5.0 Fish

The levees surrounding Hamilton Army Airfield were breached on April 25, 2014, reconnecting San Pablo Bay to 648 acres of potential aquatic and terrestrial habitat. In doing so, a large expanse of tidal and seasonal wetland, transitional ecotone and upland environments was made accessible to colonizing resident, migratory, and special-status species. Once part of an extensive network of tidal wetlands along the western margin of San Pablo Bay, the Hamilton Wetlands Restoration Site (Hamilton) is one of the few remaining tidal wetlands, restored or natural, within the region. As such, biological monitoring is ongoing to understand how wildlife use the constantly evolving site. Monitoring data collected at Hamilton will have broad applications and will inform future restoration efforts within the region.

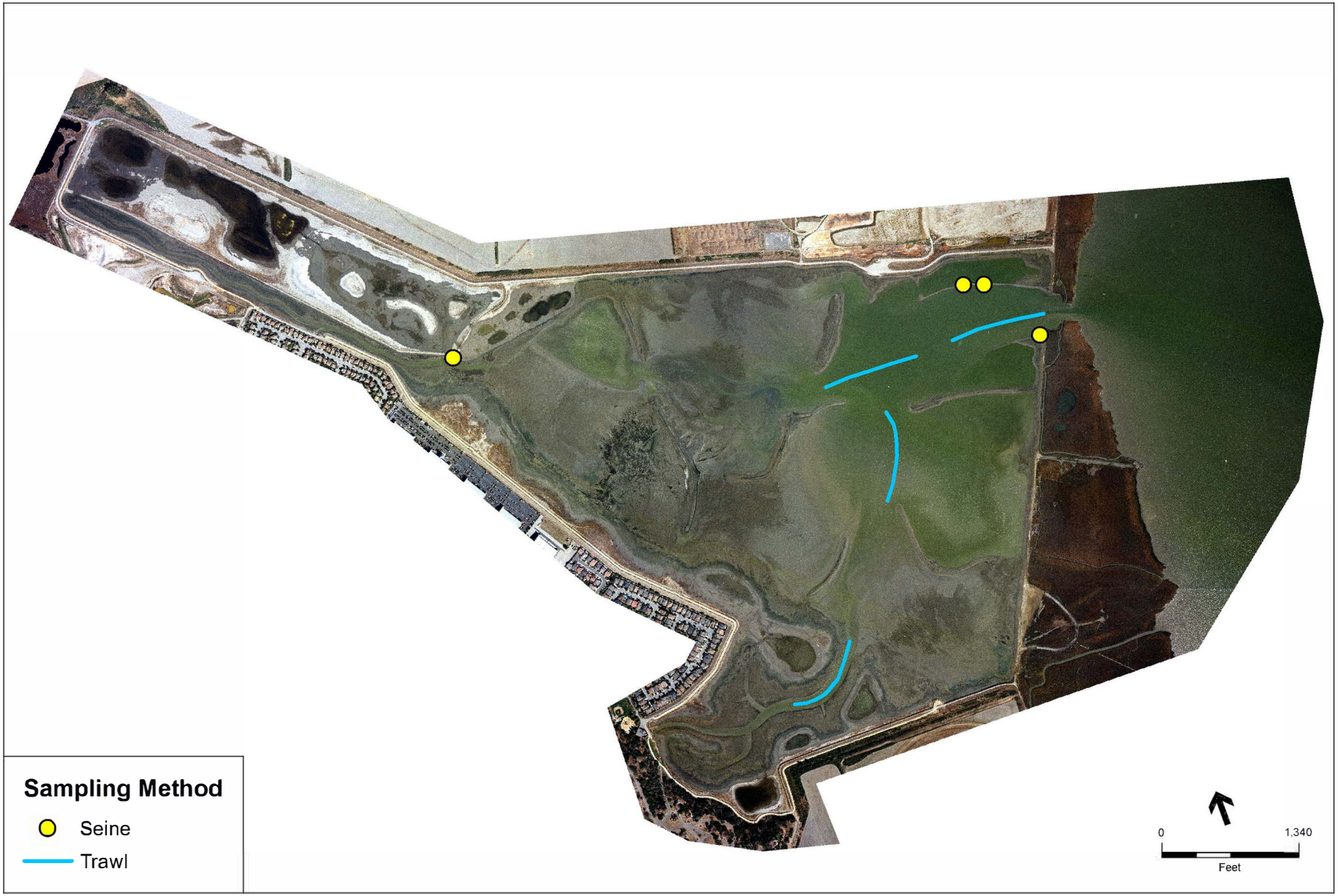
The purpose of annual fish monitoring is to document fish species richness, abundance, and distribution within Hamilton. The documentation of annual changes in fish assemblage throughout the course of the site's evolution serves as an important variable in evaluating the overall efficacy of the site in supporting aquatic species. Additionally, a monitoring dataset collected over multiple, sequential years may provide insight into how the San Francisco Bay fish community will respond to climatic shifts in precipitation, temperature, and water quality.

5.1 Materials and Methods

5.1.1 Fish Sampling Methods

On May 6 & 7, 2019 Environmental Science Associates (ESA) conducted the fifth consecutive year (Year 4) of spring fish sampling at Hamilton. This report documents the sampling results and compares the 2019 (Year 4) survey results with previous survey years.

The fish sampling methodology for the 2019 survey was consistent with the preceding four survey events (2015-2018). The 2019 surveys utilized identical sampling equipment, occupied the same survey locations within the site, and occurred within the same seasonal window (late April to early May). The diversity of the aquatic environment within Hamilton is such that, in order to comprehensively sample the range of potential fish habitat, multiple sampling methods are required. A 40-foot beach seine was used to sample the nearshore areas within the main and tertiary tidal channels. Seining was conducted from the berms that flank both of these channels. Since seining is a depth-limited method, an otter trawl was used to survey the in-channel habitat within the main, secondary and tertiary tidal channels. The net head line dimensions of the otter trawl are 12 feet wide by 3 feet high. Sampling locations are shown in **Figure 17**.



SOURCE: ESA (2019)

Hamilton Wetlands Monitoring . D180888.00

Figure 17

Fish Sampling Locations

All fishes captured were identified to the species level when possible, measured (total length in mm), and returned to the channel in which they were caught. The sampling results represent a snapshot of the species abundance and distribution at a given point in time, and are not assumed to capture all species that may be present within the site.

5.1.2 Site Conditions

Fish sampling was conducted in spring 2019 (May 6 and 7) and timed to coincide with tidal elevations appropriate for ensuring sufficient depth for both sampling and navigation. Tidal elevations for the sampling dates are reported in **Table 5-1**.

Table 5-1. Predicted Tide Height During Sampling Periods

Date	Tide Height* (ft MLLW) and Time (PST)
May 6, 2019	High Tide: 6.21 (01:56)
	Low Tide: -0.58 (09:16)
	High Tide: 4.79 (15:40)
	Low Tide: 2.02 (19:03)
May 7, 2019	High Tide: 6.24 (02:31)
	Low Tide: -0.72 (09:58)
	High Tide: 4.33 (16:73)
	Low Tide: 2.29 (19:46)
*At Petaluma River Entrance, San Pablo Bay, California, Sta.ID 9415252	

5.2 Fish Sampling Results

5.2.1 Species Composition

During the sampling event, the field team captured and identified 792 individual fish representing 9 families and 12 species (**Table 5-2**)

Table 5-2. Fish Species Present in the Project Site – 2019

Common Name	Scientific Name	Family
Native Species		
Northern anchovy	*Engraulis mordax*	*Engraulidae*
Pacific staghorn sculpin	*Leptocottus armatus*	*Cottidae*
Threespine stickleback	*Gasterosteus aculeatus*	*Gasterosteidae*
Sacramento splittail	*Pogonichthys macrolepidotus*	*Cyprinidae*
Tule perch	*Hysterocarpus traskii*	*Embiotocidae*

Common Name	Scientific Name	Family
Non-Native Species		
Chameleon goby*	*Tridentiger trigonocephalus*	*Gobiidae*
Yellowfin goby	*Acanthogobius flavimanus*	*Gobiidae*
Rainwater killifish	*Lucania parva*	*Fundulidae*
Shokihaze goby	*Tridentiger barbatus*	*Gobiidae*
Shimofuri goby	*Tridentiger bifasciatus*	*Gobiidae*
Striped bass	*Morone saxatilis*	*Moronidae*
Mississippi silverside	*Menidia beryllina*	*Atherinopsidae*
* Chameleon, shimofuri, and shokihaze gobies are known to hybridize in the San Francisco Bay-Delta. It is unclear to what extent the gobies observed were of hybrid stock.		

5.2.2 Main Tidal Channel

Over the course of the two-day sampling event, eight seine hauls and four otter trawls were conducted within the main tidal channel (**Figure 17**). Each trawl was towed for approximately 10 minutes beginning at the time the gear was fully deployed to the bottom of the channel at a speed of approximately 1-1.5 knots.

Ten fish species were captured in the main tidal channel during the survey, with the assemblage being comprised of mostly non-native species (3 native species, 7 non-native species, 697 captured fish) (**Table 5-3**). Staghorn sculpin and yellowfin goby were the most abundant species captured in the main tidal channel, both nearshore and in-channel, comprising over 72% of the total catch, combined. The benthic assemblage was dominated by the two aforementioned species, as well as other non-native gobies including shokihaze, shimofuri, and chameleon goby.

In total, non-native gobies (yellowfin, shokihaze, and shimofuri goby) constituted approximately 47% of the total main tidal channel catch. Five pelagic species were recorded in the main tidal channel, the most common being juvenile northern anchovy (8%). All other pelagic species were encountered in much lower numbers and include threespine stickleback (5%), Mississippi silverside (3%), rainwater killifish (<1%), and striped bass (<1%).

5.2.3 Secondary and Tertiary Tidal Channels

The trawl was deployed within both the secondary and tertiary channels, but because of access difficulties the seine was deployed in portions of the tertiary channel network but not in the secondary channels. Each trawl followed the same methodology as the main channel, with the tow lasting approximately 10 minutes at 1-1.5 knots. This effort was similar to past sampling years.

The secondary and tertiary channels showed similar species diversity (10 total species) as observed in the main channel, but significantly less overall abundance (95 individuals). Importantly, two native species previously undocumented within the site, Sacramento splittail and tule perch, were recorded for the first time. Pelagic species, including, northern anchovy (43% of

total catch) and Mississippi silverside (29% of total catch), were the most frequently encountered species within the secondary and tertiary tidal channels. Only a small number (either one or two individuals) of threespine stickleback, rainwater killifish, and striped bass were recorded. Staghorn sculpin were the most abundant benthic species encountered (12%), however, yellowfin goby (5%) were also frequently observed within this channel network.

Table 5-3. Fishes Captured in the Main, Secondary and Tertiary Channels

Species	Main Tidal Channel				Secondary Tidal Channels				Tertiary Tidal Channels			
	Count	Total Length (mm)			Count	Total Length (mm)			Count	Total Length (mm)		
		Mean	Min	Max		Mean	Min	Max		Mean	Min	Max
Seine												
Chameleon goby	1	55	55	55	No seine in secondary tidal channel							
Northern anchovy	54	33	26	45								
Staghorn sculpin	250	35	19	82					9	42	25	65
Threespine stickleback	31	27	21	35					1	20	20	20
Yellowfin goby	239	33	18	60								
Mississippi silverside	8	65	53	83					8	51	25	75
Rainwater killifish	1	50	50	50					2	35	35	35
Unidentified larval osmerid	2	30	30	30								
Unidentified larval goby	26	25	19	40								
Trawl												
Chameleon goby	15	55	50	70								
Northern anchovy	1	30	30	30	6	33	30	35	35	33	25	40
Shimofuri goby	5	51	42	56								
Shokihaze goby	20	57	47	70					1	80	80	80
Staghorn sculpin	2	56	55	57					2	62	60	63
Tule perch					1	43	43	43				
Striped bass	1	440	440	440					2	243	205	280
Yellowfin goby	11	22	15	28	4	25	20	38	1	35	35	35
Sacramento splittail									2	164	155	173
Mississippi silverside	17	30	20	35					20	24	15	35
Unidentified larval goby	13	27	15	39					1	30	30	30

Table 5-4. Comparison between Survey Years

Species	2015	2016	2017	2018	2019
Marine					
Bat ray	3	4	0	0	0
Bay pipefish	3	1	0	1	0
Northern anchovy	2439	981	854	57	96
California halibut	11	10	30	4	0
California tonguefish	20	3	0	0	0
Diamond turbot	1	7	0	1	0
Speckled sanddab	0	0	0	1	0
Starry flounder	0	0	0	37	0
Leopard shark	12	0	0	2	0
Shiner surfperch	4	1	0	1	0
Walleye surfperch	1	0	0	0	0
Topsmelt	142	290	4	99	0
Pacific herring	0	2	1	14	0
Estuarine					
Chameleon goby	15	101	24	99	16
Pacific staghorn sculpin	45	7	63	153	263
Prickly sculpin	10	0	0	0	0
Rainwater killifish	1	3	3	3	3
Shimofuri goby	7	0	0	6	5
Shokihaze goby	119	22	65	6	21
Yellowfin goby	1	0	755	205	255
Longjaw mudsucker	0	4	0	0	0
Mississippi silverside	0	0	0	0	52
Unidentified larval goby	0	0	0	0	40
Anadromous					
American shad	6	0	0	0	0
Chinook salmon	0	0	1	0	0
Striped bass	2	3	2	1	3
Freshwater (Brackish)					
Threespine stickleback	1	11	39	7	33
Tule perch	0	0	0	0	1
Sacramento splittail	0	0	0	0	2
Species Origin (overall subtotal)					
Native	13	12	7	12	6

Species	2015	2016	2017	2018	2019
Non-Native	7	4	4	6	7
Total	**2843**	**1450**	**1841**	**697**	**792**

5.3 Invertebrates

Although no targeted invertebrate sampling was conducted as part of the survey effort, as with previous survey years, multiple species and age classes were observed throughout the site. Multiple shrimp species (*Crangon* spp.) and age classes were observed; however larval individuals were extremely abundant within all of the tidal channels. The high abundance of larval shrimp is important for the rearing larval and juvenile fish, and suggests a large amount of production at lower trophic levels. The combination of consistently high numbers of juvenile shrimp and domination of the fish assemblage by juveniles suggest that Hamilton is serving as an important rearing site for multiple species.

5.4 Discussion

The 2019 sampling season saw a small increase in the total number of fish recorded (over the preceding year), but a dramatic decrease in overall species diversity. During the 2018 survey year 697 individual fish were recorded within the site, which increased to 792 individuals in 2019. Overall, both the 2018 and 2019 total yields are similar in that they are significantly less than the number of fish encountered during any of the first three survey years (see **Table 5-4**).

The slight increase in abundance was offset by a steep reduction in overall species diversity. During the 2018 survey year 18 species (12 natives, 6 non-natives) were recorded within the site, but during the 2019 survey only 13 species were recorded (6 natives, 7 non-natives). Native species diversity was the lowest in 2019 of any year during the five-year survey history. Additionally, the 2019 survey year was the first survey that documented a greater number of non-native species relative to native species. However, two native species previously unrecorded within the site were documented, those being Sacramento splittail and tule perch. Sacramento splittail and tule perch are more commonly found east of the Carquinez Strait, where the water quality is typically less saline than water in San Pablo Bay. Increased precipitation during the 2019 water year, driving decreased salinities within San Pablo Bay, is likely responsible for these species downstream movement into the Hamilton site. 2017, also a wet water year, showed a similar decline in native species abundance.

The benthic assemblage in the 2019 survey remained relatively consistent with the 2018 survey season, and with the five-year survey period as a whole. Staghorn sculpin and yellowfin goby were once again the most common species documented throughout the site. Other non-native gobies including the shokihaze, shimofuri, and chameleon, also maintained similar levels of abundance, with a shift from chameleon to shokihaze as the second most commonly encountered goby. Unlike previous years no native flatfish were recorded during the survey. The 2019 pelagic assemblage was also relatively consistent with the 2018 survey year. Northern anchovy was once again the

most commonly encountered pelagic species. A few individual striped bass, rainwater killifish, and threespine stickleback were recorded in similar numbers as the preceding survey years. Of note, Mississippi silverside, a common invasive species throughout the Sacramento-Bay delta was documented for the first time within the site. For the first time during the five survey years, no topsmelt were observed within the site.

It remains unclear whether the decline in abundance over the 2018 and 2019 survey seasons is a result of typical year-to-year fluctuations in population size, or a result of changes in hydrologic conditions within the site. While the number and abundance of individual species has fluctuated annually, use of all portions of the project site by multiple species and life stages has been consistent. Even with the recent decreases in abundance/diversity, monitoring over the past five years (2015 to 2019) has documented a diverse assemblage of species throughout the tidal wetland restoration site. The geomorphic condition of the site continues to evolve into a more sinuous, channelized environment which could be contributing to this shift in abundance. Phytoplankton abundance, biomass, and transport are strongly influenced by marsh geomorphology (Sherman et al. 2017). Thus, changes in site geomorphology may drive changes in prey availability, and ultimately influence the distribution and makeup of the fish community within the site. More likely, increased precipitation (2019 was the wettest year over the entire survey period) created an increasingly freshwater site, as was observed during the 2017 water year. This decrease in regional salinity appears to be causing a shift in the assemblage from marine species to more estuarine and freshwater (brackish) species, which in turn is lowering the overall species diversity (i.e., there is a larger pool of potential marine species compared to freshwater species that could potentially occur within the site). It will be interesting to see if a drier hydrologic year yields increases in overall abundance, abundance of native species, or an increase in the overall species diversity within the site. It is possible that as the site continues to evolve, the overall species diversity is shifting from a more native-dominated site to one with an equal mix of native and non-native species. This shift to a more non-native dominated assemblage would be consistent with the type of fish community found within the nearby Sonoma Baylands tidal wetland restoration site. **Table 5-5** provides a comparative summary of the five years of monitoring at the Hamilton site and decade of surveys at the Sonoma Baylands.

Table 5-5. Comparison between Restoration Sites

Species	Hamilton Wetlands 2015 – 2019	Sonoma Baylands 1999 - 2014
Native Species		
Northern anchovy	X	X
Pacific herring	X	X
Topsmelt	X	X
Bay pipefish	X	X
Three-spined stickleback	X	X
Staghorn sculpin	X	X
Prickly sculpin	X	X
Longjaw mudsucker	X	X
Diamond turbot	X	X
Starry flounder	X	X
Shiner surfperch	X	
Walleye surfperch	X	
Bat ray	X	
Leopard shark	X	
California halibut	X	
California tonguefish	X	
Chinook salmon	X	
Speckled sanddab	X	
Tule perch	X	
Sacramento splittail	X	X
Longfin smelt		X
English sole		X
Arrow goby		X
Introduced Species		
Striped bass	X	X
American shad	X	X
Rainwater killifish	X	X
Shokihaze goby	X	X
Shimofuri goby	X	X
Chameleon goby	X	X
Yellowfin goby	X	X
Mississippi silverside	X	X
Brown bullhead		X