SAN FRANCISCO BAY
BIRD OBSERVATORY

Snowy Plover Recovery in Alameda County

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SUMMARY

During the 2022 breeding season, the San Francisco Bay Bird Observatory (SFBBO) monitored Western Snowy Plover (*Charadrius nivosus nivosus*; Snowy Plover) population size, nesting and fledging success, and identified potential predators at Hayward Regional Shoreline (Hayward Shoreline; Figure 1-2) and Patterson Pond (Figure 3.)

As part of the Pacific Coast breeding season window survey (May 12-22), we counted 26 adult Snowy Plovers at Hayward Shoreline and 4 adult Snowy Plovers at Patterson Pond (Table 1).

Over the course of the breeding season (March-September), SFBBO staff determined the fate of 11 nests at Hayward Shoreline, finding that 60% hatched, 10% were depredated, 10% were flooded, 10% were collected (taken to rehabilitation center before being flooded), and the fate of 10% were unknown (Table 2). The presence of one brood each at Franks Dump West and Oliver Brothers North 14 from undetected nests indicates that at least some breeding activity was missed in these ponds (Table 2). At Patterson Pond, SFBBO staff determined the fate of 11 nests, finding that 18% hatched, 73% were depredated, and 9% were lost at hatch (Table 2).

In 2022, SFBBO banded 2 Snowy Plover chicks at the Oliver Brothers North ponds and three chicks at Patterson Pond (Table 3). From band re-sighting surveys, we determined that at least 20% of these chicks survived to fledge (28 days post-hatching) as of October 1, 2022 (Table 3). One egg rescued from a flooded nest at Oliver Brothers North was hatched and raised at International Bird Rescue before being banded as a juvenile and released at Franks Dump West.

During avian predator surveys, we counted unidentified gulls (*Larus* spp.; likely California Gulls due to the time of year and locations) as the most numerous potential avian predators at Hayward Shoreline, followed by Common Ravens (Corvus corax) and American Crows (Corvus brachyrnhcos) (Table 4). Peregrine Falcons (Falco peregrines) and Northern Harriers (*Circus cyaneus*) were the most frequently observed raptors at Hayward Shoreline.

In addition to conducting surveys, SFBBO staff and volunteers conducted outreach to the public at both locations.

INTRODUCTION AND BACKGROUND

The Pacific Coast population of the Western Snowy Plover (*Charadrius nivosus nivosus*; Snowy Plover) breeds along or near tidal waters and is behaviorally distinct from the interior population (Funk 2006). Coastal-breeding Snowy Plovers have declined as a result of poor reproductive success, likely due to habitat loss, habitat alteration, human disturbance, and increasing predation pressure (Page et al. 1991, USFWS 2007). In response to this decline, the U.S. Fish and Wildlife Service (USFWS) listed the Pacific Coast Western Snowy Plover population as federally threatened in 1993 (USFWS 1993). They are listed as a species of special concern in California (CDFW 1998). The most recent 5-year review (USFWS 2019), which reviewed all

available data in all six recovery units, determined that the population remains threatened due to the same threats described above.

Western Snowy Plover Recovery Unit 3 consists of the San Francisco Bay Estuary and includes Alameda, Napa, Santa Clara, and Solano counties, and the bay portion of Marin, San Mateo, and Sonoma Counties (USFWS 2007). Snowy Plovers in this Recovery Unit nest almost exclusively in dry salt panne habitat provided by former salt evaporation ponds, as well as on pond berms, levees, and in dry, degraded marsh habitat. In 1992, the Don Edwards San Francisco Bay National Wildlife Refuge (Don Edwards NWR) began surveying for Snowy Plovers on Refuge lands.

From 2003-2022, SFBBO conducted annual Snowy Plover monitoring and research within the South San Francisco Bay in support of the goals set forth by the RU3. Specifically, we: 1) identified areas used by Snowy Plovers through regular surveys of all potential nesting habitat from March through September, 2) participated in U.S. Fish and Wildlife Service-coordinated Range-wide breeding and winter window counts to estimate Recovery Unit 3 numbers, 3) recorded nest fates, nest densities, and chick fledging rates through nest-monitoring and chick-banding, 4) surveyed for potential avian predators , and 5) identified areas of potential disturbances from predators, trespass, construction activities and other human activities.

METHODS

Study Area

From March 1 to September 15, 2022, SFBBO staff and volunteers conducted Snowy Plover and avian predator surveys at Hayward Regional Shoreline (Hayward Shoreline) in Hayward, CA and Patterson Pond (Patterson) in Fremont, CA. Hayward Shoreline is co-owned by Hayward Area Recreation District (HARD) and East Bay Regional Parks District (EBRPD) and managed by EBRPD, and includes 1,841 acres of salt, fresh, and brackish water marshes, seasonal wetlands, and public trails (Figures 1-2). Patterson is owned by the Alameda Public Works Agency and includes 67 acres of seasonal wetlands (Figure 3).

Surveys

Snowy Plover Breeding Surveys

Snowy Plovers in the San Francisco Bay nest predominantly on dry pannes, berms, and levees located within former salt production ponds. To document areas used by Snowy Plovers and to estimate the number of Snowy Plovers at Hayward Shoreline and Patterson Pond, we conducted weekly surveys at both locations. Due to staff and time constraints, Hayward Shoreline was split into two distinct areas, Franks Dump, including Franks Dump East (FDE) and West (FDW) and Oliver Brothers North (OBN), and these areas were surveyed intermittently each week.

From February 28 to September 15, 2022, SFBBO biologists, interns, and volunteers surveyed all potential breeding ponds weekly by driving slowly on the levees or walking levees without vehicle access. We stopped approximately every 0.2 miles to scan for Snowy Plovers with spotting scopes. During each survey, we recorded the number and behavior of all Snowy Plovers present, identified the sex and age class of each individual using plumage characteristics (Page et al. 1991), and marked the approximate location of sightings on a geo-referenced paper map. We also recorded the color-band status, and combination if applicable, of any banded Snowy Plover sighted. Any observed instances of interspecies aggression between Snowy Plovers and other nesting shorebirds and/or seabirds were recorded.

From May 23-29, we participated in the Pacific Coast Snowy Plover breeding window survey. This survey was coordinated by the USFWS and SFBBO as part of an annual, regional effort to census all coastal-breeding Snowy Plovers during the same week. With the exception of Least Tern Island at Hayward Shoreline and the Warm Springs unit of Don Edwards NWR, SFBBO surveyed all suitable breeding habitat across and adjacent to the South Bay, including Franks Dump and Oliver Brothers North in Hayward Shoreline and Patterson Pond.

Nest Monitoring

Snowy Plover nests were located by first scanning for incubating adults or other signs of breeding behavior during weekly surveys. We then searched for nests on foot and recorded nest location using a custom nest monitoring application (Narwhal© on a smart phone).

We monitored nests either weekly (Patterson Pond) or every other week (Hayward Shoreline) until we determined the fate of the nest. On each survey, we recorded whether the nest was still active (adults incubating) and if visited up close, the number of eggs or chicks in the nest.

We defined a nest as successful if it hatched at least one egg. We calculated apparent nest success as the percentage of nests that successfully hatched at least one egg out of the total nests monitored.

Snowy Plover Nest Monitoring

During the first visit, we floated the eggs (Hays and LeCroy 1971) to estimate egg age if incubation had been observed (typically 3 egg clutch throughout most of season, sometimes 1-2 eggs later in season). Snowy Plover nests are active for an average of 33 days, from initiation (the date the first egg was laid) to hatching (Warriner et al. 1986), and using the known egg age, we calculated the nest initiation date and predicted hatch date for all nests monitored. When there were no longer eggs in the nest, we assigned each nest a fate based on evidence seen at the nest (Mabee 1997). Potential nest fates included: hatched, depredated, flooded, abandoned, failed to hatch, unknown, or other.

Snowy Plover Color Banding

Chick Banding

Since 2008, SFBBO has banded Snowy Plover chicks to study their movements and to estimate fledging success rates in the South Bay, when resources allowed. To band chicks, biologists checked nests daily, starting four days before the estimated hatch date. Due to the precocial nature of chicks, arrival at nests was timed to allow complete hatching of chicks prior to their movement away from the nest; this is typically a several hour window. We banded each chick with a unique four-color combination by placing two bands on each leg below the tibiotarsal joint. Each combination consisted of three darvic (XCLA Darvic Leg Bands I/D 3.1mm n.d.) or acetal (XCLA Acetal Leg Bands I/D 3.1mm n.d.) color bands and one silver U.S. Geological Survey band. All bands were then wrapped in colored auto pin-striping tape. Both darvic and acetal color bands were used depending on availability.

We defined a fledged chick as one that survived to 28 days of age, at which point it is considered to be capable of flight (Warriner et al. 1986). We calculated apparent fledging success as the percentage of fledged, banded chicks out of the total chicks banded. Since re-sighting banded chicks on large salt ponds can be very difficult, this method of estimating fledging success has significant limitations and is a conservative estimate.

Chicks fledged per male was determined using the same data for broods in which all chicks were banded, allowing for an estimate of the number of chicks fledged per male.

Adult Banding

In an effort to increase the number of color banded adults within the South San Francisco Bay, on several occasions we attempted to trap adults right after the eggs had hatched using snare mats placed near the nest. If adults were trapped while the chicks were being banded, biologists would quickly band and process the adult, then release and confirm they came back to the nest. If they were not trapped while the chicks were being banded, biologists would remove the snare mats and allow adults to return to the chicks.

Avian Predator Surveys

To identify avian predators in the area that might impact breeding Snowy Plovers, SFBBO biologists and interns conducted predator surveys concurrently when surveying ponds for Snowy Plovers. Volunteers conducted avian predator surveys at ponds surveyed monthly for Snowy Plovers. Observers chose survey points that provided a comprehensive scan of 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. In addition, observers documented any predator nests in the area and their fates when possible. We calculated the average number of predators observed per survey at each pond during the season. While most predators likely have a larger territory than a single

pond (Strong et al. 2004), we felt it meaningful to present indices of predator abundance at the pond scale since both predator, Least Tern, and Snowy Plover surveys were conducted at this level.

We defined avian predators as any species that could potentially prey on a Snowy Plover nest, chick, or adult. This includes most raptors, gulls, corvids, herons, and egrets (Table 5) found at Hayward Shoreline. While there are a number of potential mammalian predators (Table 6), and their signs (e.g., tracks) were recorded opportunistically, these surveys were not designed to detect mammals, particularly since many are nocturnal. Among all predators, we considered Northern Harriers, Peregrine Falcons, Common Ravens, California Gulls, and mammals (especially coyotes, red fox and striped skunk) to be the most critical potential predators to Snowy Plover adults, eggs, and chicks due to previous predation captured on camera and consistent with previous documentation of predation.

RESULTS

Snowy Plover Surveys

We observed a mean of 25.1±32.0 adult Snowy Plovers per week from February 28 through September 15 at FDW, with a maximum of 107 adults observed during the week of September 6 (Figure 6). Zero snowy plovers were observed at Franks Dump East throughout the season. At the OBN ponds, we observed a mean of 4.4±4.8 Snowy Plover adults, with a maximum of 20 observed during the week of April 25 (Figure 7). At Patterson Pond, we observed a mean of 9.9±8.6 Snowy Plover adults, with a maximum of 31 observed during the week of August 8 (Figure 8).

Early and Late Season Trends

Few Snowy Plovers were observed at Hayward Shoreline in March and April, with 2.2±2.0 adults observed at FDW (Figure 6) and 6.6±8.4 observed at OBN (Figure 7). During the same time frame, 9.6±4.7 adults were observed at Patterson Pond (Figure 8).

From the week of June 27 through the week of September 12, we observed large flocks of 47.9±34.2 adults at FDW (Figure 6), while at OBN we observed 4.3±1.8 adults during this time frame (Figure 7). During the same time frame, 13.5±11.6 adults were observed at Patterson Pond (Figure 8).

We observed a maximum of 107 adults at FDW during the week of September 6 (Figure 6), 20 adults at OBN during the week of April 25 (Figure 7), and 31 adults at Patterson Pond during the week of August 8 (Figure 8).

Snowy Plover Nesting

Nesting Abundance and success

Over the course of the breeding season, we monitored a total of 10 Snowy Plover nests at Hayward Shoreline. At FDW, we monitored six nests, finding that 83% hatched and the fate of 17% were unknown (Table 2). At OBN, we monitored four nests, finding that 25% hatched, 25% were depredated, 25% flooded, and 25% were collected and taken to a rehabilitation facility. (Table 2). Two nests were detected at the brood stage (one each at FDW and OBN), and since these locations were not surveyed weekly, it is possible that additional breeding activity went undetected.

At Patterson Pond we monitored a total of 11 Snowy Plover nests, finding that 18% hatched, 73% were depredated, and 9% were lost at hatch (Table 2). Three nests were detected at the brood stage, indicating that some breeding activity went undetected.

Snowy Plover Color Banding

Chick Fledging Success

As part of our efforts to document breeding success, we banded two chicks from one successfully hatched nest at OBN5 (Table 3). As of September 22, one of these chicks was determined to have fledged. It was first observed as fledged at Eden Landing Ecological Reserve (Eden Landing) pond E14 on September 13, and on September 19 was observed by Audubon Canyon Ranch biologist Nils Warnock at Abbott's Lagoon in Point Reyes National Seashore (Figure 9). One additional chick from OBN was banded, however this chick came from an OBN1 nest in danger of being flooded out and was hatched and raised in captivity. Once it was ready for release, it was banded and released at FDW.

At Patterson Pond, we banded three chicks that successfully hatched from one nest (Table 3). One of these chicks survived for at least two weeks after banding, however it was observed again and it not believed that any of these chicks survived to fledge.

Adult banding

Due to limited time and resources, we did not attempt to capture and band any adults at Hayward Shoreline or Patterson Pond. However, in the case of the OBN5 nest that was banded, the male of the nest ng:bb (brown over green on right and blue over blue on left) had been previously banded by SFBBO biologists on April 29, 2022 at Eden Landing pond E14.

Avian Predators

During avian focused predator surveys, we counted Common Ravens and Red-tailed Hawks as the most numerous potential avian predators at Franks Dump (0.5/survey), followed by California Gulls (Table 4). Throughout the season we observed Common Ravens foraging on pond bottoms in FDE and FDW, while Red-tailed Hawks were often perched on power towers.

California Gulls were present during the early and late parts of the season, and were observed either roosting or foraging in shallow water.

At OBN ponds, we counted Herring Gulls as the most numerous predators (0.94/survey), followed by Common Ravens (0.72/survey) and California Gulls (0.45/survey) (Table 5). A large flock of Herring Gulls were observed roosting at OBN5 in the early part of the season, but were not present during active nesting. Common Ravens were observed flying over and foraging within the ponds throughout the season, especially early in the season when there was a raven nest located in a power tower next to the Highway 92 toll plaza. This nest was removed by Don Edwards NWR Biologists and Pacific Gas and Electric (PG&E). California Gulls were observed roosting and foraging in the early and late portions of the season.

At Patterson Pond, California Gulls were the most frequently observed predator (3.68/survey), followed by Common Ravens (0.64/survey) and Northern Harriers (0.43/survey). The majority of California Gulls observed were in transit over the pond and were likely headed to or from their breeding colony located 1.5 miles to the south on levees within the Coyote Hills salt ponds. Common Ravens nested within a PG&E transmission tower in the corner of the pond during the first half of the season, and later in the season were observed foraging in the pond. Northern Harriers, often males, were observed hunting in the pond, and on several occasions a male harrier was observed roosting on the vegetated levee in the interior of the pond.

Mammalian Predators

Although our predator surveys are designed to detect avian activity, we did make some opportunistic observations of mammalian predators. At FDE, a feral cat was observed hunting on one occasion (Table 4), while at OBN, a coyote was observed once (Table 5).

No observations of mammalian predators occurred at Patterson Pond, however skunk tracks near a depredated plover nest indicate that they may have impacted plover breeding success. Sheep, herders and herding dogs were brought to adjacent Coyote Hills Regional Park (Coyote Hills RP) by EBRPD for vegetation management, and on August 10 we observed a sheep stuck in mud on the north central edge of the pond. We also found evidence of sheep walking along the inner vegetated levee on the pond. The sheep was pulled out of the mud by herders. On August 17, approximately 20 sheep were observed in the northeast corner of the pond. They were guided by herders back onto the park by herders.

Human Disturbance

FDW is located along the intersection of two heavily used public trails, and pedestrians were frequently observed using both trails during surveys (0.55/survey)(Table 4). They were not observed trespassing onto the pond, but footprints on the western edge of the pond indicate that trespass onto sensitive habitat did occur. Domestic dogs were observed 0.25/survey, with many not on leash and some venturing onto sensitive habitat on the pond.

No observations or human tracks indicating trespass were observed at OBN.

Patterson Pond is located along a busy section of the SF Bay Trail along the Alameda Flood Control Channel, and although we did not record pedestrians observed using the trail, on two occasions we observed trespass from Coyote Hills RP onto the southern levee where access is restricted.

DISCUSSION

Population Size

Hayward Shoreline

The number of adult Snowy Plovers observed at Hayward Shoreline during the breeding window declined by approximately 1/3 from 2021 (58) to 2022 (36)(Table 1). As opposed to 2021, when all adults were found at FDW and OBN, in 2022 26 adults were found in these areas and 10 were found at EBRPD monitored Least Tern Island. The decline in population size may have been due to higher water levels at both FDW and OBN during the survey, resulting in a lower amount of available breeding habitat at the time of the survey. Nevertheless, the 2022 count was the second largest breeding window survey count at Hayward Shoreline and accounted for 13% of the South San Francisco Bay window survey total, highlighting the regional importance of this site to reaching the Snowy Plover Recovery Unit 3 population goal of 500 adults.

Patterson Pond

At Patterson Pond, we observed four adult Snowy Plovers during the breeding window survey (Table 1), also a decline from 2021 (8). The decline in adults observed during the window survey was likely in part due to higher water levels and less available breeding habitat on-site. Since this site is seasonal and available breeding habitat is dictated by winter and spring precipitation, installing water control structures connected to the Alameda Flood Control Channel would allow for consistent seasonal management of this pond for plovers during the breeding season, while it could be managed for migrating and wintering shorebirds and waterfowl during the rest of the year. This strategy is used to great effect at both Don Edwards NWR and Eden Landing, including at the Eden Landing 2C System directly across the flood channel from Patterson Pond. Since this system will soon be restored to muted tidal action, providing similar habitat at Patterson Pond would help account for the habitat loss.

The lower population observed during the survey may have been also due to the presence of a Common Raven nest on-site. Two of the first three nests initiated on-site were depredated, possibly by the ravens, and it is possible that as a result these plovers dispersed in search of safer nesting habitat.

Nest Abundance and Success

Hayward Shoreline

We monitored a total of ten nests at FDW and OBN in 2022 (Table 2), a notable decline from 2021 when we monitored a total of 25 nests in these areas. As with population size, the decline in nest abundance may have been linked to a lack of available breeding habitat for part of the season. The first nest initiation at FDW in 2022 occurred on June 2 (Figure 10), while the first nest initiation at FDW in 2021 occurred on May 5. Similarly, the first nest initiation at OBN in 2022 occurred on June 5 (Figure 11) and the first 2021 nest initiation occurred on April 10. With nesting beginning close to a month later at FDW and almost two months later at OBN, there would have been less time for Snowy Plovers to nest at these sites.

The decline in nest abundance may have also been due to the poor nest success observed in 2021, when only 24% of monitored nests at FDW and OBN hatched. Snowy Plovers have a high degree of natal site fidelity (Stenzel et al. 2007), and adults may also show high levels of breeding site fidelity to locations where their eggs hatched in prior years (Carleton Eyster, pers. comm.). Thus, the combination of few juveniles potentially returning to breed at their natal site and poor hatching success in 2021 may have also contributed to the reduction in nest abundance.

Although we observed a decline in nest abundance at FDW, hatching success improved in 2022 (83%) compared to 2021 (15%). While it is difficult to draw strong conclusions due to the smaller sample size, it is important to note that Snowy Plovers are a semi-colonial species that rely upon crypsis to evade predation. As part of this strategy, incubating adults flush off nests when predators are observed from as far away as 600ft, thus reducing the likelihood that a predator knows a nest is in the area. High density nesting such as what was observed at FDW in 2021 can sometimes reduce the effectiveness of this strategy because it increases the chances that a predator will observe an incubating plover on the pond and depredate one of, if not many of the nests. This occurred at FDW in 2021, when seven nests were depredated in one week. Thus, the higher hatch success observed at FDW in 2022 may have been in part a result of reduced nesting density.

Flooding at OBN

Although only one monitored nest and one undetected nest survived to hatch at OBN, the biggest impact to hatch success at these ponds in 2022 was rising water levels during king tides in July. Due to rising water levels overtopping levees, on July 12 one nest in OBN1 was found wet, and had it been left alone, the eggs would have floated away by the next tide when more water entered the pond. SFBBO biologists collected the eggs and took them to International Bird Rescue, where two eggs hatched and one juvenile was successfully raised and eventually banded and released at FDW. During the same king tide event, water also overtopped the levees adjacent to OBN12 and inundated a nest in this pond. SFBBO learned that OBN1 floods up during July 2021 king tides, and thus we were monitoring water levels in the pond as the

tides began to rise. We did not realize that OBN12 also flooded up during high tide events, and thus were surprised to find that the nest had been flooded out.

The OBN ponds are planned to be restored to tidal action under the Hayward Area Shoreline Planning Agency's Adaptation Master Plan. Until this occurs, these ponds will continue to support breeding Snowy Plovers, and as such, it is important that the issue of nests being flooded out by water overtopping levees is addressed. Since the area may eventually be opened to tidal action, the issue could be addressed via a short term solution such as placing sandbags along the length of the levees. Alternatively, if it is later determined that these ponds won't be opened to tidal action due to impacts to Snowy Plovers, the levees could be raised and the entire pond system could be reconfigured to provide high quality breeding habitat.

Patterson Pond

Nest abundance declined slightly at Patterson Pond, with 11 nests monitored and three nests detected at the brood stage in 2022 (Table 2) compared to 19 nests monitored in 2021. More importantly, hatching success decline greatly from 2021 (73%) to 2022 (18%). While higher water levels may have reduced the amount of available breeding habitat on-site until later in the season, the first nest was initiated on April 5, with additional nests initiated on April 8, 15 and 20 (Figure 12). Instead, the presence of an active Common Raven nest in a PG&E transmission tower in the northwest corner of the pond likely impacted breeding activity. Ravens were first observed building the nest on April 15, and by April 20, two of the first three initiated Snowy Plovers nests had been depredated. These nests were located 345 and 425 meters away from the raven nest, respectively, and would have been easily spotted from the tower. The first nest initiated was located 805 meters from the raven nest, and thus was able to survive longer. However, based upon our nest monitoring data we believe that the eggs and/or chicks were depredated while in the process of hatching, possibly by the ravens. Additional nests were not initiated on-site until May 17 and May 26, with one surviving to hatch and one being depredated by June 9. Only five additional monitored nests were initiated the rest of the season, in June and July, possibly due to the high rate of observed nest loss early in the season. Similar trends have been observed in other areas by SFBBO, most notably at Eden Landing pond E14. This pond is often the most important Snowy Plover breeding site in the Bay Area, supporting as many as 145 nests in 2018 (Pearl et al. 2019). However, in recent years the pond has suffered high nest depredation early in the season, resulting in only 40 nests monitored in 2021 and abandonment of the pond by breeding Snowy Plovers by July.

Snowy Plover Banding

Chick Fledging Success

Despite making several attempts to band nests at FDW, we were unable to time our efforts with when chicks were ready to band, and thus no chicks were banded at FDW in 2022. We observed that at all three unbanded chicks from the last nest to hatch survived to fledge, indicating that this pond produced at least three juveniles and possibly more. We were able to band two chicks from the only monitored nest to hatch at OBN, and from our band resighting

efforts we confirmed that at least one of these chicks survived to fledge (Table 3). One additional banded chick raised in captivity also came from OBN. Three other chicks hatched from an undetected nest at OBN and survived for at least two weeks, but it is unknown if they survived to fledge. Therefore, we can confirm that at least two juveniles were produced from 15 eggs laid at OBN, with a maximum of 6 juveniles produced if the other banded chick and all three undetected chicks also fledged.

With a small sample size of chicks hatched and banded in OBN in 2021 and 2022, it is difficult to make conclusions about the habitat quality for broods. However, based upon our experience at other sites it appears to be low quality currently. The presence of power towers along Highway 92 and seasonal overtopping of levees does limit habitat quality, but there are many habitat improvements that could attract more plovers to nest in OBN and improve their hatching and fledging success. The most straightforward of these is removal of remnant salt production infrastructure, which is littered across OBN and both obstructs Snowy Plovers viewshed (what is visible from their standpoint) and provides numerous perches for avian predators. Eliminating perches would improve Snowy Plovers viewshed, allowing them to better detect approaching predators, while reducing avian predator's ability to hunt in these ponds. In addition, spreading oyster shell, gravel, or other enhancement materials at both OBN and FDW would improve the crypsis of adults, eggs, and chicks, possibly resulting in more nests on-site and better hatching and fledging success. This type of work has been carried out by SFBBO at nearby Snowy Plover breeding habitat, including Eden Landing and Don Edwards NWR. While these efforts have been successful to a degree, they have eventually resulted in high rates of predation due to high breeding density. Thus, increasing habitat quality at OBN and FDW could improve habitat quality for breeding Snowy Plovers across the South San Francisco Bay by providing them with additional high quality breeding habitat and possibly reducing nesting density across all sites.

As with Hayward Shoreline, we were unable to band as many chicks as we hoped to due to lack of nests hatching. Three chicks were banded from one nest, but only one was observed at two weeks old and it is not believed to have fledged. We did observe that five unbanded chicks appeared to have survived to fledge, and thus it appears that this site produced at least five juveniles. In order to hatch more chicks and improve fledging success, habitat quality must be addressed at Patterson. One of the most pressing issues is the presence of an electrical transmission tower in the corner of the pond that supported a Common Raven nest in 2022. PG&E was unable to remove the nest due to the type of tower, and along with remnant hunting blinds and salt pond infrastructure, provides a perch for avian predators. The presence of raised levees in the interior and exterior of the pond also obstruct the viewshed of Snowy Plovers, reducing the ability of chicks to hide and adults to leave the area. Furthermore, the lack of habitat complexity limits the ability of chicks to evade predators. There are a number of habitat enhancements to address these issues that could lead to increased hatching and fledging success. Modification of the transmission tower to prevent nesting in it and removal of all remaining perches could improve fledging success. Lowering the inner levee and spreading the soil from the lowered levee around the pond would have the dual benefit of increasing Snowy Plovers viewshed and creating more suitable nesting habitat by raising the elevation of portions

of the pond. Spreading oyster shell, gravel, or other habitat enhancement materials would improve the crypsis of adults, eggs and chicks. Lastly, installation of a water control structure connected to Alameda Flood Control Channel would allow for consistent management of the pond, ensuring that the site would provide suitable nesting and foraging habitat and would not run out of water, which occurred in 2021. Collectively, these actions would create high quality Snowy Plover breeding habitat that would increase on-site productivity, and as with FDW and OBN, provide another alternative breeding site to the large sites elsewhere in the South Bay.

Avian Predators

Common Ravens were either the first or second most observed avian predator at FDW, OBN, and Patterson (Tables 4-6). They have previously been identified as the predator posing the greatest hurdle to Snowy Plover recovery at nearby Eden Landing (Pearl et al. 2016, Pearl and Chen 2018), as well as at Hayward Shoreline (Pearl and Wang 2021), and it is likely that they again were at Hayward Shoreline and Patterson Pond in 2022. The most important step to reducing their impact on Snowy Plovers is to prevent them from nesting near breeding habitat, as research has found that ravens provision their chicks with a higher proportion of other bird's eggs and chicks when close to a high density nesting area (Harju et al. 2021). Don Edwards NWR and PG&E have worked in cooperation to remove the nests of ravens and other predators from sensitive areas near Don Edwards NWR and Eden Landing, including in 2022 when they removed one raven nest from a power tower along Highway 92. The raven nest located at Patterson Pond was within a transmission tower that was difficult to access, and as a result it was not removed. In future years, it is important that this tower is either retrofitted to prevent nesting in it or a method to remove nests is identified. Furthermore, if EBRPD and HARD were to join in this program by scouting power towers and other potential nesting sites within and adjacent to Hayward Shoreline, this could further strengthen the effectiveness of this program and limit raven predation on Snowy Plover and Least Tern eggs and chicks.

In addition to preventing ravens from nesting nearby, implementing predator control at FDW, OBN, and Patterson Pond is an important tool that could further reduce the impact of ravens and other predators on breeding Snowy Plovers and Least Terns. Predator control is already implemented at Least Tern Island in Hayward Shoreline and nearby Eden Landing and Don Edwards NWR, and it is possible that expanding to these areas would improve the overall efficacy of these efforts. As a component of expanding this program, plover/least tern volunteer docents stationed along trails could also keep watch on breeding areas and notify SFBBO, EBRPD, and HARD staff when ravens and other predators are observed in ponds.

Human/Dog Disturbance

Pedestrian and cyclist use of trails at Hayward Shoreline and along the Alameda Creek Trail next to Patterson remained high in 2022. We did not observe any signs of trespass at OBN, but found pedestrian and dog tracks on the pond at FDW. Both dogs and people are viewed as predators by Snowy Plovers, and on coastal sandy beaches dogs have been observed chasing

Snowy Plover adults and chicks and occasionally killing them, as well as accidentally trampling eggs. Off-leash dogs are currently permitted on the trails surrounding FDW, and since there is no interpretive signage in these areas, dog owners likely would not realize that the pond provides habitat for sensitive species. FDW is proposed for tidal marsh restoration under the Hayward Area Shoreline Planning Agency's Adaptation Master Plan, but will continue to provide Snowy Plover breeding habitat in the near future. Requiring dogs on-leash around FDW, as well as installing interpretive signage, would help reduce the impact of both dogs and people on breeding Snowy Plovers at this site.

At Patterson we observed bicycle tracks on the pond and both pedestrians and cyclists on the southern levee. The bicycle tracks were found in the northern central area of the pond near the Alameda Creek Trail, an area with concentrated breeding activity in 2021 but only two known nesting attempts in 2022, likely due to the substrate being wetter in 2022. However, the pedestrians and cyclists on the southern levee would have been close to active nests and foraging broods, resulting in adults flushing off of nests and broods pushed away from preferred foraging and hiding locations. This issue was addressed by Alameda County Public Works Agency, who installed permanent barb wire fence to block access to this levee from the Coyote Hills RP Bayview Trail and a locked chain linked fence to block access to this levee from the Alameda Creek Trail. Installation of additional interpretive signage along the Alameda Creek Trail would help to reduce trespass into the northern areas of the pond.

MANAGEMENT RECOMMENDATIONS

We have provided a list of management recommendations for each site monitored based upon our surveys and observations from 2022 and expertise in Snowy Plover conservation, habitat enhancement and management.

Franks Dump West

1. Require dogs to be on-leash along trails adjacent to the pond
2. Install interpretive signage at key trail locations highlighting the importance of the habitat to breeding Snowy Plovers and their sensitivity to disturbance
3. Install signage/symbolic fencing along the trail to reduce/prevent trespass
4. Enhance the pond bottom with oyster shells, gravel, or other materials to increase crypsis for adults, eggs, and chicks
5. Institute avian and mammalian predator management

Oliver Brothers North

1. Install interpretive signage at key trail locations highlighting the importance of the habitat to breeding Snowy Plovers and their sensitivity to disturbance
2. Implement short-term solution (i.e. sandbags) to levees overtopping during extreme high tides, consider long term solutions to provide high quality habitat
3. Remove remnant salt production infrastructure that provide predator perches and obstruct Snowy Plovers ability to detect predators

4. Enhance the pond bottom with oyster shells, gravel, or other materials to increase crypsis for adults, eggs, and chicks
5. Institute avian and mammalian predator management

Patterson Pond

1. Install interpretive signage at key trail locations highlighting the importance of the habitat to breeding Snowy Plovers and their sensitivity to disturbance
2. Install additional signage/symbolic fencing along the trail to reduce/prevent trespass
3. Remove remnant salt production infrastructure that provide predator perches and obstruct Snowy Plovers ability to detect predators
4. Enhance the pond bottom with oyster shells, gravel, or other materials to increase crypsis for adults, eggs, and chicks
5. Institute avian and mammalian predator management
6. Install a water control structure on Alameda Flood Control Channel and reconfigure the pond to provide consistently available high quality breeding and foraging habitat

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Figure 1. Ponds in HARD/EBRPD's Hayward Regional Shoreline, Hayward, California.

Figure 2. Ponds within Oliver Brother's North, Hayward Regional Shoreline, Hayward, CA.

Figure 3. The location of Patterson Pond, located next to Coyote Hills Regional Park and the Alameda Flood Control Channel in Fremont, CA.

Figure 4. Snowy plover nest at Frank's Dump West, Hayward Regional Shoreline, Hayward, CA. The female of this nest hatched at Point Reyes National Seashore in 2021 and was banded av:rv (aqua over violet on the left, red over violet on the right) as a chick.

Figure 5. Three color banded snowy plover chicks at Patterson Pond, Fremont, CA.

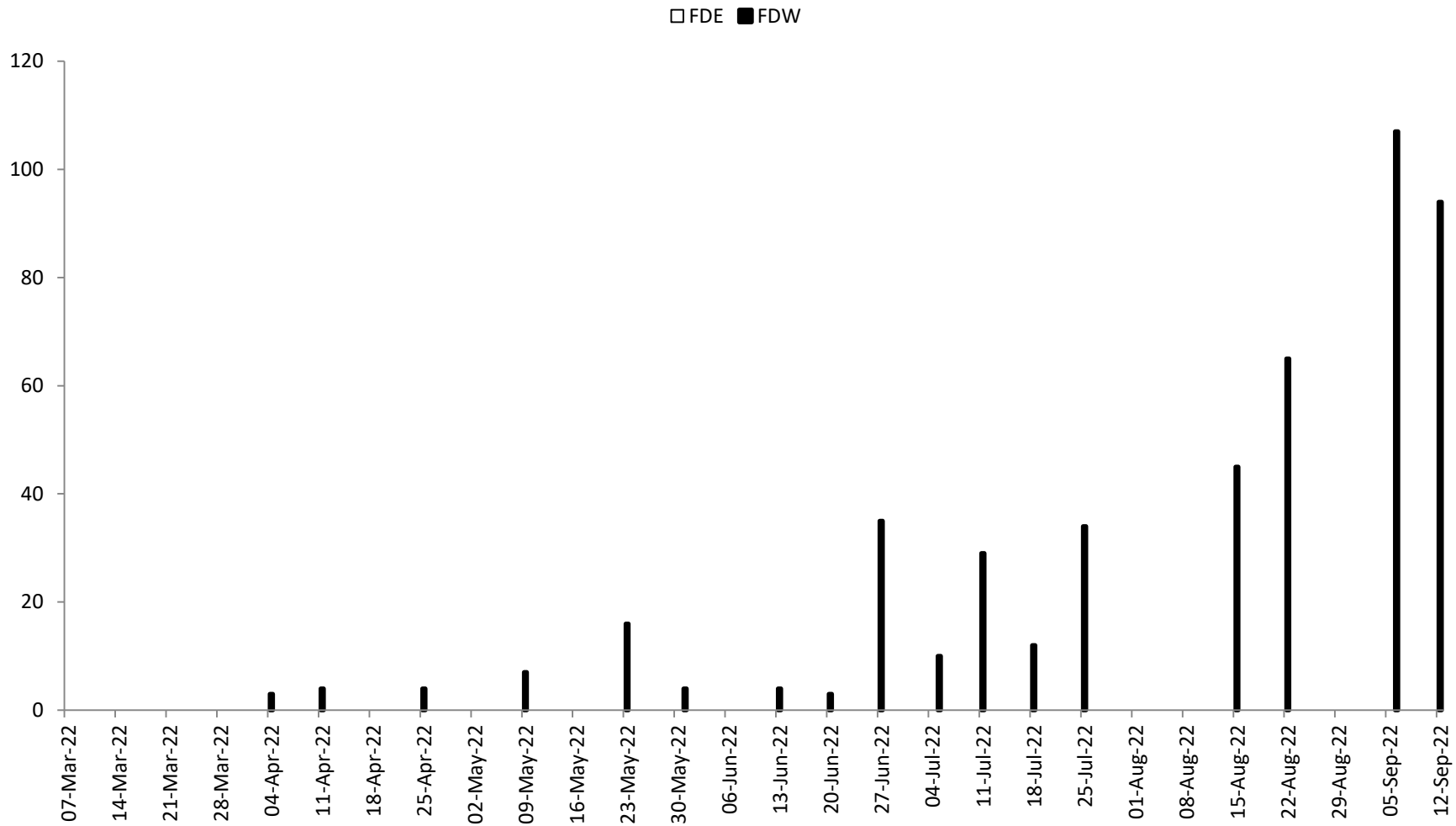

Figure 6. Weekly counts of Snowy Plover adults observed from March 7-September 15, 2022, at Frank's Dump West (FDW) and East (FDE), Hayward Shoreline, Hayward, CA. A total of 19 surveys were conducted at these ponds, with Snowy Plovers observed at Franks Dump West during all surveys with the exception of March 7 and March 21. Zero Snowy Plovers were observed at Franks Dump East throughout the season.

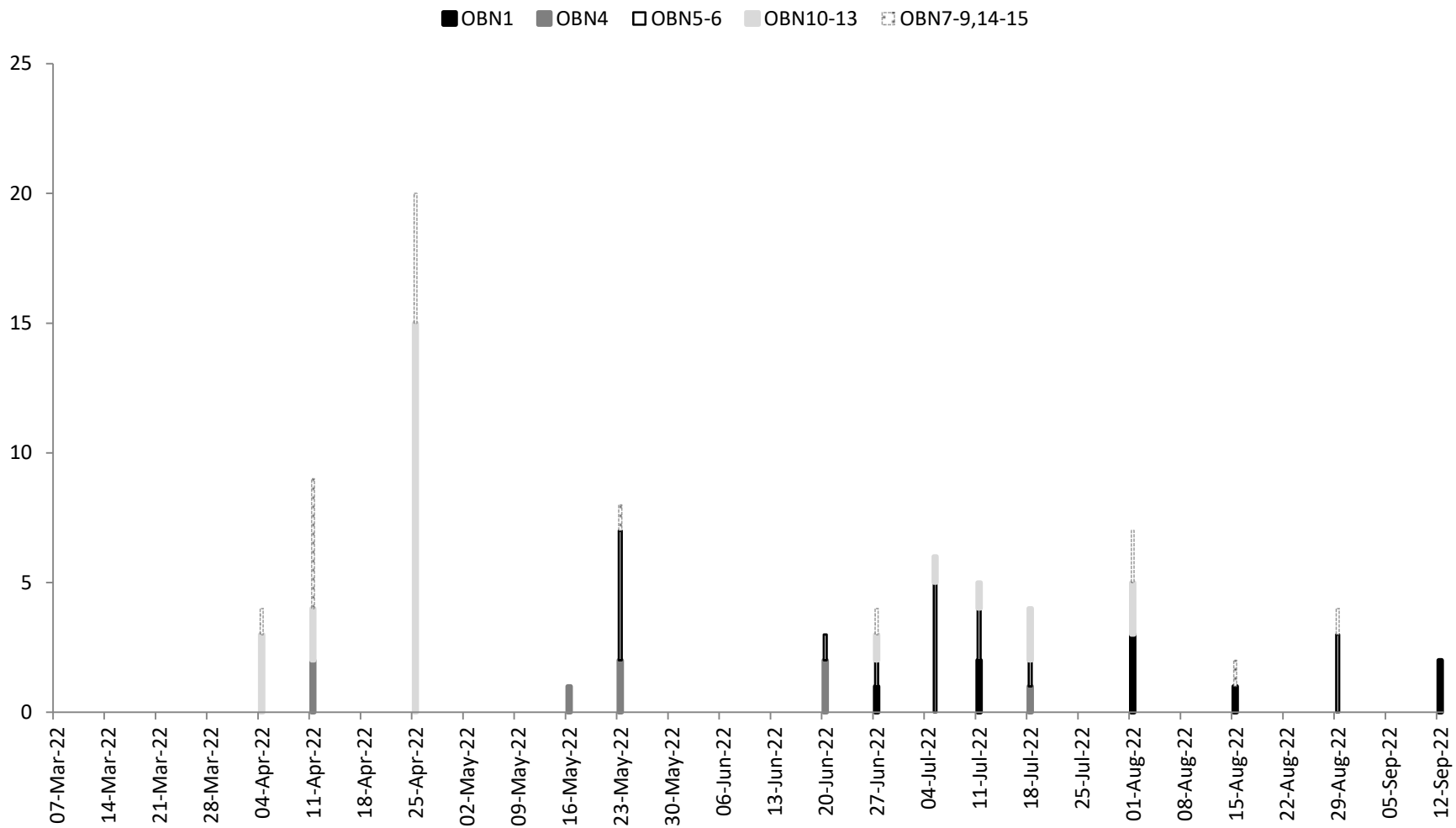

Figure 7. Weekly counts of Snowy Plover adults observed from March 7-September 15, 2022, at the Oliver Brothers North Salt Ponds, Hayward Shoreline, Hayward, CA. A total of 18 surveys were conducted at these ponds, with Snowy Plovers observed during 14 of these surveys. Snowy Plovers were not observed on March 7 and 21, May 2, or June 6. Ponds were grouped together if remnant salt production fences were the only separation between them. Zero Snowy Plovers were observed at ponds OBN2-3 and OBN16-17.

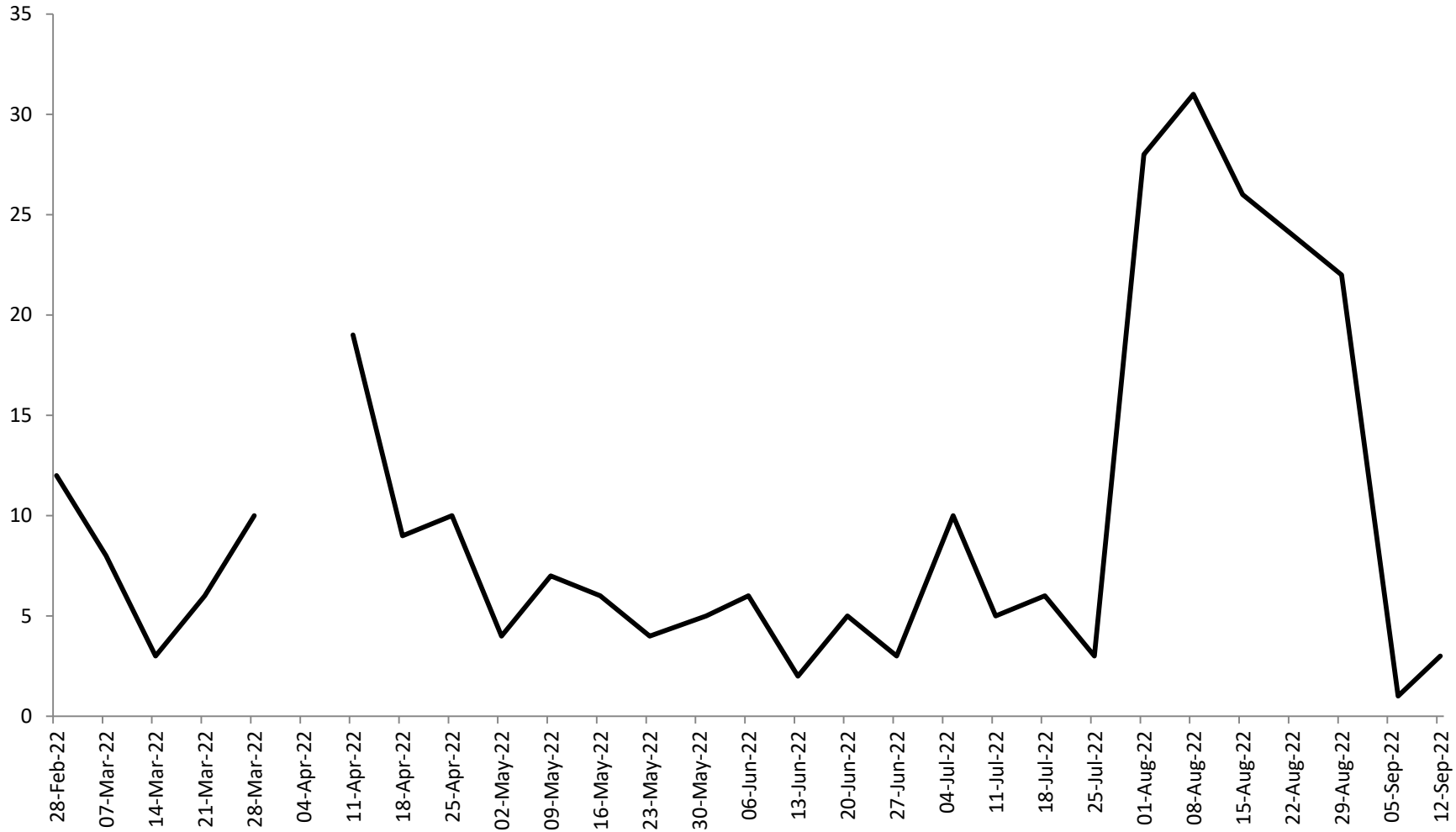

Figure 8. Weekly counts of Snowy Plover adults observed from February 28-September 15, 2022 at Patterson Pond, Fremont, CA. A total of 28 surveys were conducted at this site.

Figure 9. Snowy Plover juvenile na:rw (brown over aqua on left, red over white on right) banded as a chick at OBN5 on July 21, 2022, observed at Abbott's Lagoon, Point Reyes National Seashore, CA on September 19, 2022. Photo courtesy of Nils Warnock.

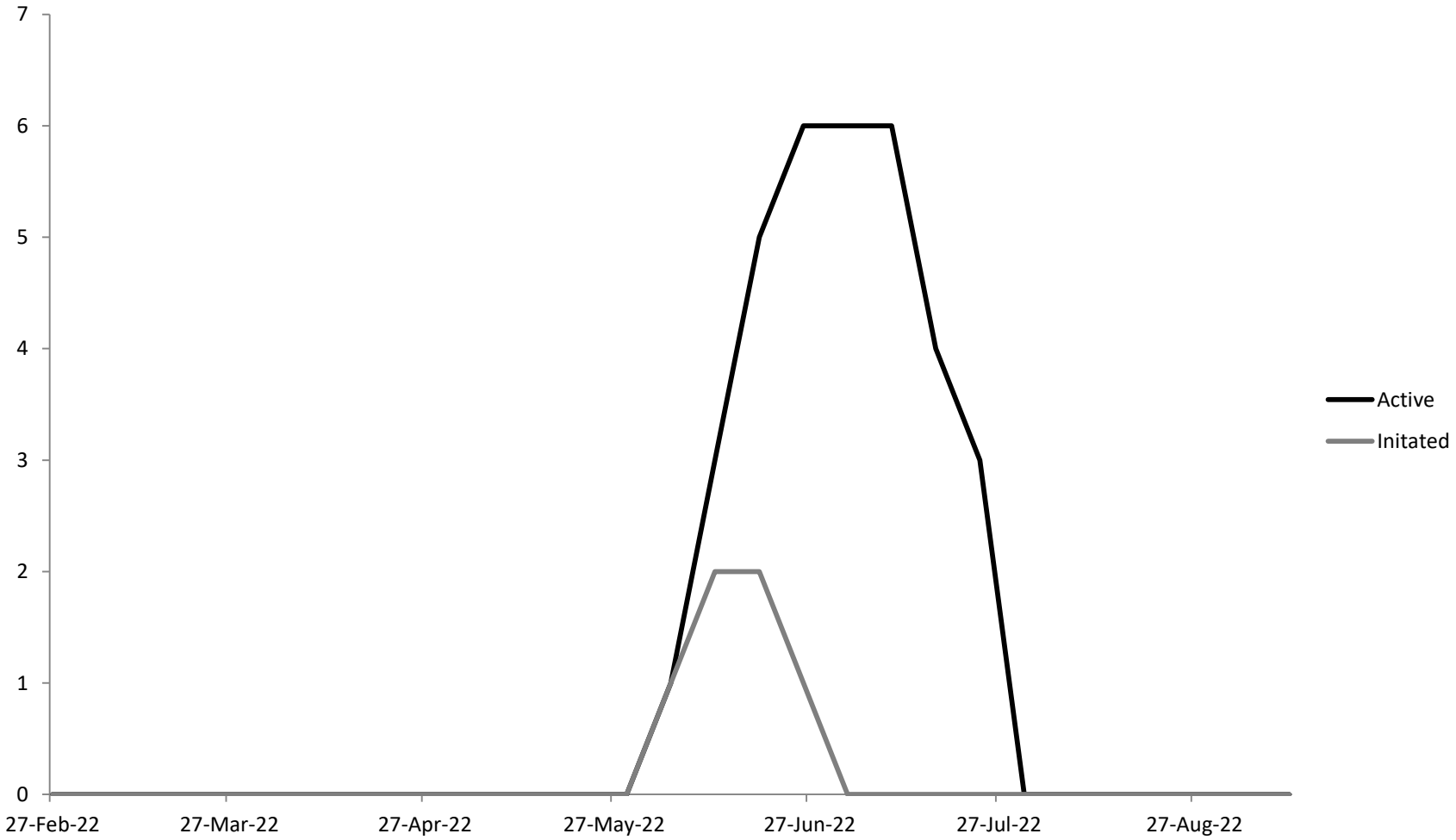

Figure 10. Active and Initiated Snowy Plover nests by date at Franks Dump West, Hayward Shoreline, Hayward, CA during the 2022 breeding season.

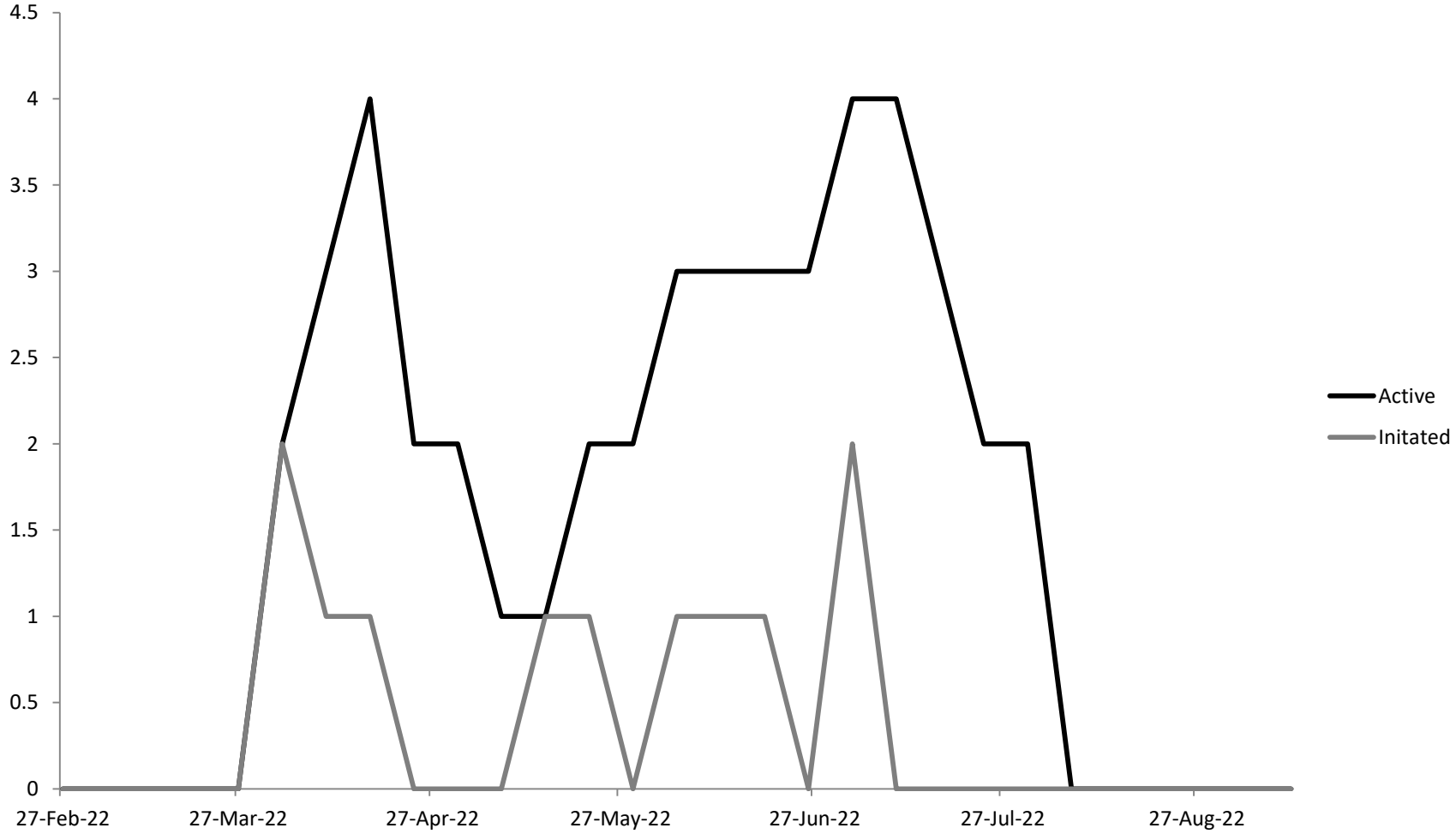

Figure 11. Active and Initiated Snowy Plover nests by date at Patterson Pond, Fremont, CA during the 2022 breeding season.

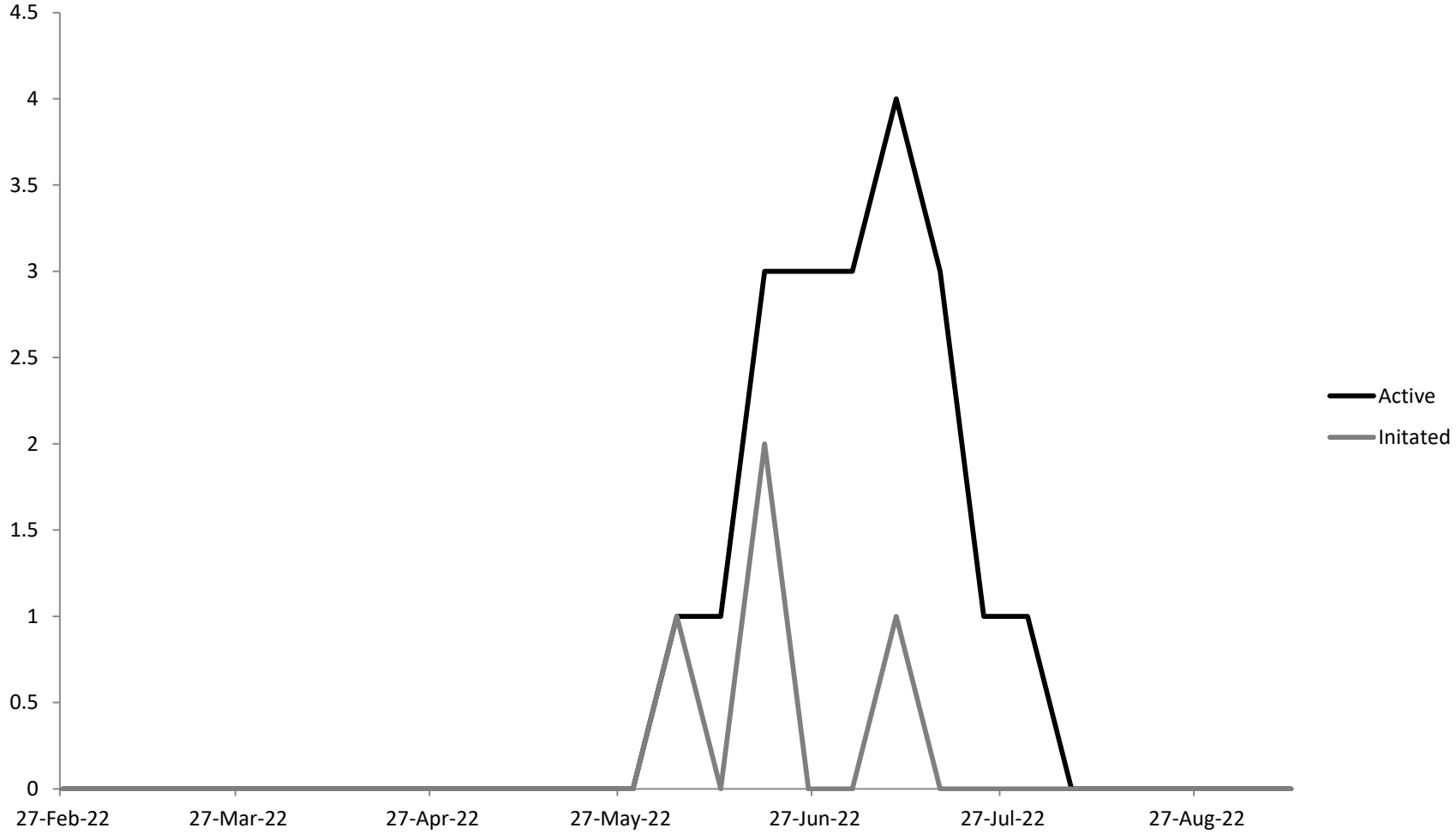

Figure 12. Active and Initiated Snowy Plover nests by date at the Oliver Brothers North ponds, Hayward Shoreline, Hayward, CA during the 2022 breeding season.

Table 1. Number of Western Snowy Plovers observed at Recovery Unit 3 sites during annual breeding window surveys in May, 2007-2022. A dash in place of a number indicates that the site was not surveyed. Note that the East Bay Regional Parks District surveyed one site at Hayward Shoreline in 2022, where they observed 10 adult Snowy Plovers.

REGION	SITE	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Alameda	Eden Landing	184	185	82	97	94	76	120	144	142	117	115	44	89
	Coyote Hills	0	0	0	0	0	0	1	0	0	1	0	8	4
	Crown Beach	-	-	-	-	0	0	0	-	-	-	-	0	0
	Dumbarton	0	0	0	0	0	0	0	2	7	2	-	16	12
	Hayward	12	8	9	32	7	2	4	0	7	12	19	56	36
	Warm Springs	27	17	3	1	11	24	14	2	20	7	-	5	5
Marin	Hamilton Wetlands	-	-	-	-	-	-	0	-	0	0	2	0	5
Napa	Napa	10	1	0	3	10	10	0	-	2	2	-	0	4
San Mateo	Ravenswood	42	27	33	59	45	68	42	76	51	48	-	67	74
Santa Clara	Alviso	0	11	20	10	0	1	21	19	4	1	-	23	39
	Mountain View	-	-	-	-	11	0	0	0	2	0	8	35	8
North Bay Delta	Montezuma Wetlands	-	-	-	-	-	14	6	3	0	0	3	9	5
Total Unit 3		**275**	**249**	**147**	**202**	**178**	**195**	**208**	**246**	**235**	**190**	**147**	**263**	**281**

Table 2. Snowy Plover nest fates in 2022 at Hayward Regional Shoreline, Hayward, CA and Patterson Pond, Fremont, CA.

Location	Hatched	Depredated	Lost at Hatch	Flooded	Collected	Unknown	**Total Nests Monitored**	**Detected as Brood**	**Total Nests**
Hayward									
FDW	5	0	0	0	0	1	**6**	1	**7**
*Least Tern Island	5	0	0	0	0	1	**6**	0	**6**
OBN1	0	0	0	0	1	0	**1**	0	**1**
OBN4	0	1	0	0	0	0	**1**	0	**1**
OBN5	1	0	0	0	0	0	**1**	0	**1**
OBN12	0	0	0	1	0	0	**1**	0	**1**
OBN14	0	0	0	0	0	0	**0**	1	**1**
Hayward Total	11	1	0	1	1	2	**16**	2	**18**
Coyote Hills									
Patterson	2	8	1	0	0	0	**11**	3	**14**
Total	**13**	**9**	**1**	**1**	**1**	**2**	**27**	**5**	**32**

*Least Tern Island was monitored by EBRPD; nest totals are included to provide context for Snowy Plover breeding effort at Hayward Regional Shoreline.

Table 3. Apparent fledging success of Snowy Plover chicks by pond and chicks fledged per male at Hayward Shoreline, Hayward, CA and Patterson Pond, Fremont, CA, 2022. Chicks were considered fledged if they survived to 28 days. *N* is the number of individuals banded.

Pond	N	Fledged	Fledging Success	Males	Chicks fledged/Male
OBN5	2	1	50%	1	1.0
Patterson	3	0	0%	1	0.0
Total	**5**	**1**	**20%**	**2**	**0.5**

*3 eggs in danger of being flooded out were collected from OBN1, of which two hatched at International Bird Rescue and one was successfully raised, banded, and released at FDW.

Table 4. The average number of predators observed per survey at Franks Dump East and West, Hayward Shoreline, Hayward, CA March-September 2022. The number of surveys conducted is in parentheses.

Species	FDE (20)	FDW (20)
Human	0	0.55
Red-tailed Hawk	0.5	0
Common Raven	0.25	0.25
California Gull	0	0.35
Domestic Dog	0	0.25
Northern Harrier	0	0.15
American Crow	0.05	0.1
Peregrine Falcon	0.05	0
Cooper's Hawk	0	0.05
Feral Cat	0.05	0
Glacuous-winged Gull	0	0.05
Great Blue Heron	0	0.05
White-tailed Kite	0	0.05

Table 5. The average number of predators observed per survey at Oliver Brothers North Ponds, Hayward Regional Shoreline, Hayward, California, March-September 2022. The number of surveys conducted is in parentheses.

Species	OBN1(18)	OBN4(18)	OBN5(18)	OBN 10-13(18)	OBN14-15(18)	OBN17(18)
Herring Gull	0	0	0.94	0	0	0
Common Raven	0	0.22	0	0.22	0.28	0
California Gull	0.17	0.11	0	0.11	0.06	0
Red-tailed Hawk	0.06	0.06	0.06	0	0.06	0
Peregrine Falcon	0.11	0	0	0	0.06	0
Northern Harrier	0	0	0	0	0.06	0
Coyote	0	0	0	0	0	0.06
Great Egret	0	0	0	0.06	0	0
Western Gull	0	0	0.06	0	0	0

*OBN ponds with zero observed predators: OBN 2-3, 6-8, 16

Table 6. The average number of predators observed per survey at Patterson Pond, Fremont, California, March-September 2022. The number of surveys conducted is in parentheses.

Species	Patterson Pond (28)
California Gull	3.68
Common Raven	0.64
Northern Harrier	0.43
Great Blue Heron	0.18
Snowy Egret	0.14
Great Egret	0.11
Human	0.04
Peregrine Falcon	0.04

Table 7. Potential avian predator species.

Common Name	**Scientific Name**
American Kestrel	*Falco sparverius*
Merlin	*Falco columbarius*
Peregrine Falcon	*Falco peregrines*
Prairie Falcon	*Falco mexicanus*
Bald Eagle	*Haliaeetus leucocephalus*
Golden Eagle	*Aquila chrysaetos*
Cooper's Hawk	*Accipiter cooperii*
Red-Tailed Hawk	*Buteo jamaicensis*
White-tailed Kite	*Elanus leucurus*
Northern Harrier	*Circus Cyaneus*
California Gull	*Larus californicus*
Western Gull	*Larus occidentalis*
Herring Gull	*Larus argentatus smithsonianus*
Glaucous-winged Gull	*Larus glaucescens*
Short-billed Gull	*Larus brachyrhynchus*
Ring-Billed Gull	*Larus delawarensis*
American Crow	*Corvus brachyrhynchos*
Common Raven	*Corvus corax*
Black-crowned Night-Heron	*Nycticorax nycticorax*
Great Blue Heron	*Ardea herodias*
Great Egret	*Ardea alba*
Snowy Egret	*Egretta thula*
Loggerhead Shrike	*Lanius ludovicianus*

Table 8. Potential mammalian predator species.

Common Name	Scientific Name
Red fox	*Vulpes vulpes*
Grey Fox	*Urocyon cinereoargenteus*
Striped Skunk	*Mephitis mephitis*
Virginia Possum	*Didelphis virginiana*
Domestic Cat	*Felis catus*
Coyote	*Canis latrans*

Table 9. Docent survey results at Hayward Shoreline, Hayward, CA and Patterson Pond, Fremont, CA.

Date	Location	Group Size	Type	Info. Shared	Nature of Contact	Notes
06/03/22	Patterson	3	B	E,P,C,R,H,S	Very Positive	Showed incubating Snowy Plover adult through scope; SFBBO contacted two weeks later by one of the bicyclists, recorded American Kestrel taking three Snowy Plover Chicks nearby at Don Edwards NWR HQ
6/28/22	Patterson	2	P	E,C,S	Positive	Couple jogging along the trail, curious to see what docents looking at since they use trail frequently.
6/28/22	Patterson	1	B	E	Positive	Never heard of Snowy Plovers, appreciate efforts of SFBBO to monitor
7/01/22	OBN1-17	2	P	E,P,C,R	Very Positive	Interested to learn about breeding Snowy Plovers, didn't know they were present in the Bay. Showed incubating plover on OBN1
7/08/22	OBN1-17	4	P	E,P,C,R	Positive	Interested to learn more about how to get involved with SFBBO
7/26/22	Patterson	3	P	E,P,C	Positive	Familiar with Snowy Plovers, didn't know they nested at this site.

Type: P=Pedestrian, B=Bicyclist, O=other
Information Shared: E = tern/plover breeding ecology, P = salt pond history and site information, C = conservation status, R = Restoration Project, H = how to help advocate, support, S = SFBBO general info