



**Fishery and Water Quality Monitoring of Pajaro River Estuary, 2024**  
(Sampling for Tidewater Goby under USFWS Endangered Species Recovery Permit TE-793645-5)



Upper Pajaro Estuary, looking downstream from adjacent to the model airport. 3 October 2024 (D. Alley)

**Purpose of Sampling**

The Pajaro Storm Drain Maintenance District is required to conduct annual fish sampling in the Pajaro Lagoon/Estuary as a permit condition for emergency lagoon breaching to avoid flooding. Fish sampling documents the presence/absence, distribution and abundance of Steelhead (*Oncorhynchus mykiss*), Tidewater Goby (*Eucyclogobius newberryi*), and other fish and wildlife. 2024 was the 13<sup>th</sup> year of annual sampling, which began in 2012.

## **Summary of 2024 Results**

No Steelhead or Tidewater Gobies were captured in the lower estuary along the beach berm or at sites upstream adjacent to the model airplane airport, Thurwachter Bridge and the boat ramp, 2.9 miles upstream of Watsonville Slough. In other sampling efforts in the county by our group, no Tidewater Gobies were captured in nearby Soquel Lagoon or Aptos Estuary in 2024, although they had been present there in 2022, as they had been in Pajaro Lagoon in 2022 (Alley 2023a; Alley 2023b; Alley 2024a; 2024b). The sandbar was open at the time of sampling Pajaro Estuary in 2024, with frequent tidal action adding to saline conditions. The catch was dominated by Jack Smelt (*Atherinopsis californiensis*) and Top Smelt (*Atherinops affinis*) (**Tables 1-4**). Other captured species, in order of declining numbers, included Arrow Goby (*Clevelandia ios*), Northern Anchovy (*Engraulis mordax*), Threespine Sticklebacks (*Gasterosteus aculeatus*), Plainfin Midshipman (*Porichthys notatus*), Staghorn Sculpin (*Leptocottus armatus*), Starry Flounder (*Platichthys stellatus*), Shiner Perch (*Cymatogaster aggregata*), Kelp Pipefish (*Syngnathus californiensis*), Prickly Sculpin (*Cottus asper*) and California Halibut (*Paralichthys californicus*), Longjaw Mudsucker (*Gillichthys mirabilis*) and a new one- Gopher Rockfish (*Sebastes carnatus*). Arrow gobies were most abundant in the sheltered back-bay where tidal current was most attenuated during tidal fluctuations. The estuary was lightly saline in the upper 0.25 meters but moderate to heavily saline below that, except at the uppermost boat ramp site where it was slightly saline down to 0.5 meters and moderately saline below that. The lower estuary was moderately cool and generally below 16°C in the morning, with good morning oxygen levels above 8 mg/L, tolerable water temperature for Steelhead, but was too saline to sustain Steelhead, if they had been present previously. The upper estuary was warmer and generally between 18.5 and 21.5°C in the early afternoon, and with oxygen adequate, though stratified between 6 at the bottom and 16 mg/L at the surface at the lower two sites in late morning and early afternoon but extremely stratified at the upper boat ramp with 13 at the top and only 0.77 mg/L at the bottom in the early afternoon. The upper estuary would have been only marginal for Steelhead only near the surface during sampling, but may have been intolerably warm later in the afternoon or earlier in the summer.

Tidewater Gobies could have inhabited the lower and upper estuary in 2024, as water quality measurements confirmed that oxygen was available throughout the water column. But high salinity measured at the bottom, combined with the tidal fluctuations and water current would be problematic for successful Tidewater Goby spawning. With the limited overwintering refuge between the levees during the previous wet winter having high stormflows, the surviving Tidewater Goby population may have been small in spring 2024 when nesting began. Their absence in our sampling was consistent with likely low survival over the winter. Tidewater Gobies were also absent during our sampling of Soquel Lagoon and Aptos Estuary in 2024.

## **2024 Estuary Conditions**

During fish sampling in early October, an estuary with fluctuating depth and current was present due to an open sandbar. On an incoming tide, water entered the estuary with upstream current.

On an outgoing tide, water evacuated from the estuary, reversing the current direction. A back-bay existed in the lower lagoon against the beach berm, it being sheltered from the stiff tidal currents. The drought years of 2015, 2021 and 2022 were the latest previous years of having a closed sandbar. In 2024, the lower estuary in the morning remained cooler than the upper estuary and unstratified at depth to 1 meter in regard to temperature (15-16°C) and salinity (29-31 ppt), with good oxygen concentration (8- 11 mg/L from bottom to surface) . These conditions were very adequate for saltwater fish life but not Steelhead and other freshwater fish species. Salinity there was beyond the tolerance of freshwater acclimated Steelhead and would likely have eliminated them if they were present earlier in the spring when stream inflow was higher. The secchi depth in the lower estuary was to the bottom (1 meter where measurements were taken). The upper estuary was inhospitable to freshwater fish life except near the surface and in shallow margins in the vicinity of the boat ramp and presumably upstream. In the upper estuary, habitat for saline-tolerant species was present throughout the water column. In the early afternoon, the upper estuary's water temperature was moderate to warm throughout the water column (18.6 to 21.3°C). In the upper estuary, salinity was stratified between 4.7 ppt at the surface at the boat ramp to bottom salinities of 20.6 ppt (boat ramp), 26.7 ppt (Thurwachter Bridge) and 27.4 ppt (model airport) 30 ppt at the bottom at all three upper estuary sites. Water temperature was unstratified in the upper estuary, although it was somewhat warmer at the surface in the afternoon. In the upper estuary, oxygen concentration was stratified at the lower two sites, though above 6 mg/L at the bottom. However, at the uppermost boat ramp site, oxygen was very stratified from 13.4 mg/L at the surface to only 0.77 mg/L at the bottom in the early afternoon. Secchi depth was to the bottom (2 meters at our deepest measured site near Thurwachter Bridge).

## **Methods**

Pajaro Estuary (open sandbar) was sampled on October 1 – 3, 2024. Sampling locations in the lower estuary were similar to past years, they being spread out south along the beach berm from the mouth of Watsonville Slough to the north (**Figure 1**). The upper estuary was sampled at the previous years' locations 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 at the boat ramp (2.9 miles upstream of Watsonville Slough).

On 1 October, the lower estuary along the beach was sampled for Steelhead with the 106-foot bag seine (8 successful seine hauls). On 2 October, the upper estuary was sampled with the 106-foot bag seine (3/8-inch mesh) at the model airport and Thurwachter Bridge sites, and water quality data were collected. Three seine hauls were made at the model airport, with 3 more at Thurwachter Bridge. Water quality was measured from a boat at the perceived thalweg (deepest portion) at these two sites (water temperature (°C), salinity (parts per thousand), conductivity (umho = micro- siemens = 1 millionth of a siemens) and oxygen (mg/L = parts per million) measured through the water column at 0.25 meter intervals). Secchi depths were measured at the two sites. Conductivity is a measure of water's capability to pass electrical flow. This ability is directly

related to the concentration of ions in the water. These conductive ions come from dissolved salts and inorganic materials such as alkalis, chlorides, sulfides and carbonate compounds and not just sodium chloride. Secchi depth is the depth in the water column at which the black and white secchi disc first becomes visible as it is raised through the water column.

On 3 October, Tidewater Gobies were sampled for, using a 30-foot seine with 1/8-inch mesh. Five seine hauls were made in the lower estuary along the beach berm. Three seine hauls were made in the upper estuary (model airport, Thurwachter Bridge and boat ramp). Water quality was measured at four stations. Water quality measurements at three lower estuary stations were made nearshore by wading in at seining locations. Water quality measurements at the uppermost upper estuary site (boat ramp) were made nearshore by wading out from the boat ramp. Water quality measurements taken on 2 and 3 October were sufficient to determine general water quality conditions during the fish sampling period in early fall.

Figure 1. Pajaro Lagoon Fish and Water Quality Sampling Sites



**Legend**

- Sampling site - tidewater goby
- Sampling site - tidewater goby and steelhead



**Results – Fish Capture**

Sampling of the lower estuary along the beachfront with the larger bag seine yielded 10 native fish species (**Table 1**). Smelt were again the most abundant species, with those being identified as Jack Smelt and Top Smelt. Many young-of-the-year smelt were very small and escaped through the seine mesh. Other fish species captured with the large seine, in order of declining numbers, included Plainfin Midshipman, Northern Anchovy, Starry Flounder, Staghorn Sculpin, Kelp Pipefish, California Halibut, Longjaw Mudsucker and a new one- Gopher Rockfish. Yellowshore and Purpleshore crabs were captured in low numbers. Dungeness crabs were in higher numbers. Using the large seine, no Steelhead were detected in the upper or lower estuary in 2024.

Sampling results with the large seine in the upper estuary near the model airplane airport and Thurwachter Bridge yielded Smelt, Northern Anchovy, Threespine Stickleback and Staghorn Sculpin (**Table 2**).

Our sampling for Tidewater Goby in the lower estuary with the smaller, fine-meshed seine yielded two native species, those being Arrow Goby and Staghorn Sculpin (**Table 3**). Arrow Gobies were captured at all 5 sites along the beachfront, but no Tidewater Gobies were observed or captured. All 5 sites were north of the estuary outlet. In 2022 when the sandbar was closed, Tidewater Gobies were captured at all 5 sites in the lower lagoon. In 2024, Arrow Gobies were most abundant in the sheltered back-bay along the beach berm.

In the upper estuary, sampling results with the small seine at the 3 sites yielded no Tidewater Gobies (**Tables 3 and 4**). Species captured included 5 native species in declining numbers, those being Arrow Goby, Threespine Stickleback, Shiner Perch, Staghorn Sculpin and Prickly Sculpin. One nonnative Mosquitofish was also captured. All fish were in relatively low numbers.

**Table 1. Fish capture\* results from sampling lower Pajaro Estuary with the 106-foot bag seine (3/8-inch mesh), 1 October 2024.**

Date	Location	Seine Haul #	Steel-head	Tide-water Goby	Long-jaw Mud-sucker	Plain-Fin Mid-Ship-man	Smelt (jack and top)**	Staghorn Sculpin	Northern Anchovy	Starry Flounder	Kelp Pipe-fish	Gopher Rock-fish	Calif. Halibut
1 Oct 2024	South of Watson-ville Slough	1							5				
	South of #1	2											
	South of #2	3											
	South of #3	4				2	66			2		1	1
	South of #4	5				2	186	1	1		1		
	South of #5	6			1	15	44	2		4			
	South of #6	7					12						
	South of #7	8					19				1		
	South of #8	9					25						
<b>Total</b>		<b>8</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>19</b>	<b>352</b>	<b>3</b>	<b>6</b>	<b>6</b>	<b>2</b>	<b>1</b>	<b>1</b>

\*9 Yellowshore crabs, 2 Purpleshore crabs, 236+ Dungeness crabs.

\*\*Some YOY smelt escaped through the seine due to their small size.

**Table 2. Fish capture\* results from sampling upper Pajaro Estuary with the 106-foot bag seine (3/8-inch mesh), 2 October 2024.**

Date	Location	Seine Haul	Steel-head	Tide-water Goby	Arrow Goby	Northern Anchovy	Smelt	Staghorn Sculpin	Three-spine Stickle-back	Starry Flounder	Longjaw mudsucker goby
2 Oct 2024	Model Airport	1-3				31	294	1	1		
	Thurwachter Bridge	4-6				1	34	1	10		
<b>Total</b>			<b>0</b>	<b>0</b>	<b>0</b>	<b>32</b>	<b>328</b>	<b>2</b>	<b>11</b>	<b>0</b>	<b>0</b>

**Table 3. Fish capture\* results from sampling the periphery of lower and upper Pajaro Estuary with the 30-foot seine (1/8-inch mesh), 3 October 2024.**

Date	Location	Seine Haul	Steel-head	Tide-water Goby	Arrow Goby	Three-spine Stickle-back	Shiner Surf-perch	Smelt	Mosquito Fish Gambusia	Stag-horn Sculpin	Starry Flounder	Prickly Sculpin
3 Oct 2024	Approx. 100 m south of Pajaro Dunes *	1			5					1		
	South of #1	2			1					1		
	South of #2	3			5					1	1	
	South of #3	4			28							
	South of #4	5			3							
	Model Airport- 0.3 miles down from Thurwachter Br	6			2		3		1	1		
	Thurwachter Bridge- 2.1 miles upstream from Watsonville Slough	7			5							
	Boat Ramp- 0.8 miles upstream of Thurwachter Br.	8			1	23						2
<b>Total</b>		<b>8</b>	<b>0</b>	<b>0</b>	<b>50</b>	<b>23</b>	<b>3</b>	<b>0</b>	<b>1</b>	<b>4</b>	<b>1</b>	<b>2</b>

\* First 4 seine hauls made in northern, sheltered back-bay against the beach berm.

**Table 4. Annual Number of Tidewater Gobies Captured in Pajaro Estuary/ Lagoon in Fall.**

Year	# of Tidewater Gobies Captured in Pajaro Lagoon/Estuary	# of Seine Hauls at Approximately Similar Locations with 30-foot Seine (1/8-inch mesh)
2012	111	8
2013	436	8
2014	414	8
2015	42	8
2016	29	8
2017	0 (1 with 3/8-inch mesh seine adjacent model airplane airport)	8
2018	0	8
2019	0	8
2020	11	8
2021	0	8
2022	7	8

2023	0	8
2024	0	8



**Gopher Rockfish 1 October 2024 (I.M. Laursen)**



**Plainfin Midshipman 1 October 2024 (I.M. Laursen)**



**Jack Smelt 1 October 2024 (I.M. Laursen)**



**Longjaw Mudsucker 1 October 2024 (I.M. Laursen)**



**Kelp Pipefish 3 October 2023 (I.M. Laursen)**



Dungeness Crabs 3 October 2023 (I.M. Laursen)



Native Hitch (*Lavinia exilicauda*) once common in Pajaro Lagoon in the 1960's, now rarely observed.  
7 October 2014 (D. Alley)

## **Water Quality**

In 2024 at the time of sampling in late morning and early afternoon on October 2 and October 3, the upper estuary was warmer and slightly stratified at Thurwachter Bridge (19.3-21.3°C) and the boat ramp (19.1-20.1°C) and unstratified at the model airport (18.6-18.8°C) compared to the cooler lower estuary in mid-morning on October 3 (15-16°C) where water temperature was unstratified (**Tables 5 and 6**). Salinity in the upper estuary was stratified at all 3 sites with it increasing down to the bottom. Salinity was unstratified in the lower estuary (29-31 ppt). Oxygen concentrations were slightly stratified in the lower estuary but were high (8.8 at the bottom to 10.6 mg/L at the surface). In the upper estuary, oxygen was stratified with it diminishing down the water column at the model airport (10.65 down to 6.27 mg/L) and the boat ramp (13.4 down to 0.77 mg/L). But at Thurwachter Bridge it went down and then back up nearer the bottom (16.47 down to 6.93 and then back up to 9.63 mg/L), which was unusual. Estuary conditions in 2024 were adequate for saltwater-tolerant fish life but too salty for Steelhead. Salinity-related stress to freshwater acclimatized Steelhead would occur when conductivity levels reach 12,000 to 15,000 micro-mhos, associated with sudden increases in salinity to 10–12 ppt (**J. Cech, fish physiologist, personal communication**). However, Steelhead acclimatized to estuary conditions with fluctuating salinity and stratification can survive where salinity increases with depth as long as near surface, salinity is low and water temperature is cool enough. In the lower estuary, salinity was beyond the tolerance of freshwater acclimated Steelhead in October and would likely have eliminated them from this portion of the estuary if they had been present earlier in the spring and early summer even when good stream inflow still existed.

The upper estuary was inhospitable to freshwater acclimated Steelhead except near the surface due to high salinity through most of the water column. Oxygen concentration in the upper estuary was adequate for Steelhead at the two lower sites but only within 0.5 m of the surface at the upper boat ramp site. In the upper estuary, water temperature would likely become marginal for Steelhead even near the surface later in the afternoon as air temperature increased. Steelhead would be especially vulnerable to bird predation near the surface, and they prefer to swim near the bottom, given the choice. Water temperatures above 22° C (72° F) and oxygen below 5 mg/L are considered stressful for Steelhead. The high water temperature detected near the surface (and that undoubtedly occurred earlier in summer) would likely eliminate the sometimes marginal Steelhead habitat near the surface in the upper estuary.

**Table 5. Water quality measurements in the upper Pajaro estuary during fish sampling for Steelhead, 2 October 2024.**

		2-Oct-2024						
	Model Airport (mid-channel)			1122	Thurwachter Bridge (mid-channel)			
	Air temp. 25.1°C			hr	Air temp. 24.6°C			1345 hr
<b>Depth</b>	<b>Temp</b>	<b>Salin</b>	<b>Oxygen</b>	<b>Cond</b>	<b>Temp</b>	<b>Salin</b>	<b>Oxygen</b>	<b>Cond</b>
(m)	( C)	(ppt)	(mg/l)	micro-	( C)	(ppt)	(mg/l)	micro-

				<b>mhos</b>				<b>mhos</b>
<b>0</b>	18.8	7.3	10.65	11234	21.3	10.3	16.47	16311
<b>0.25</b>	18.6	19.7	7.77	27547	20.7	11.0	12.65	17085
<b>0.5</b>	18.6	26.5	8.42	36187	19.6	22.5	7.31	31612
<b>0.75</b>	18.6	26.9	8.48	36634	19.4	25.2	6.93	35187
<b>1.0</b>	18.6	26.9	7.32	36646	19.3	25.7	7.45	35755
<b>1.25</b>	18.6	27.0	7.09	36867	19.3	26.4	9.59	36650
<b>1.38bot</b>					19.3	26.7	9.63	36945
<b>1.50</b>	18.6	27.1	7.08	36972				
<b>1.75</b>	18.6	27.3	6.65	37160				
<b>2.00</b>	18.6	27.4	6.27	37265				
<b>2.13bot</b>	18.6	27.4	5.93	37327				

\* “bot” indicates the estuary bottom where measurements were taken through the water column.

**Table 6. Water quality measurements in the lower Pajaro estuary (Seine Hauls 1, 3 and 5 nearshore along beach) and 1 upper estuary sites during fish sampling for Tidewater Goby, 3 October 2024.**

3-Oct-2024									
	Seine Haul 1 (l. estuary) air temp 21.2°C			0933 hr		Seine Haul 3 (lower estuary) air temp 22.1°C			1010 hr
Depth	Temp	Salin	Oxygen	Cond	Temp	Salin	Oxygen	Cond	
(m)	( C)	(ppt)	(mg/l)	micro- mhos	( C)	(ppt)	(mg/l)	Micro- mhos	
0	15.7	29.3	10.63	37947	16.2	30.0	10.16	38344	
0.25	15.7	30.0	8.98	37966	15.9	30.1	8.96	38212	
0.5	15.7	30.0	9.01	37967	15.7	30.2	9.01	38169	
0.75	15.7	29.9	8.98	37878	15.6	30.2	9.07	38139	
0.95bot	15.7	29.9	8.84	37884					
1.0bot					15.6	30.2	8.89	38165	
	Seine Haul 5 (lower estuary) air temp			1050 hr	Seine Haul 8- Boat Launch Ramp (upper estuary nearshore) air temp (Adjacent to Wastewater Plant)			1259 hr	
Depth	Temp	Salin	Oxygen	Cond	Temp	Salin	Oxygen	Cond	
(m)	( C)	(ppt)	(mg/l)	micro- mhos	( C)	(ppt)	(mg/l)	micro- mhos	
0	15.9	30.5	10.90	38810	20.1	4.7	13.40	7657	
0.25	16.0	30.4	9.22	38675	19.2	5.4	13.75	8566	
0.5	15.9	30.4	9.30	38618	19.1	7.6	6.46	11630	
0.75	15.9	30.4	9.33	38587	19.4	17.3	0.92	25026	
0.90bot					19.6	20.6	0.77	29453	
1.00bot	15.9	30.4	9.20	38601					

\* “bot” indicates the estuary bottom where measurements were taken through the water column.

After 15 years of water quality monitoring and Steelhead/Tidewater Goby sampling of Santa Rosa Creek Lagoon near Cambria, CA (Alley 2008), and 30+ years of the same at Soquel Creek Lagoon in Capitola, CA (Alley 2025a), the following recommendations were made to insure Steelhead habitation in Central Coast lagoons. They would be difficult to attain in Pajaro Lagoon/Estuary due to the absence of/ or extremely limited summer stream inflow.

- *The 7-day rolling average water temperature within 0.25 m of the bottom should be 19°C or less.*
- *Maintain the daily maximum water temperature below 25°C (77°F).*
- *If the maximum daily water temperature should reach 26.5°C (79.5°F), it should be considered the lethal limit for Steelhead.*
- *Water temperature at dawn near the bottom for at least one monitoring station should be 16.5°C (61.7°F) or less on sunny days **without** morning fog or overcast **and** 18.5°C (65.3°F) or less on days **with** morning fog or overcast.*
- *Maintain the daily dissolved oxygen concentration near the bottom at 5 milligrams/liter or greater, though it does not become critically low and potentially lethal until it is less than 2 mg/l throughout the water column for several hours, with the daily minimum occurring near dawn or soon after.*

Coastal lagoons/estuaries are very food-rich environments where Steelhead growth rates are very high, despite warmer water temperatures. A study completed by **Farrel et al. (2015)** indicated that the thermal range over which a Tuolumne River *O. mykiss* population could maintain 95% of peak aerobic capacity was 17.8°C to 24.6°C. Furthermore, up to a temperature of 23°C, all individual fish could maintain a factorial aerobic scope (FAS) value >2.0 (FAS = Maximum metabolic rate (MMR) / Routine metabolic rate (RMR)), one that is predicted to provide sufficient aerobic capacity for the fish to properly digest a meal.

Tidewater Gobies can physiologically tolerate the warmest, most saline, and lowest oxygen conditions that may be found in lagoon/estuary conditions, so long as some oxygen is present on the bottom. However, they typically build their nests in sand on the bottom under freshwater or low salinity conditions and minimal tidal fluctuation and current. Therefore, to reproduce they need freshwater conditions, or nearly so, and oxygen along the bottom away from tidal fluctuations. This condition may only exist at the upper end of a lagoon/estuary where freshwater inflow occurs. If the sandbar closes and a freshwater lagoon develops from sufficient freshwater inflow in the summer, spawning conditions may be extensive. Artificial summer and fall sandbar breaching unassociated with stormflow, especially after freshwater conversion of the lagoon, would negatively impact Tidewater Gobies. Tidewater Gobies are poor swimmers and require overwintering backwater habitat that is protected from river water current to avoid being flushed out of the wet-season estuary by stormflow.

Tidewater Gobies could inhabit the lower and upper estuary in 2024, as water quality

measurements confirmed that oxygen was available throughout the water column. But high salinity measured at the bottom, combined with the tidal fluctuations and water current would be problematic for successful Tidewater Goby spawning. With the limited overwintering refuge between the levees during the previous wet winter having high stormflows, the surviving Tidewater Goby population may have been small in spring 2024 when nesting began. Their absence in our sampling was consistent with likely low survival over the winter. Tidewater Gobies were also absent during our sampling of Soquel Lagoon and Aptos Estuary in 2024 (Alley 2025a; 2025b).

### **Conclusions**

No Steelhead or Tidewater Gobies were detected in the Pajaro Estuary in fall 2024, as was the case for Steelhead in the previous 12 years of annual monitoring. The sandbar was open at the time of sampling, creating a moderate to highly saline estuary except near the surface at our uppermost boat ramp monitoring site, 2.9 miles upstream of Watsonville Slough. The lower estuary had ample oxygen and water temperature within the Steelhead thermal tolerance range and could have supported freshwater acclimated Steelhead, except it was too saline for Steelhead. The same was true at the two lower sites in the upper estuary extending upstream to the Thurwachter Bridge with respect to tolerable water temperature, adequate oxygen but too high salinity for Steelhead. The uppermost site in the upper estuary, adjacent the wastewater plant, had salinity and oxygen levels within the Steelhead tolerance range in the upper 0.5 m layer of the water column, but not at greater depth on the monitoring day in early October. However, water temperature in this upper layer was already at 20.1°C by 1300 hr on 3 October, indicating that Steelhead habitat near the surface was marginal at best and likely disappeared from time to time at this site on warm days earlier in the summer, especially later in the afternoon/evening. For comparison, July and August are typically the warmest months in Soquel Lagoon (Alley 2025a), as well as in other smaller lagoons in San Luis Obispo County, such as San Simeon and Santa Rosa Creek Lagoons (Alley 2003; 2004). Water temperature declines by October. These comparisons are weak because these are smaller lagoons which have sandbars that close every summer, and the sandbar at the Pajaro rivermouth often does not. However, it is reasonable to assume that with longer day lengths and warmer air temperature earlier in the summer, water temperatures will be cooler near the surface in early October in the Pajaro Estuary than earlier in the summer, even without a closed sandbar.

Water quality was adequate for Tidewater Gobies in 2024. But spawning conditions were likely very marginal only in the uppermost estuary and absent in the lower estuary due to high salinity at the bottom and tidal fluctuations, with strong water currents associated with an open sandbar. With the leveed channel in Pajaro Estuary, protected backwaters with tules are limited for providing overwintering cover during high stormflow events that occurred the previous winter and spring. Tidewater Gobies were not detected at Soquel Lagoon or Aptos Estuary in 2024 either, presumably due to their poor overwinter survival.

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