, Least Tern nest initiation began much later in 2019 (May 27-June 3) compared to 2018 (May 7-May 14). Despite the later start, Least Terns established at least 98 nests between May 27 and July 1. These nests experienced high survival, resulting in a much larger amount of active nests than SFBBO had expected to monitor. At the same time, a large amount of Snowy Plover nests and broods were located in the same part of the pond, making the area extremely sensitive. In an effort to limit disturbances to both species, SFBBO biologists strictly limited the amount of time spent conducting nest searches in any one area. As a result, Least Terns likely established more nests in 2019 than reported here.

In addition to the high breeding effort observed at E14, Least Terns also nested on two constructed nesting islands at E12 (Figure 3). These islands were built in 2013 as part of Phase 1 of the South Bay

Salt Pond Restoration Project. Pond E12, which had been a seasonal pond, was converted to a managed pond with four cells, each with one nesting island and varying water salinity. Although these islands had been used by breeding Snowy Plovers, American Avocets (*Recurvirostra americana*), and Black-necked Stilts (*Himantopus* mexicanus) since their construction, 2019 marked the first year that these islands were used by breeding Least Terns. Least Terns used the island in the medium salinity cell most extensively, with at least 39 nests established on the island. Only two nests were initiated on the low salinity island, likely in response to the high density Least Tern breeding on the medium salinity island and resulting lack of available space.

Low Reproductive Success

Least Terns breeding at Eden Landing experienced poor reproductive success in 2019. However, unlike in 2018, when only a handful of nests were active long enough to hatch, at least 37 nests hatched between E12 and E14, and it is likely that some of the 30 nests established between June 3-June 17 with unknown nest fates also hatched. One possible reason for the higher hatch rate was due to consistent predator control efforts by USDA-APHIS in 2018 and 2019, especially to remove red foxes. In 2018, red foxes were frequently sighted on the ponds, and they were identified as responsible for depredating the majority of Least Tern nests in E14 by trail camera photos and scat left at nests. Conversely, in 2019 red foxes were observed on only one occasion at the ponds and zero times on trail cameras.

Predation at E14 began to rapidly accelerate by July 1, when six nests in the low density east side of the pond were predated. SFBBO biologists found long, continuous snake-like tracks leading to each nest (Figure 4-5), at first leading biologists to believe that a large snake was taking Least Tern eggs. By June 8, just as many nests were hatching, the vast majority of Least Tern nests in the more densely populated west side of the pond had also been depredated, with similar tracks observed at many of these nests as well. During this depredation event, a trail camera placed at the edge of the colony showed a striped skunk visiting the colony on consecutive nights and depredating at least one Least Tern nest. After showing the tracks to USDA-APHIS staff, they determined that the likely predator making the tracks was a striped skunk. In the past, though mostly during the winter, USDA-APHIS had observed striped skunks leaving similar tracks on ponds after their tail got wet and accumulated mud (Eric Covington, pers. obs.). In their past experiences protecting other Least Tern colonies, USDA-APHIS personnel noted that striped skunks appeared to be attracted to colonies once chicks had hatched. Trail cameras placed by SFBBO biologists at apparent pond access points (based upon tracks) captured photos of a striped skunk with a tail that was heavily caked with mud, confirming USDA-APHIS's theory (Figure 6.) Thus, despite trapping efforts that removed 27 striped skunks from Eden Landing between Febuary 3 and May 3, and an additional six striped skunks between July 11 and August 7, it is likely that striped skunks played a significant role in the poor hatching and fledging success observed at E14.

In addition to mammals, raptors, especially Northern Harriers, also played a role in the poor reproductive success of Least Terns at E14. Northern Harriers were the most frequently sighted predator of adults, eggs, and chicks on the pond (Table 7). On several occasions SFBBO biologists driving on the levee past the colony to band Snowy Plover chicks, as well as volunteer Least Tern surveyors, observed Northern Harriers successfully taking Least Tern chicks from the colony.

At E12, Least Terns nested on shelled islands measuring approximately 1200 sq. meters in area. Between May 27 and July 8, Least Tern nest survival appeared to be relatively high. Compared to E14, the smaller breeding areas of the islands represent breeding habitat type more similar to those found at other San Francisco Bay Least Tern breeding colonies. Nesting on an island surrounded by water may have reduced the likelihood of a mammal finding and depredating nest, while forming a more dense colony compared to E14 may have allowed for better colony defense, reducing the threat from raptors and corvids. However, the biggest reason for Least Terns breeding success during this time frame may have been due to a lack of gulls in the pond. Between June 3, when two California Gulls were observed transiting over the pond, and July 1, when 28 California Gulls were observed foraging in the water in the pond, zero gulls were observed in the pond. During this timeframe, it is likely that local breeding California Gulls were instead found at their breeding colonies. On July 8, 97 California Gulls were observed in the pond, and on July 15, 95 California Gulls were observed in the pond. On July 15, all but one hatching Least Tern nest and all young chicks were found to have been depredated. If a gull flock of 100 individuals (or even a portion of the flock) were to land on either nesting island, it is unlikely that Least Terns would have been able to successfully defend their nests and chicks from depredation. At the Least Tern colony at nearby Hayward Shoreline, East Bay Regional Park District biologists and USDA-APHIS staff prevented gulls from roosting or foraging in the general vicinity of the colony to reduce the likelihood of a large scale depredation event by gulls (Dave Riensche, pers. comm.). Therefore, we believe that the return of a gull flock to pond E12 in early July likely resulted in gulls depredating the majority of Least Tern nests and chicks by July 15.

Future Least Tern Breeding at Eden Landing

In 2020, SFBBO will be implementing a social attraction project designed to improve Least Tern breeding success at E14. This project will begin at the end of February/early March with a large community habitat restoration event. During the event, volunteers will remove overgrown vegetation that reduces breeding habitat size and quality, remove remnant salt production fencing and posts that are often used as predator perches, and spread Least Tern decoys, an audio playback device, and chick shelters in the restored area of the west shell plot. This event will improve the quality of Least Tern breeding habitat at E14 and direct the colony to establish a dense colony in an area of the pond that will facilitate monitoring. SFBBO will monitor Least Terns twice weekly, rather than weekly as was the case in 2019, and will grow the size of the volunteer monitoring program at Eden Landing. As a result, we will be able to better monitor colony breeding success and track colony health at both E12 and E14. Thus, if SFBBO biologists or volunteers directly observe any depredation or identify signs of nest loss, SFBBO will be able to more quickly work with USDA-APHIS trappers to identify and control problematic predators.

It is likely that Least Terns will again establish a breeding colony on nesting islands in E12 and/or E13. SFBBO biologists plan to closely monitor California Gull activity in these ponds during April-July, and will work with USDA-APHIS to prevent large flocks from foraging and roosting in these ponds. By doing so, Least Terns in these ponds may take advantage of the otherwise high quality breeding habitat provided by the islands.

ACKNOWLEDGEMENTS

In 2019, California Least Tern Monitoring was supported by Alameda County Fish and Game Commission and SFBBO donors. We are especially grateful to John Krause of CDFW for logistical support at Eden Landing. We thank SFBBO Biologists Jessica Gonzalez, Alex Rinkert, Josh Scullen, SFBBO intern Illianna Termuehlen, and Refuge intern Aurelie Muckhirn for their hard work throughout the season. We also thank our dedicated volunteers, Bill and Tanya Hoppes, Jeff Englander, Jing Zhu, and Debbie Ottman for conducting Least Tern Surveys.

Table 1. Number of surveys and average number of adult Least Terns observed per survey by SFBBO Staff at ponds in Eden Landing Ecological Reserve during the 2019 breeding season. Data was omitted from surveys with zero observations of adults, or when biologists suspected adult and fledgling Least Terns were passing through the reserve from other nearby colonies.

Pond	N	Average Adults/Survey
E12	10	35±20
E14	16	36±48

Table 2. Maximum number of adult Least Terns observed and date of observation during surveys at Eden Landing Ecological Reserve during the 2019 breeding season.

Pond	Max. Adults Observed	Date of Observation
E12	68	7/15/2019
E14	155	6/24/2019

Table 3. Minimum number of adult Least Terns observed and date of observation during surveys at Eden Landing Ecological Reserve during the 2019 breeding season.

Pond	Min. Adults Observed	Date of Observation
E12	6	6/3/2019
E14	2	8/5/2019

Table 4. Number of surveys and average number of adult Least Terns observed per survey by volunteers at ponds in Eden Landing Ecological Reserve during the 2019 breeding season.

Pond	N	Average Adults/Survey
E12	4	29.3±25.2
E14	16	17.0±8.5

Table 5. Least Tern nest fates by pond at Eden Landing Ecological Reserve, Hayward, California, 2019.

Pond	Hatched	Presumed Hatched	Depredated	Unknown	Total
E12	2	2	6	31	41

E14	13	20	36	32	101
TOTAL	**15**	**22**	**42**	**63**	**142**

Table 6**.** Average number of predators observed per survey at ponds E12, E13, and E14 in Eden Landing Ecological Reserve during the 2019 breeding season.

Predator Species	E12 (29)	E13 (29)	E14 (29)
California Gull	14.59	47.55	1.55
Unidentified Gull	10.45	30.83	1.79
Snowy Egret	5.76	4.86	4.31
Great Egret	4.35	3.38	1.41
Western Gull	0.59	0.41	0.07
Great Blue Heron	0.24	0.35	0.07
American Crow	0.83	0.00	0.00
Northern Harrier	0.03	0.00	0.69
Peregrine Falcon	0.00	0.07	0.52
Ring-billed Gull	0.21	0.35	0.00
Black-crowned Night-Heron	0.14	0.31	0.03
Bonepart's Gull	0.41	0.00	0.00
Common Raven	0.00	0.10	0.24
Red-tailed Hawk	0.10	0.03	0.10
White-tailed Kite	0.03	0.07	0.17
Herring Gull	0.07	0.07	0.00
Burrowing Owl	0.07	0.03	0.00
Bald Eagle	0.03	0.00	0.03
Merlin	0.00	0.00	0.03
Red Fox	0.00	0.00	0.03

Table 7. The minimum and maximum number of Least Tern breeding pairs, fledglings produced, and fledglings per pair at ponds in Eden Landing Ecological Reserve during the 2019 breeding season.

Pond	Min. Pairs	Max Pairs	Min. Fledglings	Max. Fledglings	Min. Fledglings/Pair	Max. Fledglings/Pair
E12	41	41	5	8	0.12	0.20
E14	48	101	5	5	0.05	0.10
TOTAL	**89**	**142**	**15**	**22**	**0.11**	**0.25**

Figure 1. Ponds in the CDFW's Eden Landing Ecological Reserve, near Hayward, California.

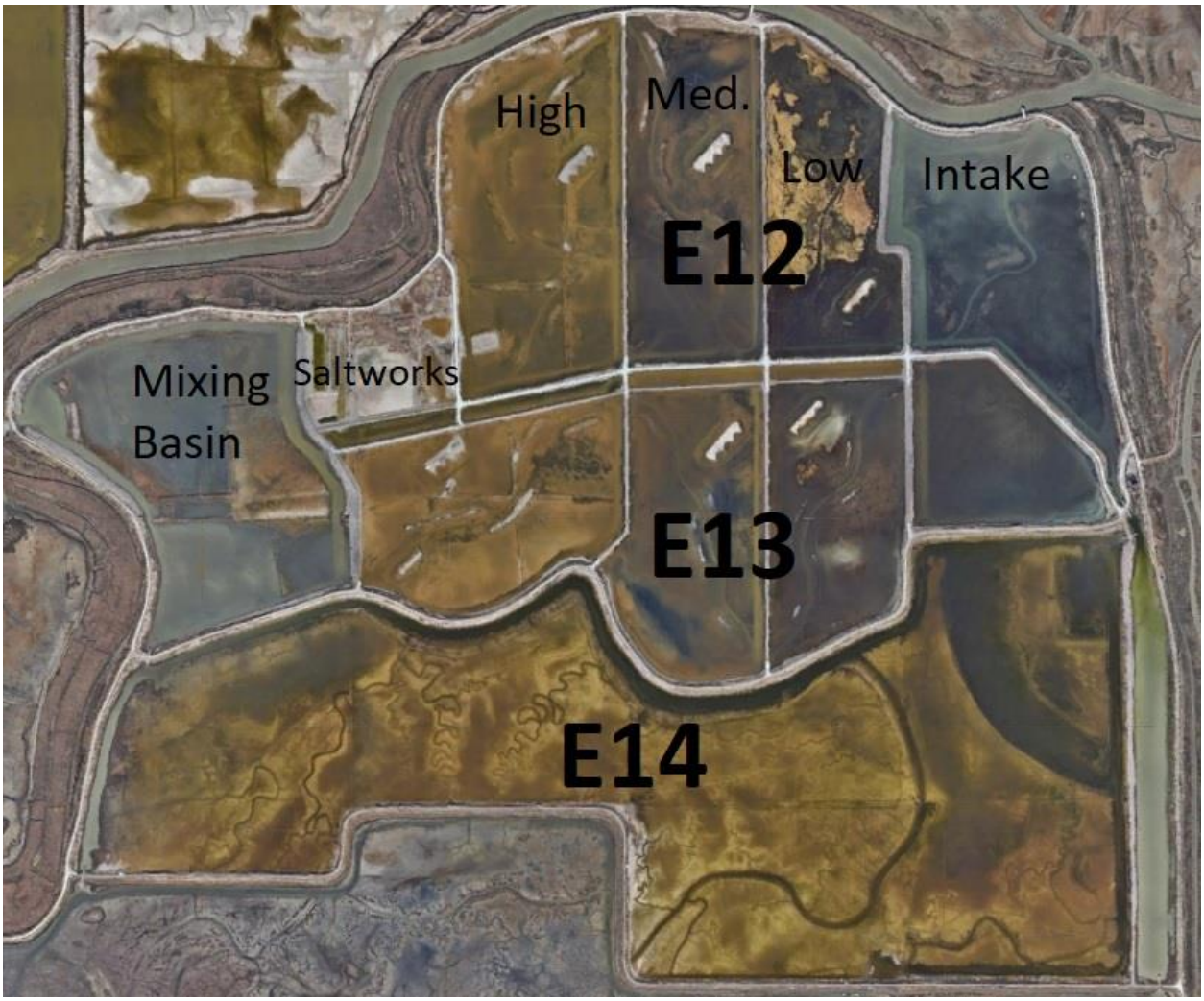

Figure 2. Ponds E12-14 in the CDFW's Eden Landing Ecological Reserve, near Hayward, South San Francisco Bay, California. Note that ponds E12 and E13 are subdivided into intake cells, three cells with varying water salinities, and a shared mixing basin to bring salinity levels down to acceptable levels before being released back into the bay.

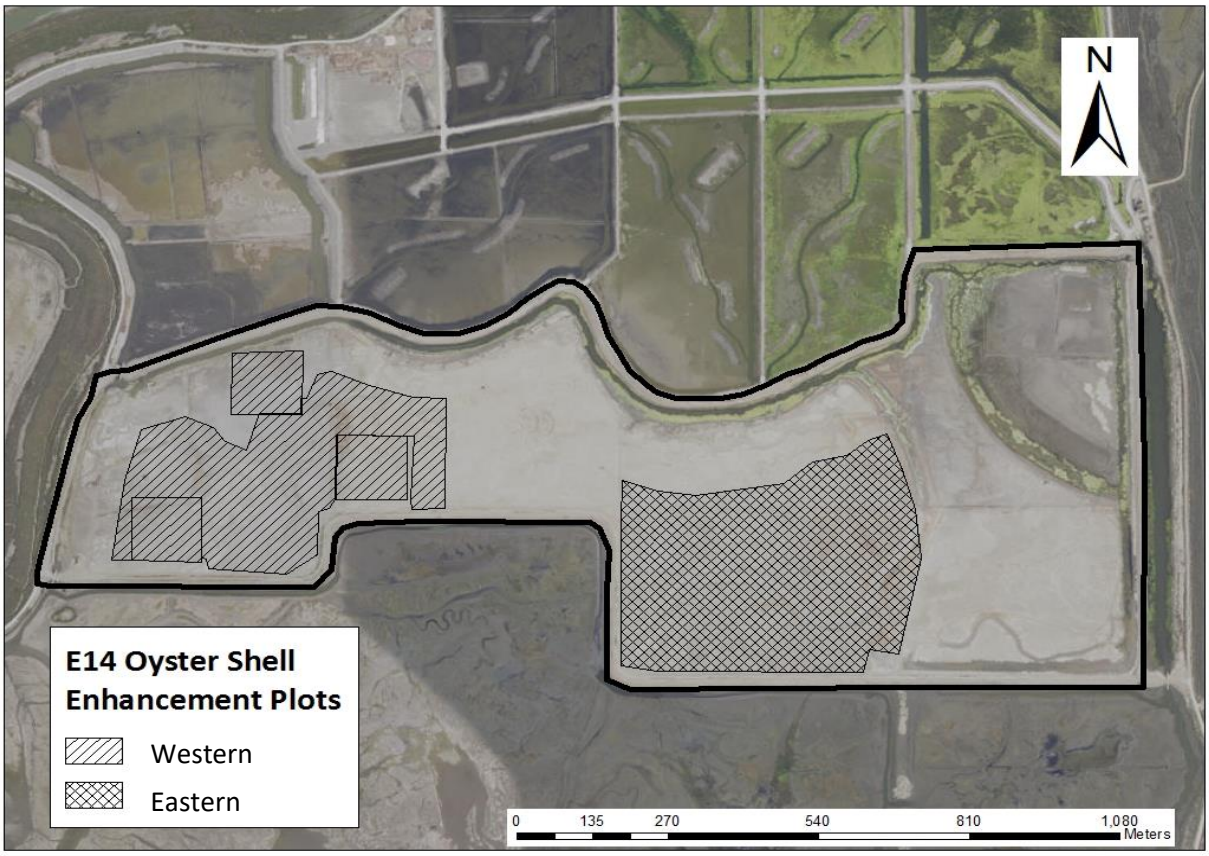

Figure 3. Large scale oyster shell plots at pond E14, Eden Landing Ecological Reserve, Hayward, CA.

Figure 4. Up close view of striped skunk tail tracks leading to depredated nests in an oyster shell plot at pond E14, Eden Landing Ecological Reserve, Hayward, CA.

Figure 5. Set back view of striped skunk tail tracks leading to depredated nests in an oyster shell plot at pond E14, Eden Landing Ecological Reserve, Hayward, CA.

Figure 6. Striped skunk photographed using a trail camera along an access point to pond E14, Eden Landing Ecological Reserve, Hayward, CA. Note that the tail of the skunk is heavily caked with mud, preventing the skunk from properly lifting its tail and causing the observed snakelike tracks.