Salt River Ecosystem Restoration Project Monitoring

Background

The Salt River is a tidally influenced slough tributary to the Eel River estuary located in Humboldt County near Ferndale, California. Salinity in the Salt River varies with the interactions of tides, Eel River flows, and freshwater inflows from its tributaries (Williams, Francis, Smith and Reas creeks). In the mid-1800s, the Salt River channel was sufficiently deep to support ship traffic up to Port Kenyon, however increased sediment delivered from the upper watershed and reduced tidal prism to flush sediment resulted in an aggraded channel with significantly reduced widths and depths. The frequency of flooding in Ferndale and the surrounding farmland progressively increased as the Salt River filled with sediment during the past century, and continuous efforts have been made to alleviate flooding. An intensive multi-stakeholder planning process started in 1990 that initiated studies on sedimentation, hydrology, and aquatic and avian biology and culminated with a multi-phase plan to restore the hydraulic and ecological function of the Salt River.

Project Purpose

The Salt River Ecosystem Restoration Project (SRERP) is a cooperative public/private partnership that seeks to restore tidal marsh and seven miles of the Salt River Channel and floodplain corridor, and reduce upslope sediment. A total of 2.5 miles of the Salt River and 330 acres of tidal marsh were restored in 2013, 1.2 miles were restored in 2014, 0.4 miles were restored in 2015, and the remaining three miles will be completed in 2017 and 2018. This project is intended to relieve annual flooding on the delta plain and to restore, create and enhance wildlife habitat. The newly excavated Salt River channel and associated slough channels are intended to provide a substantial increase in tidal prism that will keep sediment suspended in the water column so it will be carried out of the system to the ocean on each tidal cycle. The project design also provides increased habitat for salmonids and other brackish and marine species.

Monitoring Timeline

Project Monitoring was conducted by the California Department of Fish and Wildlife (CDFW), Humboldt State University, and Humboldt County Resource Conservation District (RCD) during March–August 2014 and April–July 2015 in the Riverside Ranch and channel corridor portion of the project. Project monitoring was conducted by RTA and Associates (RTA) from November 2014–March 2015 and December 2015–April 2016.

Monitoring Purpose

Monitoring was conducted to determine the presence and distribution of fish within the restored main channel and sloughs to assess and document use of newly accessible habitat, particularly by ESA-listed species, such as coho salmon (*Oncorhynchus kisutch*), tidewater goby (*Eucyclogobius newberryi*), and Chinook salmon (*O. Tshawytscha*).

California Fish Passage Forum

Barrier Removal Effectiveness Monitoring

PROJECT AT-A-GLANCE

Project Title: Salt River Ecosystem Restoration Project

Project Applicant: Humboldt County Resource Conservation District (RCD)

Partners: State Water Resources Control Board, State Coastal Conservancy, Wildlife Conservation Board, California Department of Fish and Wildlife, Natural Resources Conservation Service, Caltrans, Department of Water Resources, Department of Conservation, North American Wetlands Conservation Act, US Fish and Wildlife Service, National Fish and Wildlife Foundation, NOAA Restoration Center, Ducks Unlimited, California Conservation Corps, US Army Corps of Engineers, Humboldt County RCD, Humboldt County, Humboldt State University, Pacific Coast Joint Venture, Pacific Marine and Estuarine Fish Habitat Partnership, California Fish Passage Forum, Pacific States Marine Fisheries Commission, City of Ferndale, Greater Ferndale Community, Western Rivers Conservancy

Project funding provided by: Numerous partner organizations

Groups Conducting Monitoring: Ross Taylor and Associates, NOAA Fisheries, Humboldt County RCD, California Department of Fish and Wildlife, Humboldt State University, NOAA/CCC Veterans Corps, and others.

Project Location: Salt River Estuary, tributary to the Eel River Estuary, Humboldt County

Monitoring Methods

Water quality attributes, including salinity, dissolved oxygen, and water temperature, were recorded during each type of fish distribution sampling.

Fish distribution sampling

Low tide seine net: Sites were selected to encompass the diversity of channel sizes, depths and locations through the main Salt River channel, the northern and southern sloughs, and smaller side channels to the two sloughs. Seine nets (20-feet long x 4-feet tall, 1/8-inch mesh; 30-feet long x 4-feet tall, 1/8-inch mesh) were pulled by wading against the current to sample a 150-foot reach. Start time was recorded. Species captured were identified to species, enumerated, and released.

High tide sampling at main channel sites: A kayak was used to set a 100-foot long seine net (6-feet tall with a ¼-inch mesh).

High tide sampling at slough and side channel sites: A 30-foot seine net with a 1/8-inch mesh was used to sample using a wading technique.

Sampling with minnow traps: Minnow traps baited with frozen steelhead (*O. mykiss*) eggs were used to sample juvenile coho salmon in the Salt River upstream of the Riverside Ranch, where narrower channel geometry and more constant downstream current occurs. Deployment and retrieval times were recorded.

Monitoring Results/Discussion

March–August 2014 and April–July 2015 Sampling Results

Nineteen species of fish were detected using seining and minnow trapping at 11 monitoring sites from March–August 2014 (Table 1) (CDFW and Humboldt County RCD) in the Riverside Ranch and channel corridor of the project. In 2014, salmonid juveniles (coho and Chinook) were only present during the months of March and April, and primarily located in the northern and southern slough channels. Tidewater gobies were present during the entire sampling season, though more abundant during the summer months. A significantly greater abundance and distribution of juvenile coho and tidewater gobies was identified by project monitoring only six months after removal of tidegates and levies from the Riverside Ranch.

No salmonid juveniles (coho and Chinook) were present during the any of the sampling months (April to July) in 2015 (Table 1) (CDFW). Drought conditions may have attributed to the absence of salmonids during the sampling effort. Tidewater gobies were present during the entire sampling season, though more abundant during the summer months. The gobies were sampled across most locations in the estuary, including the Salt River main channel, and at the Reas Creek mouth, though they were most abundant in areas associated with specially designed backwater feature Goby lift.

Table 1. Species and numbers of fish captured during the March–August 2014 and April–July 2015 sampling seasons (CDFW and Humboldt County RCD).

Fish species	Number sampled March–August 2014	Number sampled April–July 2015
Bay pipefish	17	12
California roach		5
Coho salmon (juvenile)	40	
Chinook salmon (juvenile)	6	
Copper rockfish	1	
Crab spp.		133
Dungeness crab	8	131
Flatfish spp.		18
Jellyfish	5	
Night smelt	183	
Pacific herring	5	1
Pipefish	17	
Sacramento pike minnow	34	17
Saddleback gunnel	8	6
Sculpin spp.	1,753	1,131
Shiner surfperch	6	3
Smelt (unidentified juvenile)	1,026	
Smelt spp.		3,388
Speckled Sanddab		33
Starry flounder	3	1
Sticklebacks	25,975	4,633
Surf perch	8	
Surf smelt	29	144
Tidewater goby	327	160
Top smelt	929	
Top smelt (juvenile)		255
Whitebait smelt		1

November 2014–March 2015 and December 2015–April 2016 sampling seasons (RTA)

During the 2015–2016 sampling season, minnow traps baited with steelhead eggs were deployed in areas upstream of the Riverside Ranch to access and sample narrower channels in constant downstream current created when the channel reaches were excavated during the summers of 2014 and 2015. A total of 12 fish species as well as Dungeness crab, green shore crab, and bay shrimp were detected during the December 2015–April 2016 sampling seasons (RTA and Associates 2016) (Table 2). During the January 2016 sampling a nonnative green sunfish (*Lepomis cyanellus*) was captured with two coho salmon in a large settling basin at the upper end of the 2015 channel excavation. The two coho salmon were the furthest upstream coho salmon have been captured in the restored Salt River channel. During the February 2016 sampling, a total of 15 of the 18 coho salmon were captured during low tide; eight coho salmon were captured in minnow traps.

A total of 17 fish species as well as Dungeness crab and bay shrimp were detected during the fall 2014–spring 2015 sampling seasons (RTA and Associates 2015) (Table 2). Juvenile Dungeness crab (*Metacarcinus magister*) and bay shrimp (*Crangon* sp.) were detected at sampling sites with higher salinity water (juvenile Dungeness crabs were most abundant in the Salt River main channel whereas the bay shrimp were captured at most of the sites). During the December 2014 sampling, longfin smelt (*Spirinchus starksi*) (the furthest upstream a longfin smelt has been sampled within the Salt River), and juvenile Pacific lamprey (*Entosphenus tridentatus*) were detected. The greatest diversity of fish was sampled during the March 2015 season (Table 2).

Table 2. Species and numbers of fish captured during the November 2014–March 2015 and December 2015–April 2016 sampling seasons (RTA and Associates).

Fish Species	November 2014	December 2014	January 2015	February 2015	March 2015	December 2015	January 2016	February 2016	March 2016	April 2016
Bay pipefish	0	0	0	1	2	0	0	0	0	0
California roach	0	0	0	12	6	0	127	97	0	31
Green sunfish	0	0	0	0	0	0	1	1	0	0
Juvenile Chinook salmon	0	0	0	1	0	0	0	0	0	1
Juvenile coho salmon	0	1	9	23	4	0	10	18	14	0
Juvenile Dungeness crab	126	3	0	0	28	2	0	0	0	0
Juvenile rockfish	0	0	0	0	4	0	0	0	0	0
Juvenile steelhead	0	0	0	0	0	0	0	0	1	0
Longfin smelt	0	1	0	7	0	0	0	0	0	0
Pacific herring	0	0	0	0	1	0	0	0	0	1
Pacific lamprey	0	1	0	0	0	1	0	0	0	0
Pacific staghorn sculpin	4	19	30	45	59	13	19	267	115	67
Sacramento pike minnow	0	0	4	118	9	0	107	138	42	121
Saddleback gunnel	0	0	0	0	2	0	0	0	0	0
Sculpin sp.	32	49	35	75	901	2	5	2	0	1
Shiner surfperch	0	0	0	0	1	0	0	0	0	0
*Shrimp (*Crangon *sp.).*	568	438	0	10	4	42	0	0	0	0
Starry flounder	1	0	0	1	0	0	0	0	0	0
Surf smelt	3	16	71	107	36	35	0	0	0	8
Threespine stickleback	2,014	967	391	3,737	2,766	90	60	114	13	3,398
Tidewater goby	36	12	83	90	97	2	0	2	0	3
	568	**438**	**623**	**4,231**	**3,920**	**187**	**329**	**639**	**185**	**3,522**

November 2014–March 2015 Sampling Season

The November 2014–March 2015 Salt River sampling resulted in the capture of 17 fish species, as well as Dungeness crab and bay shrimp. Threespine sticklebacks were consistently the most common species captured, comprising 63%–97% of the monthly totals. Juvenile coho salmon were first sampled in December, and their numbers peaked during the February sampling. Tidewater gobies were more frequently sampled in the sloughs and smaller channels than within the Salt River main channel.

After large peak flows in February, sediment aggradation was observed at several sampling sites, giving the appearance of shallow sites at low tides. At one site, a goby lift located downstream of the sampling location seems to have partially failed (incised) during the high flows.

Setting the 100-foot seine with a kayak proved an effective method for sampling the Salt River's main channel at high tide.

During high tide sampling in the main channel, more fish were consistently captured at the upper sites. They may be more attractive for fish because of the extended periods of slack water compared to lower reaches where the current may be constantly moving. The upper sites were also within a channel reach lined with mature riparian trees and several deadfalls extending into the water, thus possibly providing in-channel habitat and overhead cover that was generally lacking at the lower main channel sites.

In November and December 2014, minnow traps baited with salmon roe and fished for one hour caught very few fish, thus they were no longer used for the remainder of the fall and winter sampling.

November 2014–March 2015 and December 2015–April 2016 sampling seasons

Fish sampling within the restored Riverside Ranch reach of the Salt River has occurred for two consecutive winter/spring seasons; November through March of 2014-2015 and December through April of 2015-2016. During these two sampling periods RTA has captured 20 fish species. A comparison summary of the two winter/spring data sets provided a closer examination of species diversity by year; by month and tide; and how frequently each fish species was captured (Table 3). This comparison of the two data sets was limited to the months and tides that were sampled during both seasons; for example, sampling occurred in November 2014, but not in November 2015, thus the 2014 data were not included (Table 3).

When comparing the two data sets, the most apparent difference is the species diversity between the two winter/spring seasons (Table 3). A total of 18 fish species was captured during the 2014–2015 season versus 12 fish species during the 2015–2016 season (Table 3). The reduced number of species captured in 2015–2016 was most likely a function of the wetter winter season and consistently lower salinity levels. At least six species not sampled in 2015–2016 (starry flounder, saddleback gunnel, shiner surfperch, bay pipefish, juvenile rockfish, and top smelt) could be considered more brackish to marine species, thus were not present in the lower Salt River during the winter/spring of 2015–2016.

Tidewater goby were captured during all eight sampling events in 2014–2015, but were only present in four sampling events in 2015-2016 (Table 3). The total numbers of tidewater gobies captured dropped dramatically between the two sampling seasons; 318 fish in 2014–2015 versus only seven fish in 2015–2016. During the winter/spring season of 2014–2015, tidewater gobies were sampled at eight locations versus only two locations during the winter/spring 2015–2016. The goby lifts constructed at two sites have failed, and the channel above these lifts filled in with fine sediments and also failed to hold back water during low tides. Overall, fish numbers (of all species) were low at both of these sites during the winter/spring 2015–2016 sampling. The reason for the absence of and lower numbers of tidewater gobies at six sites during the winter/spring of 2015–2016 is unknown. Again, the main difference between the two winter/spring sampling periods was the wetter conditions in 2015–2016, which resulted in higher flows and lower salinities. Continued sampling may provide more insight into the dynamics of tidewater goby distribution and relative abundance within the lower Salt River.

Another shift in species distribution and relative abundance between the two winter/spring sampling periods was evident with Pacific staghorn sculpin and sculpin species. During the 2014–2015 sampling, sculpin species were widely distributed and common. During 2014–2015 sampling, Pacific staghorn sculpins were also well distributed (present at 10 sites), but seemed less common. Then during the 2015–2016 season, the distribution and relative abundance of sculpin "species" decreased to a total of 10 fish captured at six sites; whereas Pacific staghorn sculpin were caught at 13 sites in relatively higher numbers.

Sacramento pike minnow and California roach were sampled during periods (or in areas) of low salinity, and the relative abundance of both species increased between the two winter/spring sampling periods, most likely a function of lower salinities due to increased rainfall during the 2015–2016 sampling, as well as the addition of new sampling sites located upstream of Reas Creek that were also above the tidal prism.

Fish species that occurred infrequently may be either rare in occurrence, present in low numbers, or not susceptible to the sampling methods employed by RTA. For example, the two juvenile Pacific lamprey sampled by RTA in December (one in each season) were caught with a 100-foot seine. Both times, the lampreys wriggled through the ¼-inch mesh and were almost missed as fish were being collected. Conversely, other species, such as starry flounder, are relatively strong swimmers and may be able to avoid capture because seine nets are hauled-in at a relatively slow pace.

A total of 37 juvenile coho salmon were captured during the 2014–2015 season and 42 fish were captured during the 2015–2016 season. During both seasons, within the Salt River main channel below Reas Creek, juvenile coho salmon were more frequently captured during high tide than during low tide. During the winter/spring of 2014-2015, juvenile coho salmon were captured during six of the eight events and in four months, December through March. In contrast, during the winter/spring 2015-2016 sampling, juvenile coho salmon were captured in only three of the five months, January through March. During this second season of sampling, more effort was made with minnow traps in the recently excavated channel upstream of Reas Creek, and 17 juvenile coho calmon (40% of the total catch) were captured in baited minnow traps. In the channel reaches associated with Sites #20-23, RTA experimented with setting traps in open channel areas and adjacent to wood structures; overwhelmingly juvenile coho salmon were caught in traps placed next to wood structures. RTA also measured the fork length to the nearest millimeter of all juvenile coho salmon caught winter/spring 2015-2016 sampling. As during the previous year's sampling, juvenile coho salmon captured in January-March of 2016 appeared in good condition and were larger each subsequent month.

During the 2015-2016, no juvenile Chinook Salmon were captured, compared to four individuals caught the previous season. RTA captured a juvenile steelhead during the March 2016 high tide sampling at Site #1-A; this was the first Steelhead documented in the restored Salt River channel.

Table 3. Comparison summaries of Salt River fish species diversity by month/tide and fish species occurrence per sampling event. Time periods covered were December 2014 to April 2015 (A) and December 2015 to April 2016 (B). NOTE: an "X" denotes that at least one fish of a particular species was caught during a sampling event; please refer to Tables 2, 4, 6, 8, and 10 for fish numbers and capture locations (RTA and Associates 2016).

SPECIES LIST	DEC. HIGH TIDE	DEC. LOW TIDE	JAN. HIGH TIDE	FEB. HIGH TIDE	FEB. LOW TIDE	MARCH HIGH TIDE	MARCH LOW TIDE	APRIL LOW TIDE	Number of Occurrences in 2014–2015	Number of Occurrences in 2015–2016
STICKLEBACK	A B	A B	A B	A B	A B	A B	A B	A B	8	8
SCULPIN SP.	A	A B	A B	A B	A	A	A	A B	8	4
TIDEWATER GOBY	A	A B	A B	A	A B	A	A	A B	8	4
SURF SMELT	A B	A B	A	A	A	A	A	A B	8	3
STAGHORN SCULPIN		A B	A B	A B	A B	A B	A B	B	6	7
COHO SALMON	A		A B	A B	A B	A B	B	A	6	5
PIKE MINNOW			A B	AB	A B	A B	A B	B	5	6
BAY PIPEFISH					A	A			2	0
SHINER SURFPERCH							A		1	0
CALIFORNIA ROACH				A B	A B	A	A	B	4	3
LONGFIN SMELT		A		A	A				3	0
TOP SMELT							A	A	2	0
STARRY FLOUNDER					A				1	0
SADDLEBACK GUNNEL						A			1	0
CHINOOK SALMON					A			A	2	0
STEELHEAD						B			0	1
GREEN SUNFISH			B		B				0	2
PACIFIC HERRING							A	B	1	1
JUVENILE ROCKFISH							A		1	0
PACIFIC LAMPREY	A B								1	1
Number of Species per Sampling Event	A=6 B=3	A=6 B=5	A=7 B=7	A=9 B=6	A=12 B=7	A=10 B=5	A=11 B=4	A=7 B=8		

Monitoring and Project Considerations

Recommendation: Constructed goby lift features functioned and were used by tidewater gobies during the first year following project construction and may have been beneficial to recolonization of newly opened habitat. Aggradation behind goby lifts or erosion of the lifts in subsequent years following construction **occurred,** and gobies while still present and well distributed were less associated with the features constructed for them. Additional observations and monitoring should be conducted to assess the short and long term benefit and functionality of goby lifts.

Recommendation: Avoid attempting to set a dry net that had been stored since the previous month's sampling to avoid a tangled net or a wrapped lead line. On the first set of a sampling day, lay the dry 100-foot net out in the river channel, completing wet it down, and carefully restack it into a cooler.

Recommendation: Sample areas with gently sloped banks to allow the lead line to remain close to the channel bottom when the net was pulled. Avoid steep, near-vertical banks, which will likely result in few fish being captured.

Recommendation: Set seine nets at the top of the tide when the current is slack. Setting nets in a moving current will cause the net to be swept to the up-current bank with the cork line running over the top of the lead line and few, if any, fish being captured. Depending on the main channel sampling site, the timing and duration of slack water at high tide varies greatly.

Recommendation: Minnow traps may be a feasible way to sample newly constructed channels that have narrow width and nearly vertical banks.

Recommendation: Fish sampling across a suite of sites, incorporating new sites as additional channel excavation and restoration activities occur, can inform the temporal and spatial use of restored channels by fish species.

Recommendation: Employing a seine net with a kayak at high tide can be effective at capturing juvenile coho salmon in a deep main channel.

Recommendation: Minnow traps baited with frozen steelhead roe are effective sampling newly constructed channels with narrow widths and steep banks, however, juvenile salmon are more often caught in traps placed adjacent to woody structures compared to Pacific staghorn sculpin and threespine sticklebacks, which are more frequently caught in open channel areas.

Recommendation: Consider use of PIT tags and antenna/receiver arrays to assess movement and growth of juvenile coho salmon.

Seining on the main channel. Photo credit: RTA.

Kayak with cooler holding a 100-foot seine net for high tide sampling. Photo credit: RTA.

*Threespine stickleback (*Gasterosteus aculeatus*) gravid female captured in March of 2015. Photo credit: RTA.*

d roe.
RTA.

Identifying fish captured during sampling the Salt River channel. Photo credit: CDFW.