5 Fish Survey

This chapter presents the results of the annual fish monitoring, completed to document species richness, abundance, and distribution within the HWRP site. Documenting annual changes in the fish community throughout the course of the site's evolution over time serves as an important variable in evaluating the overall health of the site, and will help inform future restoration efforts in the region.

5.1 Materials and Methods

5.1.1 Fish Sampling Methods

Environmental Science Associates (ESA) conducted the third year of fish sampling throughout the HWRP site on April 27 and 28, 2017. The fish sampling methodology for 2017 (year 2) survey was consistent that of 2015 and 2016 (year 0 and year 1), in that it consisted of the same modes of sampling and reoccupied the same locations within the site. The timing of the survey was also relatively similar (i.e. late April to early May).

The habitat complexity within HWRP is such that, in order to comprehensively sample all available habitats, multiple sampling methods were utilized. A 40-ft. beach seine was used to sample the nearshore areas within the main and tertiary tidal 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 channels. The net head line dimensions of the otter trawl 12 ft. wide by 3 ft. high. Sampling locations are shown in Figure 5-1.

Over the course of the 2-day sampling event, 8 seine hauls and 4 otter trawls were conducted within the main tidal channel (Figure 5-1). Each trawl was towed for approximately 10 minutes beginning at the time the gear was fully deployed (on the bottom) at a speed of approximately 1-1.5 nautical miles per hour (knots).

The trawl was also deployed within both the secondary and tertiary channels, but because of access difficulties, the seine was deployed only in portions of the tertiary channel network and not at all 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.

All fishes captured were identified to the species, measured (total length in millimeters [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, as such they are not assumed to capture all species that may be present within the site.

5.1.2 Site Conditions

Fish sampling was conducted spring 2017 (April 27 and 28) 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.

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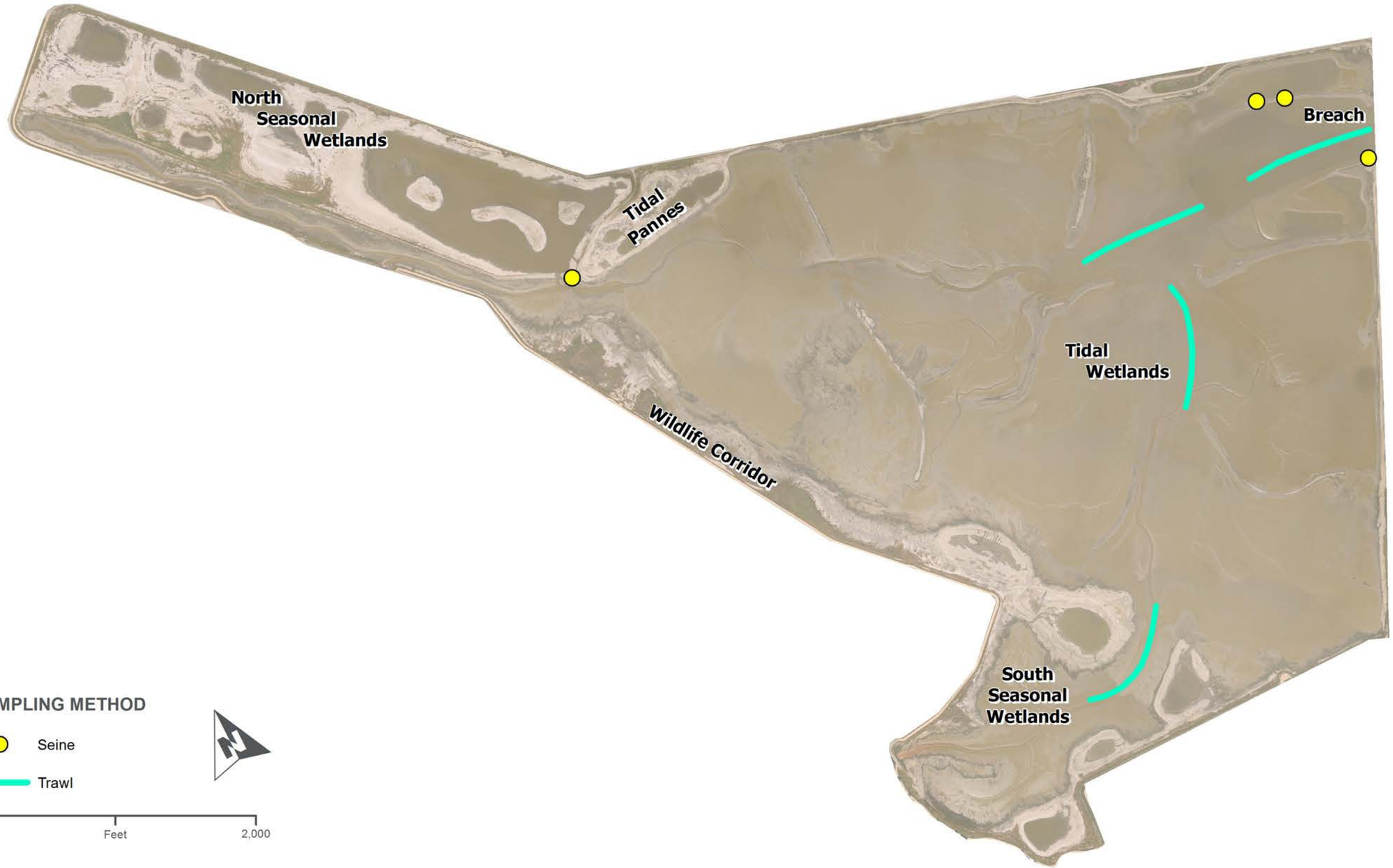

Figure 5-1. Fish Sampling Locations

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Table 5-1. Predicted Tide Height During Sampling Periods

Date	Tide Height (ft MLLW) and Time (PT)
April 27, 2017	High Tide: 6.67 (01:44)
	Low Tide: -0.88 (08:51)
	High Tide: 5.40 (15:01)
	Low Tide: 1.30 (20:49)
April 28, 2017	High Tide: 6.75 (02:25)
	Low Tide: -1.05 (09:40)
	High Tide: 5.29 (15:59)
	Low Tide: 1.63 (21:38)
Petaluma River Entrance, San Pablo Bay California, Sta.ID 9415252	

5.2 Fish Sampling Results

5.2.1 Species Composition

This sampling effort resulted in the capture and identification of 1,841 individual fish representing 10 families and 12 species presented in Table 5-2.

Table 5-2. Fish Species Present in the Project Site – 2017

Common Name	Scientific Name	Scientific Family
Native Species		
Northern anchovy	*Engraulis mordax*	Engraulidae
Pacific herring	*Clupea pallasii*	Clupeidae
Pacific staghorn sculpin	*Leptocottus armatus*	Cottidae
Three-spined stickleback	*Gasterosteus aculeatus*	Gasterosteidae
Topsmelt	*Atherinops affinis*	Atherinopsidae
California halibut	*Paralichthys californicus*	Paralichthyidae
Chinook salmon	*Oncorhynchus tshawytscha*	Salmonidae
Non-Native Species		
Chameleon goby[1]	*Tridentiger trigonocephalus*	Gobiidae
Yellowfin goby	*Acanthogobius flavimanus*	Gobiidae
Rainwater killifish	*Lucania parva*	Fundulidae
Shokihaze goby	*Tridentiger barbatus*	Gobiidae
Striped bass	*Morone saxatilis*	Moronidae

5.2.2 Main Tidal Channel

Ten fish species were captured in the main channel during the survey, with the assemblage split between native and non-native species (6 native species, 4 non-native species) (Table 5-3). Juvenile yellowfin goby was the most abundant species captured in the main tidal channel, both nearshore and in-channel, comprising over 68 percent of the total catch. The benthic assemblage was dominated in number by three non-native goby species, the aforementioned yellowfin goby, shokihaze goby (10%), and chameleon goby (2%). The dominant native benthic species were Pacific staghorn sculpin (4%) and California halibut (3%). The native three-spine stickleback represented 3 percent of total catch. Only four pelagic species were recorded in the main tidal channel, the most common being juvenile northern anchovy (13%). The other three pelagic species were Chinook salmon (juvenile), striped bass, and topsmelt, for which only a single individual was recorded.

[1] Chameleon goby and shimofuri goby are known to hybridize in the San Francisco Bay-Delta, it is unclear to what extent the chameleon gobies observed were of hybrid stock.

5.2.3 Secondary and Tertiary Tidal Channels

The secondary and tertiary channels showed similar species abundance patterns as observed in the main channel, albeit with slightly less diversity. Northern anchovy was by far the most abundant pelagic species observed (77% in secondary and 86% in tertiary channel). Only a small number (less than 1%) of other pelagic species including; topsmelt, striped bass, and Pacific herring were recorded. Yellowfin goby was once again the most abundant benthic species encountered (21% in secondary and 9% in tertiary channel). The native benthic species sculpin and flatfish were also observed and represented (less than 5% of catch). All species recorded in the secondary and tertiary channels were also present in the main channel, with the exception of Pacific herring and rainwater killifish (both representing less than 1% of catch).

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												
Northern anchovy	**32**	30	28	30	No Seine in Secondary Channels				**14**	30	30	30
Chameleon goby	**2**	61	56	65					**1**	60	60	60
California halibut	**1**	20	20	20								
Pacific staghorn sculpin	**30**	45	20	75					**11**	37	20	80
Rainwater killifish									**3**	40	35	45
Three-spined stickleback	**30**	31	25	47					**4**	29	25	35
Topsmelt									**3**	125	105	140
Yellowfin goby	**346**	37	10	103					**27**	43	25	60
Pacific herring									**1**	160	160	160
Trawl												
Northern anchovy	**94**	30	30	30	**86**	30	30	30	**628**	31	30	40
Topsmelt	**1**	180	180	180								
California halibut	**28**	152	5	245					**1**	20	20	20
Chameleon goby	**21**	56	45	70								
Shokihaze goby	**65**	71	50	98								
Yellowfin goby	**321**	42	30	150	**23**	40	30	50	**38**	65	30	135
Pacific staghorn sculpin	**8**	50	20	75	**1**	25	25	25	**13**	26	20	35
Three-spined stickleback	**5**	38	30	48								
Chinook salmon	**1**	103	103	103								
Striped bass	**1**	160	160	160	1	314	314	314				

Table 5-4. Comparison between survey years

Species	Origin	2015	2016	2017
Marine				
Bat ray	Native	3	4	0
Bay pipefish	Native	3	1	0
Northern anchovy	Native	2,439	981	854
California halibut	Native	11	10	30
California tonguefish	Native	20	3	0
Diamond turbot	Native	1	7	0
Leopard shark	Native	12	0	0
Shiner surfperch	Native	4	1	0
Walleye surfperch	Native	1	0	0
Topsmelt	Native	142	290	4
Pacific herring	Native	0	2	1
Estuarine				
Chameleon goby	Non-Native	15	101	24
Pacific staghorn sculpin	Native	45	7	63
Prickly sculpin	Native	10	0	0
Rainwater killifish	Non-Native	1	3	3
Shimofuri goby	Non-Native	7	0	0
Shokihaze goby	Non-Native	119	22	65
Yellowfin goby	Non-Native	1	0	755
Longjaw mudsucker	Native	0	4	0
Anadromous				
American shad	Non-Native	6	0	0
Chinook salmon	Native	0	0	1
Striped bass	Non-Native	2	3	2
Freshwater (Brackish)				
Three-spined stickleback	Native	1	11	39
Species Origin (raw count and [species count])				
Native		2,692 [13]	1,321 [12]	992 [7]
Non-Native		151 [7]	129 [4]	849 [5]
Total		**2,843**	**1,450**	**1,841**

5.3 Invertebrate Sampling

No targeted invertebrate sampling was conducted as part of the survey effort, however, 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 throughout the site; 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 HWRP is serving as an important rearing site for multiple species.

5.4 Discussion

Overall, the distribution and diversity fish species encountered during the 2017 (year 2) sampling effort showed a reduction in species diversity as seen from 2015 and 2016 (years 0 and 1). The number of species recorded decreased from 20 species in 2015, and 16 in 2016, to 12 during 2017 (year 2) as shown in Table 5-4 presented above. While there was a slight increase in the raw number of individual fish captured, this was primarily caused by the dramatic increase in abundance of juvenile yellowfin goby over previous years.

It is likely that the continued reduction in species diversity is a result of the significant drop in salinity from the preceding two survey years. During the 2015 and 2016 sampling events (years 0 and 1) salinities within the Project site fluctuated between 22 and 27 psu due to the respective critically dry and below normal water years; however, during the 2017 (year 2) sampling event (anticipated to be a wet water year) the salinity within the Project site was 8 psu. This dramatic shift in salinity is further reflected in the shift from marine fish dominated assemblage to one made up primarily of estuarine species (Table 5-4).

The relative abundance of pelagic species generally remained consistent with previous years, as northern anchovy were once again the most common fish encountered within the site. Topsmelt abundance did significantly reduce and is likely due to the drop in water salinity. Nonetheless, the benthic assemblage continued to be dominated by non-native goby species and showed a dramatic increase in the number of juvenile yellowfin goby.

Native species captured during the 2015 (year 0) and 2016 (year 1) surveys including bat ray, shiner surfperch, bay pipefish, California tonguefish and diamond turbot were not observed during the year 2 survey, and, the proportion of native to non-native species decreased from 88 percent to only 58 percent native from 2015 (year 0) to 2017 (year 2). However, one native fish species, Chinook salmon, recorded during the year 2 survey, was not encountered during the preceding 2 survey years.

Consistent with the preceding two survey years, the fish collected during this sampling event represent a diversity of trophic levels, life stages, and life history requirements. Larval and juvenile fish were primarily represented by northern anchovy and yellowfin goby. California halibut were also common within the nearshore habitats. Occupation of nearshore habitat along with usage of secondary and tertiary channels suggests that these species may be using the tidal marsh as rearing habitat.

Both seine and trawl were utilized throughout the site in order to comprehensively sample both nearshore and in-channel habitat, however, nearshore conditions made seining in secondary channels impossible. Trawling and seining captured both benthic and pelagic species, with northern anchovy and yellowfin goby being the dominant species encountered by each method. Unlike previous years when seine hauls produced significantly less biomass and showed less

diversity than trawl, both sampling methods yielded similar levels of abundance and showed a similar composition of species (biomass remained lower). Additionally, there seemed to be a fairly even distribution of fish life-stage regardless of the method used, with large numbers juvenile fish captured by both methods. However, as with previous years, the largest fish sampled were captured by trawl. All species captured by seine were also captured by trawl, with the exception of Pacific herring and rainwater killifish.

Monitoring over the past three years has documented a diverse assemblage of species throughout the tidal wetland restoration site. While the number and abundance of individual species has fluctuated annually, utilization of all portions of the project site by multiple species and life stages has consistently been documented.

The trends established over the recent three years of monitoring are insightful and provide a relatively early look as to how the HWRP site is functioning for aquatic species. Continued monitoring over numerous different water years and through varying annual conditions will allow for an improved understanding of how the restoration site design will benefit fishes over time. The early results suggest that the site is meeting its intended goal by providing habitat to important native species.