Fishery and Water Quality Monitoring of Pajaro River Lagoon in 2017

Purpose of Sampling

The Santa Cruz County Flood Control and Water Conservation District Zone 7 is required to conduct annual fish sampling in the Pajaro Lagoon as a permit condition for lagoon breaching. The fish sampling documents the presence/absence, distribution and abundance of steelhead *(Oncorhynchus mykiss*), tidewater goby (*Eucyclogobius newberryi*), and other fish and wildlife. 2017 was the sixth year of annual sampling, which began in 2012.

Summary of 2017 Results

No steelhead were captured in Pajaro River Estuary in fall 2017, as was the case in fall 2012−2016. Only one tidewater goby was captured in 2017, the location being adjacent to the model airplane airport. The catch was dominated by jack smelt (*Atherinopsis californiensis*).

2017 Estuary Conditions

An estuary was present with an open sandbar during fish sampling in late September and early October. There was daily tidal influence during the sampling period.

Methods

Pajaro Estuary (open sandbar) was sampled on September 29 and October 2 and 3, 2017. Sampling locations included the beach area, adjacent to the model airport (1.8 miles upstream of Watsonville Slough), at Thurwachter Bridge (2.1 miles upstream of Watsonville Slough) and behind the City of Watsonville wastewater treatment plant (2.9 miles upstream of Watsonville Slough) (**Fig.1**). On 29 September, the main estuary along the beach was sampled for steelhead with the 106-foot bag seine (3/8-inch mesh) (7 successful seine hauls; the 8th haul closest to Watsonville Slough could not be beached due to weighted accumulation of algae, detrital ooze and sand in the bag). On 2 October, the upper estuary was sampled for steelhead with the 106-foot seine. Three seine hauls were made at the model airport, with 3 more at Thurwachter Bridge. Water quality was measured mid-channel at the 2 sites (water temperature, salinity and oxygen measured through the water column at 0.25 meter intervals). On 3 October, tidewater goby were sampled using a 30-foot seine with 1/8-inch mesh. Five seine hauls were made in the estuary along the beach, and 3 were made in the upper estuary (model airport, Thurwachter Bridge and boat ramp). On 3 October, during tidewater goby sampling in the lower and upper estuary, water quality was measured at 6 stations. The 3 lower estuary measurements were made mid-channel by wading, and the 3 upper estuary measurements were made along the margin.

Results – Fish Capture

Sampling of the lower estuary along the beachfront with the larger bag seine yielded only 4 native fish species compared to 3 in 2016, 1 in 2015, 3 in 2014 and 10 in 2013 (**Table 1**). Smelt were again the most abundant species with all being identified as jack smelt. Other species included staghorn sculpins (*Leptocottus armatus*), arrow goby (*Clevelandia ios*) and bay pipefish (*Syngnathus leptorhynchus*). No steelhead were captured. Despite the presumably periodic opening and closing of the sandbar in 2017, many Bay species that were present in the 2013 estuary in sufficient numbers to be captured were absent in 2017. One harbor seal was present in the lower estuary during sampling. Results of sampling the upper estuary near the model airport and Thurwachter Bridge with the large seine yielded the same species as the lower estuary plus additional species, including 1 threespine stickleback (*Gasterosteus aculeatus*), 1 tidewater goby, 1 starry flounder (*Platichthys stellatus*) and no steelhead (**Table 2**). Crabs were common in our seine hauls. They were either green (most common), red (Dungeness) or brown (kelp) in color. One nudibranch was captured.

Our tidewater goby sampling with the finer meshed seine yielded no tidewater gobies in the lower estuary along the beachfront where arrow goby, jack smelt, staghorn sculpin, bay pipefish and all 3 colors of crabs were captured. Submerged aquatic vegetation was very scarce, as had been the case in 2015and 2016. The main estuary was very shallow and mostly wadeable except for a narrow thalweg and near the Watsonville Slough confluence. In the upper estuary, no tidewater goby were captured at the model airport, Thurwachter Bridge or the boat ramp (**Table 3**). Other species captured in the upper estuary included arrow goby (uncommon), abundant YOY smelt, staghorn sculpin, mosquitofish (*Gambusia spp.*) and one threespine stickleback.

Table 1. Fish capture* results from sampling lower Pajaro Estuary *with the 106-foot bag seine (3/8-inch mesh)*, 29 September 2017.

Date	Location	Seine Haul	Tide-water Goby	Arrow goby	Bay pipefish	Jack smelt	Stag-horn Sculpin
29 Sep 2017	East of Watsonville Slough confluence	1		10			2
	East of #1	2		4		78	1
	East of #2	3		15	1	66	2
	East of #3	4		16+		73	3
	East of #4	5		Present	8	437	21
	East of #5	6		Present	3	200	14
	East of #6	7		Present	1	120	16
	Adj. mouth of Watsonville Slough	8 (failed)					
Total			**0**	**45+**	**13**	**974**	**57**

*1 nudibranch and 54 crabs were captured. Crabs included Dungeness, green, kelp.

Table 2. Fish capture* results from sampling Upper Pajaro Estuary *with the 106-foot bag seine (3/8 inch (3/8-inch mesh)*, 2 October 2017.

Date	Location	Seine Hauls	Tide-water Goby	Arrow Goby	Bay pipefish	Jack smelt	Staghorn Sculpin	Three-spine Stickle-back	Starry Flounder
2 Oct 2017	Model Airport	1−3	1		2	344	3		1
	Thurwachter Bridge	4−6		8	1	267	4	1	
Total			**1**	**0**	**3**	**611**	**7**	**1**	**1**

*9 crabs captured (green and Dungeness)

Table 3. Fish capture* results from sampling the periphery of lower Pajaro Estuary, Watsonville Slough and upper Pajaro Estuary *with the 30-foot seine (1/8-inch mesh)*, 3 October 2017.

Date	Location	Seine Haul	Tide-water Goby	Arrow goby	Gam-busia	Bay pipe-fish	Smelt (jack and top)	Staghorn Sculpin	Three-spine stickle-back
3 Oct 2017	Approx. 200 m east of Pajaro Dunes Complex	1		12		1			
	East of #1	2		14				1	
	East of #2	3		23		2		1	
	East of #3	4		3		1			
	East of #4	5		3			6		
	Airport- 0.3 miles down from Thurwachter Br	6			100+		500+ YOY		
	Thurwachter Br.	7		2		1	25+ YOY	4	1
	Boat Ramp- 0.8 miles upstream of Thurwachter Bridge and 2.9 miles upstream of Watsonville Slough confluence.	8						1	
Total			**0**	**57**	**100+**	**5**	**531+**	**7**	**1**

* 19 crabs (green and Dungeness) were captured.

Water Quality

On 2 October, during steelhead sampling in the upper estuary, water temperature was very warm and would have been very stressful for steelhead at the airport and Thurwachter Bridge by early afternoon (range of 23−27°C through the water column), with warmer temperatures near the bottom than at the surface (**Table 4**). Salinity and oxygen were stratified at the airport site, with still better than anoxic conditions near the bottom. At Thurwachter Bridge, abundant oxygen increased with depth (supersaturated 11.5− 16.5 mg/L) despite increases in very warm water temperature and salinity with depth. On 3 October, during tidewater goby sampling in the lower and upper estuary, it was found that the water temperature and salinity were unstratified in the lower estuary but somewhat stratified in the upper estuary, with water temperature and salinity increasing with depth there (**Table 5**). Oxygen declined with depth at 2 of 3 sites in the lower estuary, but not extremely to anoxic conditions near the bottom (3 mg/L at one site and 6 mg/L at the other). Oxygen remained high throughout the water column at Thurwachter Bridge (8.3−10 mg/L), but surprisingly increased at depth at the uppermost boat ramp to supersaturated conditions (24.7 mg/L near the bottom), despite increase in water temperature to very warm levels at both sites (26.7°C at Thurwachter Bridge and 28.5°C mid-channel at the boat ramp) and increased salinity with depth.

Table 4. Water quality measurements in the upper Pajaro Estuary during steelhead sampling, 2 October 2017.

			2 October 2017					
	Model Airport (mid-channel) Air temp. 21.1 C			1108 hr	**Thurwachter Bridge** (mid-channel)			1343 hr
Depth	**Temp**	**Salin**	**O2 (%sat.)**	**Cond**	**Temp**	**Salin**	**O2 (%sat.)**	**Cond**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**Umhos**
0.00	23.8	8.8	12.06	14900	24.1	16.2	11.59	26055
0.25	24.9	18.7	9.36	30100	23.2	16.0	11.89	25904
0.50	25.5	23.6	6.50	37581	27.0	20.6	13.59	34365
0.75	25.2	25.0	6.72	39327	27.2	23.2	13.73	38275
0.85b					27.2	23.8	16.51	39098
1.00	24.6	26.2	4.46	40140				
1.25b	24.5	26.3	3.91	40730				
1.50								

Table 5. Water quality measurements in the lower Pajaro Estuary (Stations 1, 3 and 5 in mid-channel) and the three upper estuary sites (along margin) during tidewater goby sampling, 3 October 2017.

			3-October 2017					
	Station 1 (lower estuary) air temp. 17.1 C		0951 hr		**Station 3 (lower estuary)**			1043 hr
Depth	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	16.3	26.2	11.85	34479	17.1	28.2	11.91	36652
0.25	17.0	26.3	9.86	34663	16.8	27.2	8.68	35585
0.50	17.0	26.4	8.85	34799	17.0	29.2	5.11	38152
0.75	16.9	29.2	3.37	37822	16.6	31.2	4.85	38995
0.87b					16.6	30.1	6.03	38909
1.00	16.5	30.1	3.22	38743				
1.20b	16.4	30.1	3.05	38736				
	Station 5 (lower estuary)			1133 hr	**Thurwachter Bridge**			1321 hr
Depth	**Temp**	**Salin**	**O2**	**Cond**	**Temp**	**Salin**	**O2**	**Cond**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**Umhos**
0.00	17.6	27.7	12.49	36898	22.8	15.7	9.95	24603
0.25	16.6	28.8	10.79	37375	23.4	15.9	8.37	25410
0.50	16.2	30.3	12.43	38803	25.5	18.0	8.42	29366
0.75	15.9	30.3	12.54	38398	25.8	23.8	9.92	38157
0.85b					25.8	24.2	10.07	38699
1.00b	15.9	30.2	12.08	38347				

Table 5 (continued). Water quality measurements in the lower Pajaro Estuary (Stations 1, 3 and 5) and the upper estuary sites during tidewater goby sampling, 3 October 2017.

			3 October 2017					
	Boat Launch Ramp mid-channel (above Thurwachter Br.)			1354 hr	**Boat Launch Ramp- 8 ft from shore (above Thurwachter Br.)**			1402 hr
Depth	**Temp 2**	**Salin 2**	**O2 2 (%sat.)**	**Cond 2**	**Temp 2**	**Salin 2**	**O2 2 (%sat.)**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	20.0	2.5	8.19	4266	20.0	2.5	9.42	4149
0.25	20.0	2.4	7.94	4023	20.0	2.4	8.55	4086
0.50	25.2	16.4	6.77	26944	25.0	12.9	7.55	21449
0.75b	26.6	18.6	9.55	30990	26.7	18.4	13.14	30569
1.00	28.4	21.1	24.70	35963				
1.10b	28.5	21.3	23.07	36423				

CONCLUSIONS

No steelhead were detected in the Pajaro Estuary in 2017. With its daily tidal influence, the estuary was less favorable to juvenile steelhead for rearing and tidewater goby for spawning than a deeper freshwater lagoon would be without daily depth fluctuation and without stratification of oxygen and water temperature that the estuary experienced. The estuary had high saline content throughout the water column and evidence of temporal oxygen fluctuations. Though oxygen concentrations were not prohibitively low for steelhead by late morning during sampling, they may have been stressfully low near the bottom near dawn, forcing steelhead to near the surface where they would be more vulnerable to predation. It appeared from very limited water quality measurements, water temperature was prohibitively high for steelhead in the upper estuary from the airport upstream but tolerable for steelhead in the lower estuary along the beach. While water quality data were not collected throughout the summer and during periods of sandbar closure, habitat conditions for steelhead could have become difficult when the sandbar closed temporarily to form a lagoon with little stream inflow. After sandbar closure, trapped saltwater would create a stratified water column with higher water temperatures throughout and lower oxygen levels at greater depth. Much of the Pajaro Estuary was less than 1.25 meters deep at water quality stations, with a narrow thalweg present nearby in the lower estuary that was somewhat deeper.

A very small population of tidewater goby still existed in Pajaro Estuary in fall 2017, but again appeared absent in the lower estuary along the beach, as was the case in 2015 and 2016. Algae and submerged vegetation appeared absent in the lower estuary in the past 3 years. After a high flow winter of 2016−2017, only 1 tidewater goby was captured at the airport site, with none detected at Thurwachter Bridge or the boat ramp where they were abundant in earlier years. Some tidewater gobies may have been flushed from the estuary during high stormflows during the winter, leaving a small population during the dry season. Water quality was adequate for tidewater goby survival during the dry season, though oxygen may have been low at times in some locations. They spawn along freshwater margins, which were absent at sampling sites in the 2017 estuary. Freshwater habitat may have existed at the very top of the estuary where the River entered the estuary during the dry season.

Figure 1. Sampling Sites at Pajaro Estuary.