CHAPTER 5
Fish Surveys

The purpose of conducting regular fish sampling is to document the species richness, abundance, and distribution within the Hamilton restoration site. Documenting changes in the fish community throughout the course of the site's evolution serves as an important variable in evaluating the overall health of the site, and will help inform future restoration efforts in the region. On May 4 & 5, 2016 ESA conducted the second year of fish sampling throughout the Hamilton restoration site. This report documents those findings.

5.1 Materials and Methods

5.1.1 Fish Sampling Methods

The fish sampling methodology for the Year 1 survey was consistent with the Year 0 survey in that it consisted of the same modes of sampling and reoccupied the same locations within the site.

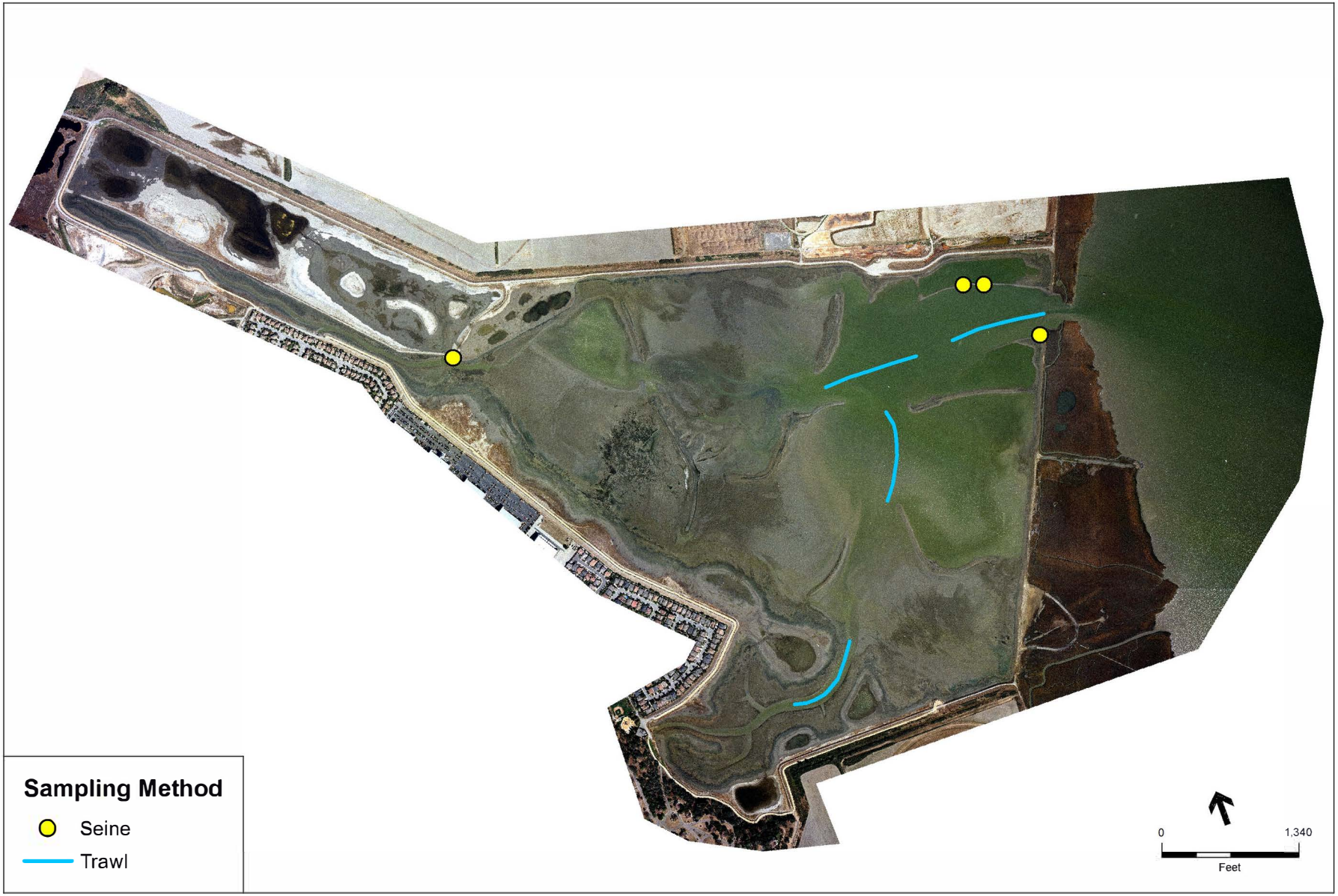
The habitat complexity within Hamilton is such that, in order to comprehensively sample all available habitats, multiple sampling methods were utilized. A 40 foot beach seine was used to sample the nearshore areas within the main and tertiary tidal channels. Since seining is a depth-limited method, an 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 are 12 feet wide by 3 feet high. Sampling locations are shown in **Figure 12**.

All fish captured were identified to the species, measured (total length in mm), and returned to the channel from which they were caught[1]. 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 2016 (May 4 and 5) and timed to coincide with tidal elevations appropriate for ensuring sufficient depth for sampling and navigation. Tidal elevations for the sampling dates are reported in **Table 5-1**.

[1] Multiple chameleon goby vouchers were collected over the course of the survey for genetic analysis to determine the extent of hybridization between chameleon and shimofuri gobies.



SOURCE: ESA (2016)

Hamilton Wetlands Monitoring . 120366.02

Figure 12

Fish Sampling Locations

TABLE 5-1
PREDICTED TIDE HEIGHT DURING SAMPLING PERIODS

Date	Tide Height (ft MLLW) and Time (PT)
May 4, 2016	Low Tide: 0.13 (06:13)
	High Tide: 5.26 (11:56)
	Low Tide: 0.55 (18:09)
May 5, 2016	High Tide: 6.51 (00:01)
	Low Tide: -0.43 (07:01)
	High Tide: 5.39 (12:55)
	Low Tide: 0.81 (18:56)

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 1,450 individual fish representing 14 families and 16 species, including[2]:

TABLE 5-2
FISH SPECIES PRESENT IN THE PROJECT SITE – 2016

Native Species	
Bay pipefish	*Syngnathus leptorhynchus*
California anchovy	*Engraulis mordax*
Pacific Herring	*Clupea pallasii*
Pacific staghorn sculpin	*Leptocottus armatus*
Three-spined stickleback	*Gasterosteus aculeatus*
Topsmelt	*Atherinops affinis*
California halibut	*Paralichthys californicus*
Longjaw mudsucker	*Gillichthys mirabilis*
Diamond turbot	*Hypsopsetta guttulata*
California tonguefish	*Symphurus atricaudus*
Shiner surfperch	*Cymatogaster aggregata*
Bat ray	*Myliobatis californica*
Non-Native Species	
Chameleon goby[3]	*Tridentiger trigonocephalus*
Rainwater killifish	*Lucania parva*
Shokihaze goby	*Tridentiger barbulatus*
Striped bass	*Morone saxatilis*

- Atherinopsidae
  - Topsmelt, *Atherinops affinis*
- Clupeidae
  - Pacific Herring, *Clupea pallasii*
- Cottidae
  - Pacific Staghorn Sculpin, *Leptocottus armatus*

[2] Non-native species are denoted with *
[3] Chameleon goby and shimofuri goby are known to hybridize

- Cynoglossidae
  - California Tonguefish, *Symphurus atricaudus*
- Embiotocidae
  - Shiner Surfperch, *Cymatogaster aggregata*
- Engraulidae
  - California Anchovy, *Engraulis mordax*
- Fundulidae
  - Rainwater Killifish, *Lucania parva**
- Gasterosteidae
  - Three-spined Stickleback, *Gasterosteus aculeatus*
- Gobiidae
  - Shokihaze Goby, *Tridentiger barbatus**
  - Chameleon Goby, *Tridentiger trigonocephalus**
  - Yellowfin Goby, *Acanthogobius flavimanus **
  - Longjaw Mudsucker, *Gillichthys mirabilis*
- Moronidae
  - Striped Bass, *Morone saxatilis**
- Myliobatidae
  - Bat Ray, *Myliobatis californica*
- Paralichthyidae
  - California Halibut, *Paralichthys californicus*
- Pleuronectidae
  - Diamond Turbot, *Hypsopsetta guttulata*
- Syngnathidae
  - Bay Pipefish, *Syngnathus leptorhynchus*

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 12**). Each trawl was towed for approximately 10 minutes beginning at the time the gear was fully deployed (on the channel bottom) at a speed of approximately 1-1.5 knots.

Eighteen fish species were captured in the main channel during the survey, with the assemblage dominated by native species (**Table 5-3**). Juvenile California anchovy was the most abundant species captured in the main tidal channel, both nearshore and in-channel, comprising over 81% of the total catch. The benthic assemblage was dominated in number by non-native goby species, in particular, the chameleon goby. However, native species of sculpin, goby, and bat ray, along with three species of native flatfish were also documented during the survey.

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												
California anchovy	**431**	41	38	64					**54**	43	38	64
Chameleon goby	**10**	49	38	65					**30**	52	30	85
Shokihaze goby									**1**	45	45	45
Longjaw mudsucker									**2**	50	50	50
Pacific staghorn theater	**1**	65	65	65					**1**	70	70	70
Rainwater killifish					**No Seine in Secondary Channels**				**3**	35	30	40
Diamond Turbot									**3**	110	85	155
Striped bass									**1**	230	230	230
Three-spined stickleback	**5**	41	38	45					**5**	31	25	45
Topsmelt									**290**	59	38	90
Pacific Herring	**1**	80	80	80								
Trawl												
Bat ray	**4**	453	340	600								
Bay pipefish	**1**	210	210	210								
California anchovy	**89**	48	38	64	**206**	48	38	65	**201**	45	38	64
Pacific Herring									**1**	38	38	38
California halibut	**10**	144	100	190								
California tonguefish	**3**	63	60	70								
Diamond turbot	**3**	172	160	190	**1**	90	90	90				
Chameleon goby	**55**	48	38	80	**4**	52	50	55	**2**	65	60	70
Shokihaze goby	**19**	67	50	80					**2**	60	60	60
Longjaw mudsucker	**1**	155	155	155					**1**	150	150	150
Pacific staghorn sculpin	**3**	70	60	80	**2**	63	60	65				
Three-spined stickleback	**1**	64	64	64								
Shiner surfperch	**1**	38	38	38								
Striped bass	**2**	150	150	150								

Significant trophic diversity was observed in the main tidal channel. Top predators including bat ray, and in the preceding year leopard shark, were only encountered in the main channel in the region closest to the breach. The high velocity environment created by tidal action in close proximity to the breach may increase predation success for those species.

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 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.

The secondary and tertiary channels showed similar species abundance to the main channel, albeit with less diversity. California anchovy was once again the most abundant pelagic species; however, a large number of juvenile topsmelt were captured by seine at one sampling site along a tertiary channel. Chameleon goby was once again the most abundant benthic species encountered, however native species of sculpin, flatfish, and goby were also observed. All species recorded in the secondary and tertiary channels were also present in the main channel, with the exception of topsmelt.

5.2.4 Comparison between Gear Types

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 California anchovy being the dominant species by both methods. As expected, seine hauls produced less relative biomass and showed less diversity than trawls, although this disparity was less pronounced than in the previous survey year. Nearshore habitat is often utilized by juveniles for rearing or as a refuge from predators, which appeared to be the case within the site. All species captured by seine were also captured by trawl, with the exception of topsmelt and rainwater killifish.

5.3 Invertebrate sampling

No targeted invertebrate sampling was conducted as part of the survey effort, however 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 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. Additionally, at least two species of crab and a number of unidentified copepods were also observed during the survey.

5.4 Discussion

Overall, the distribution, diversity and relative abundance of fish species encountered during the Year 1 sampling effort was very similar to that recorded in year 0. However, there was a reduction in the number of species observed (from 20 to 15) and in the total number of individual fish captured throughout the site. This reduction in diversity and biomass may be the result of increased water temperatures due to El Niño, changes in habitat structure from an additional year of tidal marsh evolution, or any other suite of environmental variables. More likely, since the overall drop in diversity was relatively small, changes in fish assemblage and abundance between survey years is primarily the result of expected year-to-year fluctuations in population size and community structure.

Native species captured during the Year 0 (2015) survey including prickly sculpin, walleye surfperch, and leopard shark were not were not observed during the Year 1 survey; however the proportion of native to non-native species did increase from 75% to 88% native. Additionally, longjaw mudsucker and pacific herring, both native, were first observed in the year 1 survey. All non-native species encountered were also observed in year 0 and two non-native species (yellowfin goby and american shad) present in Year 0 were not recorded in Year 1. However, non-native gobies, in particular the chameleon goby, dominated the benthic assemblage throughout the site. The proportion of native to non-native species is particularly encouraging for the future development of the site when compared to the non-native dominated assemblages found at Sonoma Baylands and within the tidal channel networks of the Napa and Petaluma rivers.

Multiple chameleon goby vouchers were collected by ESA during the Year 1 sampling effort for genetic analysis by UC Davis. Chameleon and shimofuri goby are known to hybridize making accurate identification in the field difficult.

Consistent with the Year 0 survey, the fish collected during this sampling event represent a diversity of trophic levels, life stages, and life history requirements. Larval and juvenile individuals, primarily California anchovy and topsmelt, were common within the nearshore habitats. The utilization of such habitat, along with their presence within the secondary and tertiary channels, further suggests that these species may be using the tidal marsh as rearing habitat. Additionally, bat rays were present in significant numbers within the main channel in close proximity to the breach, lending additional support to the theory that the high-velocity created by the breach facilitates predation.

Recommendations for future monitoring methods include continued seine and trawl sampling within the main, secondary, and tertiary channels, as well as the addition of fyke nets. Fyke nets should be installed within channel during high tides and fished until low tide to capture species that are using the marsh plain at higher tides then moving out with the receding tide. Fyke nets may be effective in all channels and may increase the efficiency of sampling and number of species captured. Additionally, the expansion of the monitoring effort to include fall surveys would be useful to understand how the fish community varies in response to changes to environmental variables (water temperature, salinity, etc.) between seasons.