Appendix H. Bird Monitoring Results

Appendix H

Sears Point Restoration Area
2016–2021 Avian Monitoring Report

Assessing avian richness and abundance of a tidal restoration site in San Pablo Bay

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INTRODUCTION

The San Francisco Bay Estuary (the Bay) hosts millions of migrating, breeding, and wintering birds annually (Page et al. 1999). The significant reduction of historic wetlands in the Bay has resulted in decreased abundance and diversity of the avian community that relies on the baylands habitat (Harvey 1992). Bird communities are effective indicators of marshland ecological condition (DeLuca et al. 2008) and avian abundance and diversity provide valuable insight when tracking the progress of tidal restoration.

Organizations in the San Francisco Bay Area are developing management strategies to restore coastal wetlands in advance of accelerated sea level rise, increasingly severe storms, and declining sediment supply. Sonoma Land Trust is working to reestablish tidal habitat in the diked baylands of northern San Pablo Bay via the large-scale, multi-partner Sears Point Restoration Project. This project involves a variety of features to promote development of emergent tidal marsh over time as sediment accretion from bay water raises the site's subsided elevation and contributes to the formation of transition zone habitat along a newly constructed levee. One intended outcome of this project is invigoration of wildlife habitat in the mudflats, transition zone, and uplands of Sears Point.

Concurrent with restoration efforts, Sonoma Land Trust—aided by biological consultants and citizen scientists—began field surveys to monitor bird populations within the Sears Point Restoration Area (SPRA). From 2016–2021 monitors under the direction of consulting Avian Biologist Daniel Edelstein conducted seasonal point count surveys to obtain data on annual richness and abundance, and habitat associations of waterbirds within the SPRA. Survey results were submitted to the California Avian Data Center (CADC), a regional node of the Avian Knowledge Network (AKN) that integrates data on birds and ecosystems to improve conservation outcomes today and in the future. In turn, a primary goal of the surveys is to improve our understanding of long-term avian demographics and to make the information accessible to habitat managers, scientists, and curious citizens of the Bay area.

METHODS

Survey Location
Surveys took place within the SPRA, which is part of the greater San Pablo Bay National Wildlife Refuge (38.1377895, -122.4616185) located along Highway 37 between the cities of Novato and Vallejo. Twelve survey stations, identified with permanent markers, were located at equidistant points along the site's levee (part of the San Francisco Bay Trail), paralleling the north shore of San Pablo Bay (Fig. 1).

Survey protocol
Surveys were conducted by Daniel Edelstein and volunteer citizen scientists, the latter of whom completed onsite training. Daniel Edelstein and lead monitors executed each survey by identifying birds and recording species and counts on data forms.

Surveyors conducted ten minute fixed-radius point counts at 12 survey stations. At each survey station, observers counted all shorebirds, ducks, and rails within a 0.1-mile (160 meter) radius. Weather conditions and habitat characteristics were also documented at the beginning of each point count.

Figure 1. Map of the Sears Point Restoration Area on the north shore of San Pablo Bay. The 12 avian monitoring points are marked with black triangles, labeled CS (count station) 1–12. Points are situated along the newly constructed levee, which is highlighted in red.

Point counts were scheduled to occur at moderate low tides (below two feet) and moderate high tides (above five feet). Surveys occurred twice per season, from fall 2016 through summer 2021, for a total of 40 surveys (Table 1). Each survey date included a visit to all 12 survey stations (Table 2). All datasheets were shared with the United States Fish and Wildlife Service (USFWS) and entered into the CADC online database by Sonoma Land Trust volunteer, Wendy Zukas.

Table 1 Schedule of 40 avian monitoring surveys from 2016–2021. The first survey was November 2016; thus, a survey year is defined as November through October. There were eight surveys per year: two each season at mid-low and mid-high tide.

Season	Fall			Winter		
		Low tide	High tide		Low tide	High tide
Survey Date	11/18/2016		X	1/13/2017	X	
	11/21/2016	X		1/16/2017		X
	12/08/2017	X		2/05/2018	X	
	12/11/2017		X	2/09/2018		X
	12/14/2018	X		3/07/2019	X	
	12/17/2018		X	3/14/2019		X
	12/12/2019	X		2/24/2020	X	
	12/19/2019		X	3/02/2020		X
	12/07/2020		X	2/06/2021	X	
	12/09/2020	X		2/15/2021		X
Season	Spring			Summer		
		Low tide	High tide		Low tide	High tide
Survey Date	4/19/2017	X		8/15/2017		X
	4/24/2017		X	8/22/2017	X	
	4/26/2018		X	8/17/2018	X	
	4/30/2018	X		8/23/2018		X
	4/19/2019		X	8/22/2019	X	
	4/26/2019	X		8/26/2019		X
	5/07/2020		X	9/01/2020	X	
	5/14/2020	X		9/15/2020		X
	4/20/2021		X	8/15/2021		X
	5/05/2021	X		8/29/2021	X	

Table 2 Total visits to each plot per year.

Plot	2016	2017	2018	2019	2020	2021
1	2	8	8	8	8	6
2	2	8	8	8	8	6
3	2	8	8	8	8	6
4	2	8	8	8	8	6
5	2	8	8	8	8	6
6	2	8	8	8	8	6
7	2	8	8	8	8	6
8	2	8	8	8	8	6
9	2	8	8	8	8	6
10	2	8	8	8	8	6
11	2	8	8	8	8	6
12	2	8	8	8	8	6

Summary metrics

We summarized point count data by calculating total abundance, mean abundance, density, species richness, and diversity using all detections within 160m, excluding flyovers. Mean abundance per point for a species was estimated as the average of counts across all visits to a point in a given season or year. If a species was not detected at a point it was assigned a count of zero prior to averaging (Salas et al. 2010). Total mean abundance of all species for the entire site was calculated per season, averaged across all visits at each point count location. A simple density metric, birds per hectare, was calculated as the mean abundance divided by the total area of the site (the area of a circle with 160m radius, times 12). Species richness is defined as the total number of species detected, and we estimated species diversity using a transformation of the basic Shannon index H` ($N_1 = e^{H`}$; Nur et al. 1999).

To understand our results in the context of existing San Francisco Bay waterbird data, we grouped observations into feeding guilds (State of the Estuary 2015). We used the following guilds to investigate population dynamics: diving ducks, dabbling ducks, shorebirds, herons and egrets, and rails. Diving ducks include Bufflehead, Canvasback, Common Goldeneye, Ruddy Duck, Scoter (Black, White-winged, and Surf scoter), and Scaup (Greater and Lesser Scaup). Dabbling ducks include American Wigeon, Gadwall, Green-winged Teal, Mallard, Northern Pintail, and Northern Shoveler (State of the Estuary 2015).

RESULTS

Based on results from 40 surveys at SPRA since they began in 2016, avian presence occurs in the following habitat types: wetland; tidal mudflat; upland levee; beach; rocky shoreline; open water; and marsh panne. Monitors recorded 77 species during the study, and a range of 8,000 to 12,200 total birds per year. Highest average abundance occurred in the second (2017) and fifth (2021) years of monitoring—mean abundance per year from 2016 to 2021 was 1,276, 1,533, 1,104, 1,167, and 1,530, respectively. Table 3 highlights seasonal avian metrics across all points for the five years of surveying. Abundance and density were highest in the fall and winter months, while species diversity was highest in the spring.

Table 3 Point count species richness, species diversity, mean abundance, and density of all species. Counts were summed across visits for all points at SPRA for 2016 through 2021.

	Fall	Winter	Spring	Summer
Mean species richness	54	54	48	41
Diversity	8.5	10	13.4	8.8
Mean Abundance	2125	1839	579	742
Standard Deviation of Mean Abundance	94.6	74	39.5	41
Density (birds/hectare)	22	19	6	8

Avian guilds represented with the greatest abundance during the 2016–2021 surveys were diving ducks and shorebirds. Figure 2 shows the total abundance for the top eight species at the SPRA. Although counts varied each year, Canvasback and Least Sandpiper were the most abundant species during the study. Dunlin, Ruddy Duck, Willet, Western Sandpiper, American Avocet, and Greater Scaup comprised the remaining top eight most abundant species. Canada Goose, Marbled Godwit, and Northern Pintail were also abundant, but counts were variable from year to year.

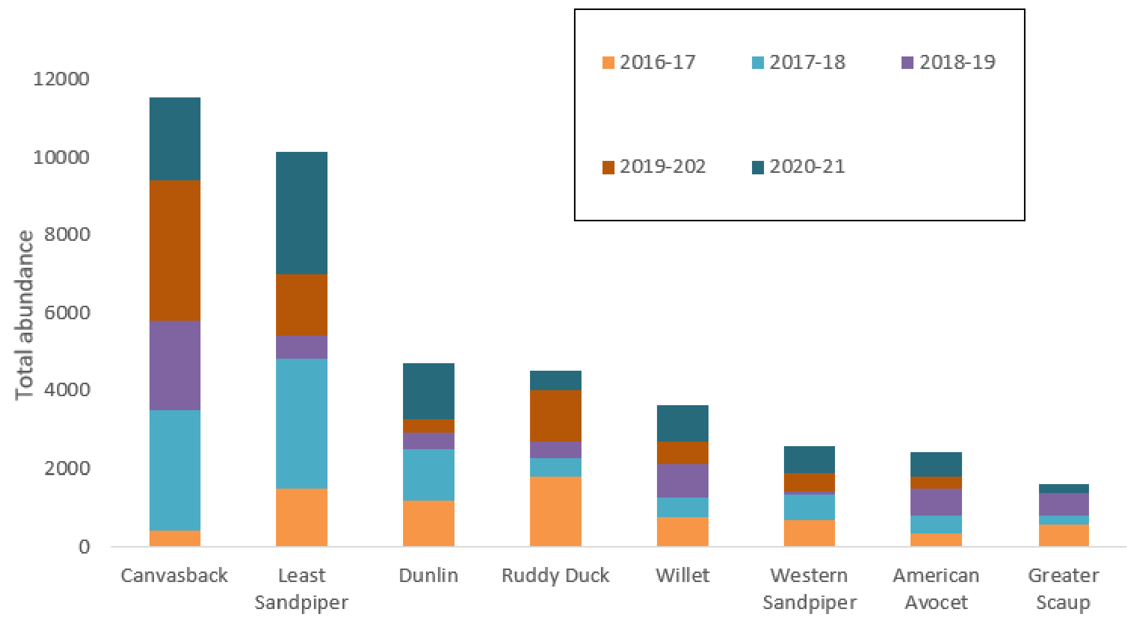

Figure 2 The most abundant species at SPRA varied slightly each study year; however, the eight most abundant species were consistent across years. Total counts for the eight most abundant species are shown above, representing observations at all count stations in 2016–17 (orange), 2017–18 (light blue), 2018–19 (purple), 2019–20 (brown), and 2020–21 (teal).

Diving ducks

Diving duck guild species were far more abundant than dabbling ducks overall (Figure 3). Canvasback was the most abundant diving duck species observed, with the following impressive total counts for each of the five survey years, respectively: 422, 3,086, 2,297, 3,582, and 2,156. Runner-up diving duck guild members by abundance: Ruddy Duck (1790, 589, 460, 1312, and 483 per survey year), Greater Scaup (579, 236, 545, 27, 215, and 1601), and Bufflehead (292, 91, 136, 134, and 14).

Dabbling ducks

The most observed members of this guild were Northern Pintail (75, 90, 45, 7, and 771 records per study year), American Wigeon (83, 274, 66, 64, and 223 per study year), and Green-winged Teal (7, 57, 267, 8, and 275 per study year). The spike in dabbling ducks in 2020–21 (Figure 3) is due to the unusually high count of Northern Pintail in winter 2021. Another common dabbling duck in the North Bay region — Mallard — was present in relatively low numbers during all surveys (50, 25, 36, 82, and 45). Gadwall was seen only in small numbers in the spring and summer of 2017, 2018, and 2020.

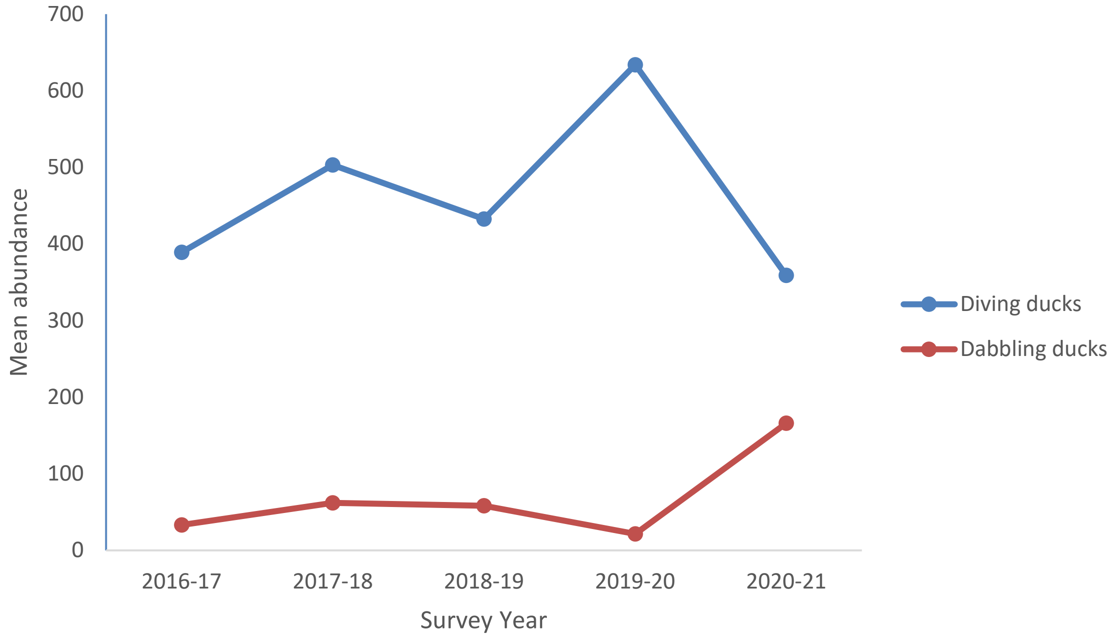

Figure 3 Mean abundance of diving ducks (blue) was greater than dabbling ducks (orange) in all survey years at SPRA.

Breeding waterfowl
Ruddy Duck, Gadwall, and Mallard were present during the breeding seasons of 2017 through 2021. Monitors observed that robust numbers of Ruddy Ducks used the "marsh mounds" constructed at SPRA for refuge during the first three survey years (Edelstein 2019). Mean abundance and density were estimated for the spring and summer counts of 2017–2021 (Table 4).

Table 4. Mean abundance and density of waterfowl in the spring and summer months. The presence of Gadwall, Mallard, and Ruddy Duck during the spring and summer months at SPRA indicates these three species may be breeding at the site.

	Mean abundance	Density (birds/ha)
Mallard	17	0.18
Gadwall	6	0.06
Ruddy Duck	12	0.12

Shorebirds
Among approximately 19 species of shorebird order members typically seen annually in the San Francisco Bay Area, 16 were observed at the SPRA site during the 40 surveys. Shorebird counts were highest in the fall and winter seasons, and mean abundances by species are summarized below (Table 5). The most abundant shorebirds were: Least Sandpiper, Dunlin, Willet, Western Sandpiper, American Avocet, Marbled Godwit, Black-bellied Plover and Long-billed Dowitcher. Represented in far fewer numbers were: Long-billed Curlew, Semipalmated Plover, Black-

necked Stilt, Greater Yellowlegs, Killdeer, Whimbrel, Red-necked Phalarope, and Lesser Yellowlegs.

Table 5. Mean shorebird abundance by season for all shorebirds recorded over the course of the study (2016–2021).

Common Name	WINTER	SPRING	SUMMER	FALL
Least Sandpiper	377.7	99.2	76.5	627.0
Dunlin	181.8	86.8	1.5	235.1
Willet	22.6	9.7	293.9	38.8
Western Sandpiper	25.3	145.3	16.7	105.8
American Avocet	112.7	22.0	48.2	68.9
Marbled Godwit	10.5	70.7	23.1	6.5
Black-bellied Plover	8.6	6.5	33.1	25.2
Long-billed Dowitcher	29.9	5.2	0.9	0.6
Long-billed Curlew	2.6	7.9	4.8	4.5
Semipalmated Plover	0.0	12.1	1.3	0.0
Black-necked Stilt	12.4	0.0	0.1	0.0
Greater Yellowlegs	2.3	0.1	2.4	5.3
Killdeer	1.1	1.1	0.0	2.9
Whimbrel	0.0	1.9	0.9	0.3
Eared Grebe	0.7	0.0	0.0	0.0
Red-necked Phalarope	0.0	0.0	0.3	0.0
Lesser Yellowlegs	0.0	0.1	0.0	0.1
Mean seasonal abundance	**157.6**	**93.7**	**100.7**	**224.2**

To facilitate comparison with State of the Estuary (2015) trends we selected nine common wintering shorebird species, grouped by body size, as habitat indicators. Large shorebirds included American Avocet, Willet, and Marbled Godwit. Medium shorebirds included Black-bellied Plover, Short-billed Dowitcher, and Long-billed Dowitcher. Small shorebirds were Least Sandpiper, Western Sandpiper, and Dunlin. Overall, medium shorebirds were the least abundant. Small and large shorebirds were relatively more abundant but varied by year (Fig. 4).

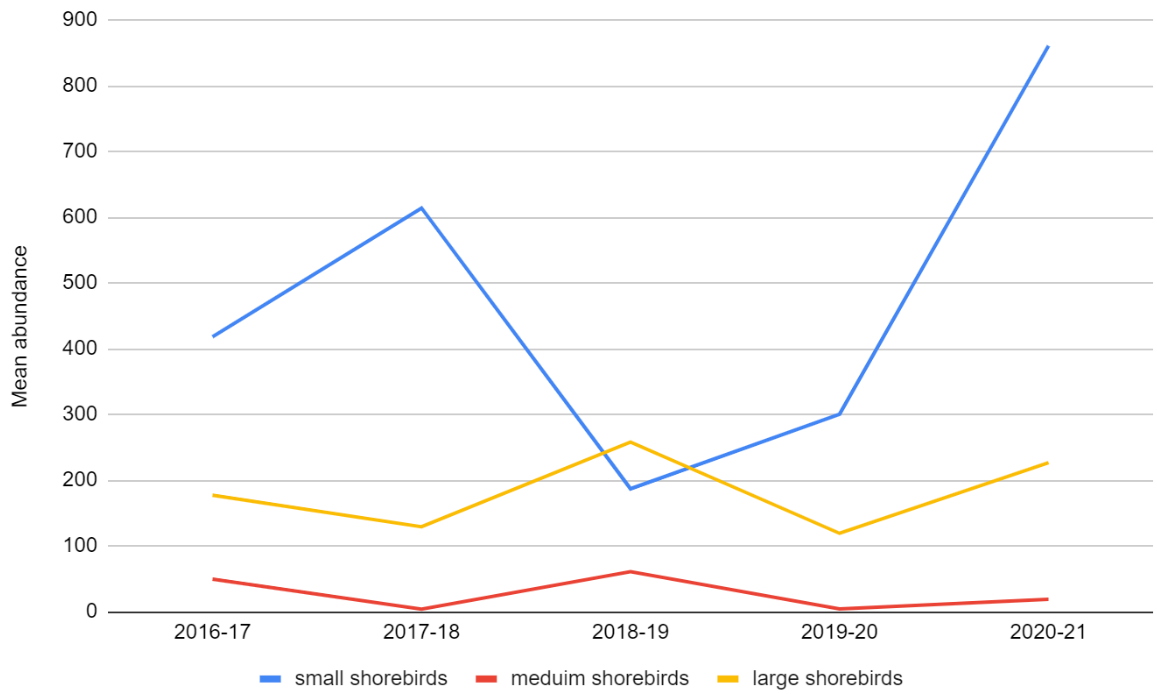

Figure 4 Mean annual shorebird abundance, estimated as the average of counts across all visits to a point, was lowest for medium shorebirds (red) at SPRA. Mean abundance for small shorebirds (blue) was greatest overall but showed a downward trend from 2018 through 2019. Mean abundance for large shorebirds (yellow) was relatively consistent over the course of the survey period.

Herons and egrets

Ardeidae family members were observed in relatively low numbers during SPRA surveys. Great Blue Heron, Great Egret, and Snowy Egret were observed year-round, but in greater abundance in the spring and summer months. The average abundance for these species over the five-year survey period was: 1.6 for Great Blue Heron, 6.6 for Great Egret, and 2.9 for Snowy Egret.

Rail Family Members

American Coot was the only Rallidae family member observed, recorded predominantly in the late fall and winter. Mean coot abundances for each of the five study years were: 27, 48, 13, 3, and 0. Neither Ridgway’s nor California Black Rail were detected during this study.

DISCUSSION

The 40 surveys at SPRA collectively represent patterns of increased avian richness and abundance as the site develops into essential habitat for both common and uncommon bird species. The wetlands, tidal mudflats, and marsh pannes designed by managers and consultants simulate environmental conditions of adjacent mature tidal wetlands. Survey results indicate that the diversified habitat types within the site can sustain both over-wintering and breeding avian populations.

The SPRA site provides important resting and foraging habitat for migratory and over-wintering bird species

Shorebirds

Shorebirds were abundant during the fall and winter months in all years of surveying and species composition mimics the 2008 San Francisco Bay shorebird census (Wood et al. 2010). Daniel Edelstein and volunteer monitors recorded especially large numbers of Least Sandpiper, Dunlin, and Western Sandpiper, which suggests SPRA serves as a non-breeding season refuge for these keystone shorebirds (Edelstein 2019). The newly-created mudflat and shallow water—environments that were previously absent from the site—have successfully attracted diverse shorebird members in need of roosting and foraging habitat during the non-breeding season. This recently restored habitat is vital in combination with adjacent mudflat parcels as a comprehensive management strategy to support increasing shorebird numbers throughout the North Bay, while buffering the decreasing South and Central Bay populations (Pitkin and Wood 2011).

While small-sized shorebird species abundance (e.g., Least and Western Sandpiper) is likely increasing in the North Bay, large and medium shorebirds are in decline (Wood et al. 2010). Congruent with this pattern, there were far fewer detections of medium shorebirds at SPRA, with small shorebirds being overall the most abundant. The abundance of Western Sandpiper at SPRA is noteworthy because this species is thought to be declining throughout the Bay (Pitkin and Wood 2011). The revived tidal mudflats of SPRA may be new and essential habitat for Western Sandpiper.

Threatened or endangered shorebirds, such as Western Snowy Plover, may eventually be attracted in small numbers to the SPRA's expanding mudflat habitat as its restoration progresses. If so, the SPRA habitat will join other North Bay mudflat areas as vital over-wintering and migration habitat for this federally threatened species that tends to be more abundant in coastal areas where sandy substrate occurs (Edelstein 2019).

Waterfowl

The expanses of open water within SPRA attracted numerous duck species during the spring, fall and winter surveys. Several foraging species were seen, and there were greater numbers of diving than dabbling ducks overall. Previous waterfowl survey data suggested dabbling ducks were more abundant in ponds of the North and South Bay, while diving ducks preferred the more vast, deeper open water of the North Bay (Strong 2019). The SPRA is transitioning from deep water to shallow mudflat habitat as the site fills with sediment (2–4 ft. of sediment had accreted by 2019). After the 2019–2020 monitoring season, the diving duck abundance showed a negative trend, while the dabbling duck abundance showed a sharp increase (Fig. 3). The inverted diving and dabbling duck trends perhaps reflect the site's shift from deep to shallow water habitat. The current surveys and subsequent years' surveys may provide more significant data

Deeper water within the SPRA site occurs only at the highest tides. At these times, it provides essential foraging opportunities to sustain current populations of Canvasback and Greater Scaup, as well as other waterfowl populations within the Pacific Flyway. Other diving ducks observed with robust numbers at SPRA were Ruddy Duck and Bufflehead. These species reside predominantly in South Bay salt ponds and Central Bay open water (Strong 2019), so their abundance at the SPRA is evidence of the site's valuable wintering habitat.

Previous waterfowl surveys indicate diving ducks are declining significantly in the North and Central Bay (State of the Estuary 2015). The habitat at SPRA may help buffer diving duck declines due to drought, range contraction and habitat loss (State of the Estuary 2015). Diving ducks rely on moderate to deep water for food and are especially susceptible to drought conditions. The extreme drought of 2013–15 significantly reduced open water habitat in the Central Valley (Reiter et al. 2018), making the San Francisco estuary increasingly critical for non-breeding waterfowl, particularly as extreme drought conditions persist. Drought conditions may explain the spike in Northern Pintail numbers observed in February 2021 at the SPRA, as this species typically winters in rice fields of the Central Valley.

Even though the SPRA's overall water depth is slowly receding as accretion progresses, the deep-water habitat available during high tide cycles at SPRA may add to a network of such sites across the Bay, allowing diving duck populations to persist through challenging drought conditions. Additionally, grebe family members such as the Western, Clark's and Eared Grebe, were all present during high-tide cycles. The diverse over-wintering bird species present at SPRA confirm that it serves as a localized refugium in the face of ongoing development throughout the Bay.

The SPRA site provides breeding opportunities for several waterfowl and shorebird species

Ruddy Duck, Gadwall, and Mallard were present during the spring and summer months, indicating SPRA provides breeding territory for these species. While breeding duck counts from 2016–21 were relatively low, their presence at the site is significant given the statewide decline in breeding waterfowl populations (Skalos and Weaver 2019). While mallards are the most abundant breeding species in the North Bay, they show the highest rates of decline (Skalos and Weaver 2019). Monitors observed comparatively high numbers of Ruddy Ducks during the breeding season, including during surveys where higher water occurred; it's likely this common species is nesting in suitable habitat within and adjacent to the SPRA region where available nesting habitat occurs above the highest tide levels.

Breeding waterfowl population numbers will likely increase as more high marsh habitat develops via sediment accretion and plant colonization. In response to the addition of emergent vegetation (e.g., cordgrass, bulrush) as well as gum plant and pickleweed, duck family and shorebird order members will have more sheltering and foraging niches to exploit, resulting in increases in their richness and abundance at the site. Likewise, as swaths of transplanted cordgrass become more established in the intertidal zone, Pied-billed Grebe, Common Gallinule, and American Coot would also be expected to begin nesting within the SPRA site (Edelstein 2019).

These data are preliminary and ongoing monitoring will help us understand the ecological conditions at SPRA

SPRA is still in the early stages of its evolution as a tidal marsh. While the survey data represent an array of feeding guilds indicative of a healthy ecosystem with diversified food webs, this is only a short-term diagnosis. Future monitoring may reveal negative impacts to native avifuana, such as competition for food and breeding territory from invasive Canada Goose and Mute Swan populations (Edelstein 2019). Conversely, as obligate salt marsh vegetation matures, it may provide suitable shelter, foraging, and nesting habitat to listed Ridgway's and California Black Rail. Ridgway's rails are increasing at sites adjacent to the SPRA (Marriott 2017), suggesting that as habitat develops at the SPRA, colonization will follow. There is much to learn about the avian community onsite as the landscape evolves and is affected by the changing climate. Ongoing surveying at the SPRA will contribute important data about the processes and implications of tidal marsh restoration and can raise public awareness through the participation of the monitors that serve as citizen scientists. As this information is continually made public it will help inform conservation efforts around the Bay.

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