OCEAN RANCH RESTORATION PROJECT

POST-RESTORATION FISH MONITORING – YEAR 1

February 2023 – January 2024

California Department of Fish and Wildlife
Wiyot Tribe Natural Resources Department

INTRODUCTION

This report represents the first of a five-year post-restoration monitoring program to document and characterize community composition and spatio-temporal distribution of fish species in the restored and enhanced estuary habitat of the Ocean Ranch Unit (ORU). Post-restoration fish validation monitoring is scheduled to continue through January of 2028 to determine if the project was successful in improving habitat conditions for special-status fish and the fish community.

The 850-acre ORU of the Eel River Wildlife Area (ERWA) is owned and managed by the California Department of Fish and Wildlife (CDFW) and is situated on the ancestral lands of the Wiyot Tribe. Historically, the ORU was comprised of coastal dunes and tidal marsh habitat that supported diverse native plant and animal communities. However, in the early 20th century, after Euro-American colonization of the region, the estuarine portion of the ORU was leveed and drained for use as pastureland. In addition, the estuary and coastal dunes are now dominated by invasive dense-flowered cordgrass (*Spartina densiflora*) and European beachgrass (*Ammophila arenaria*) respectively, which has significantly degraded the natural communities and ecological functions of these important coastal habitats.

The Wiyot Tribe shares its name with the Eel River in the Soulatluk language, *Wiya't*. Table Bluff Reservation overlooks the ORU and is about a two-minute drive, making this area easily and quickly accessible. Wiyot Tribal members utilize the area for waterfowl hunting, fishing, and firewood collection. Subsistence fishing includes Pacific lamprey, salmon, Dungeness crab, smelt, and perch, several of which can be accessed from the ORU.

The Ocean Ranch Restoration Project (ORRP) began implementation in 2021. The goals of the ORRP are to restore and expand natural estuarine and dune function, and to assist in recovery and enhancement of habitat for native fish, invertebrates, wildlife, and plant species. To achieve this, the ORRP aims to restore full tidal exchange and enhance habitat diversity in the former tidelands, control dense-flowered cordgrass in the tidal marsh, and eradicate European beachgrass in the dunes.

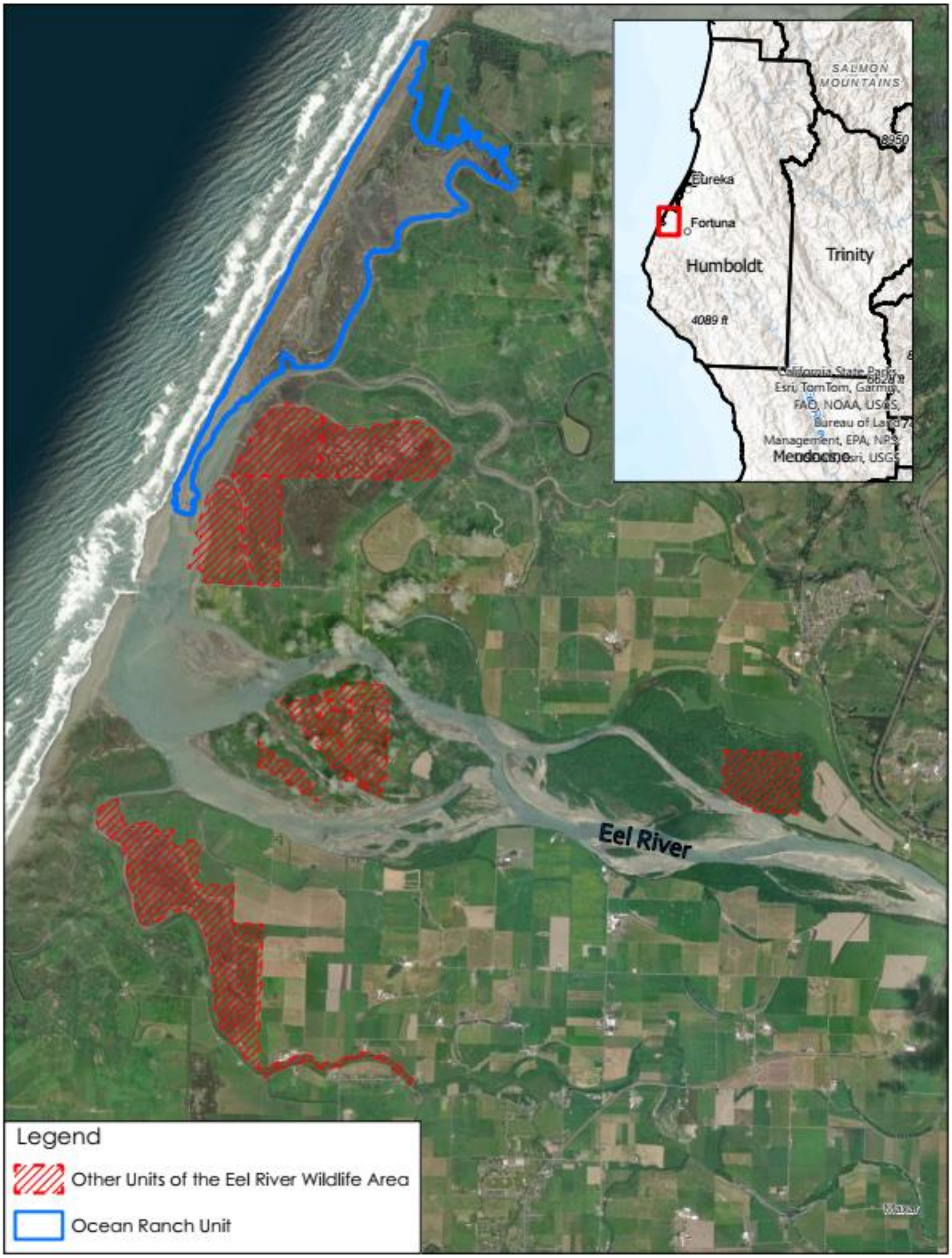

FIGURE 1. THE OCEAN RANCH UNIT WITHIN THE EEL RIVER ESTUARY, SOUTH OF EUREKA, CA.

Restoration and enhancement of approximately 571 acres of tidal marsh habitat was completed in November 2022 through the breaching and lowering of external and internal levees, removal of degraded water control structures, and the excavation of historic slough channels. In addition, the project increased estuarine habitat diversity through construction of deep and shallow-water habitat features, enhancing marsh topography with high marsh ridges, and the placement of large wood structures.

These restoration actions are expected to benefit native fish communities, including State and Federal Endangered Species Act-listed species, such as Coho Salmon (Oncorhynchus kisutch), Chinook Salmon (*O. tshawytscha*), steelhead trout (*O. mykiss*), Longfin Smelt (*Spirinchus thaleichthys*), and Tidewater Goby (*Eucyclogobius newberryi*), and culturally significant species such as Surf Smelt (*Hypomesus pretiosus*). Full tidal exchange will also promote natural sediment transport and marsh plain accretion processes, thereby increasing the resilience of this landscape to sea level rise.

METHODS

CDFW, in collaboration with the Wiyot Tribe Natural Resources Department (WTNRD), is conducting fish monitoring at ORU to document and characterize community composition and spatio-temporal distribution of fish species. In Year 1, sampling occurred monthly from February 2023 to January 2024 (Appendix I). Sampling events typically take 1-2 days per month and generally target low tides (below +3ft MHHW), which are more conducive to sampling with hand seines.

Fifteen sampling sites were chosen to represent a range of aquatic habitat types distributed throughout the ORU, including both constructed and natural features (Figure 2). Sampling sites include ponded off-channel and channel habitats across gradients of size (depth, width, area), and distance to the greater Eel River estuary.

Fish are sampled using a variety of fine mesh seines deployed either by hand (e.g., 4.6m x 1.5m x 2-4mm mesh size) or with the assistance of kayaks (e.g.,18.3m x 2.1m x 8mm mesh size). In addition, preliminary trials using a fyke-style net (aperture 2.3 m x 1.2 m, length 8.5 m and 6.4 mm mesh size) with a live box (approx. 1 m x 1 m x 0.5 m) were conducted. Similarly, a limited number of minnow traps were also deployed.

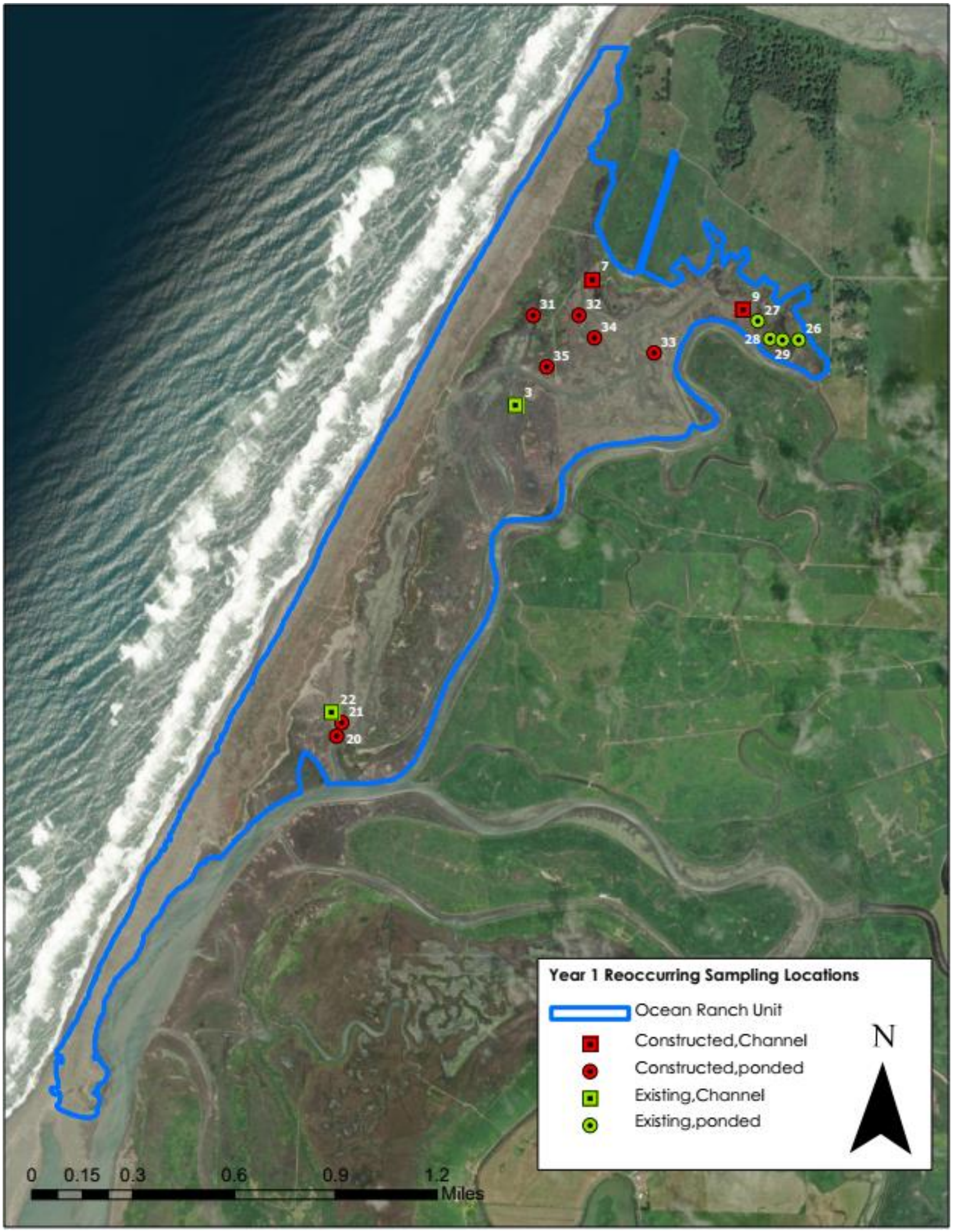

FIGURE 2. FIFTEEN SAMPLING SITES MONITORED MONTHLY DURING YEAR 1. EACH SITE HAS A CORRESPONDING ID LOCATION CODE.

In large shallow habitat units where hand seines are deployed (ID location codes 27-29 and 31-35) a randomization scheme is used to avoid sampling bias. Three random numbered points are generated at 40-foot intervals around the perimeter of the sampling unit and crews seine a 30ft linear path from the approximate centroid of the unit to the randomly selected point.

Captured fish are identified to species or the lowest possible taxa, enumerated, and released as quickly as possible. In addition, fork lengths (FL) are measured for a subset of select species, including all special-status species. Juvenile fish from the family Osmeridae not identified as Longfin Smelt are reported as Osmerid spp. in this document. However, a sub-sample of these fish (n=>1000) were all identified as Surf Smelt, suggesting the majority of the juvenile Osmerid spp. captured are Surf Smelt. Similarly, we report fish from the family Atherinopsidae as Atherinid spp.; however, a sub-sample (n=>500) were all identified as Topsmelt (*Atherinops affinis*). Invertebrates were not the focus of this sampling; however, crabs were identified to species and enumerated and shrimp in the genus Crangon were enumerated. In addition to fish sampling, water temperature (°C), salinity (ppt), and dissolved oxygen (%) are recorded at sampling sites at the top, middle, and bottom of the water column using a YSI handheld water quality meter.

Diversity of catch by month was calculated using the Shannon-Weiner Diversity Index. Catch per unit effort was also calculated to show abundance of species by month.

RESULTS

Fish Assemblage and Diversity

A total of 20 native, 1 naturalized, and 1 invasive fish species were captured during Year 1 sampling efforts (Figure 3, Table 1,Appendix ii). This included four Threatened or Endangered species: Coho Salmon, steelhead trout, Tidewater Goby and Longfin Smelt. Overall, Three-spined Stickleback (*Gasterosteus aculeatus*), Osmerid spp. (primarily Surf Smelt), Pacific Staghorn Sculpin *(Leptocottus armatus),* Prickly Sculpin *(Cottus asper*), Atherinid spp. (primarily Topsmelt), and Pacific Herring (*Clupea pallasii*) were numerically dominant in the catch, accounting for 97% of the total catch across all months (Figure 3).

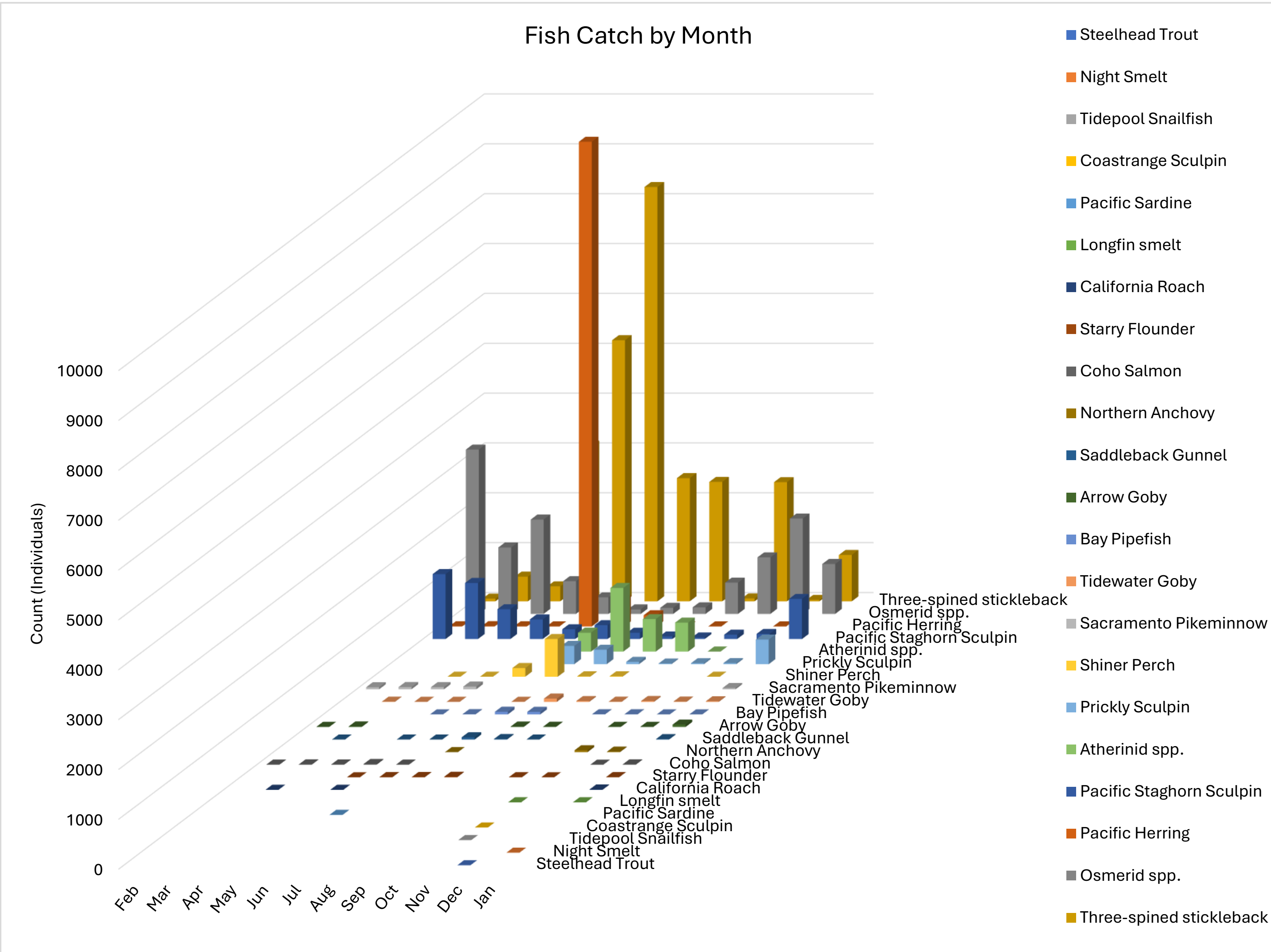

FIGURE 3. COUNT OF INDIVIDUALS BY MONTH EXCLUDING FISH NOT IDENTIFIED TO SPECIES.

Three-spined Stickleback and Pacific Staghorn Sculpin were documented within the ORU across all monthly sampling events. Catches were highest for Three-spined Stickleback in the summer and fall, and in the late-winter and spring for Pacific Staghorn Sculpin (Figure 3, Appendix 2). Osmerid spp. were also documented across all months; however, there was a marked decrease in catch abundance during the summer (Figure 3, Appendix 2). Atherinid spp. were seen in the catch at relatively high abundance in the summer and fall but were otherwise absent (Figure 3, Appendix 2). Older age classes of Pacific Herring (≥ 1 year old) were present in the catch in low numbers through the winter and spring; however, from June to August a marked pulse of subyearling fish were documented in the catch (Figure 3, Appendix 2).

December 2023 and January 2024 had the lowest and highest Shannon-Wiener diversity index scores, respectively (Table 1). Species richness was lowest in February 2023 (R=7) and highest in January 2024 (R=14) (Table 1). Species richness cumulatively increased in all months, except August – October when no new species were encountered, to a maximum of 22 at the end of the Year 1 monitoring period (Figure 4). Species evenness was generally low for all months due to the abundance of Three-spined Stickleback, Osmerid spp., and Pacific Herring, captured.

TABLE 1. MONTHLY SHANNON-WIENER INDICES (H), SPECIES EVENNESS (E_H), SPECIES RICHNESS (R), AND NUMBER OF INDIVIDUALS SAMPLED (N).

	Feb	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	Year 1
H'	0.7	1.1	0.9	0.8	0.8	1.0	1.4	0.9	1.0	0.9	0.4	**1.5**	1.6
E_H	0.2	0.4	0.3	0.3	0.3	0.3	0.4	0.3	0.3	0.3	0.1	**0.5**	0.5
R	7	10	8	12	10	12	12	10	9	13	12	**14**	22
N	4702	3026	2841	4249	**15619**	10823	4664	3309	1322	3700	2088	3348	59691

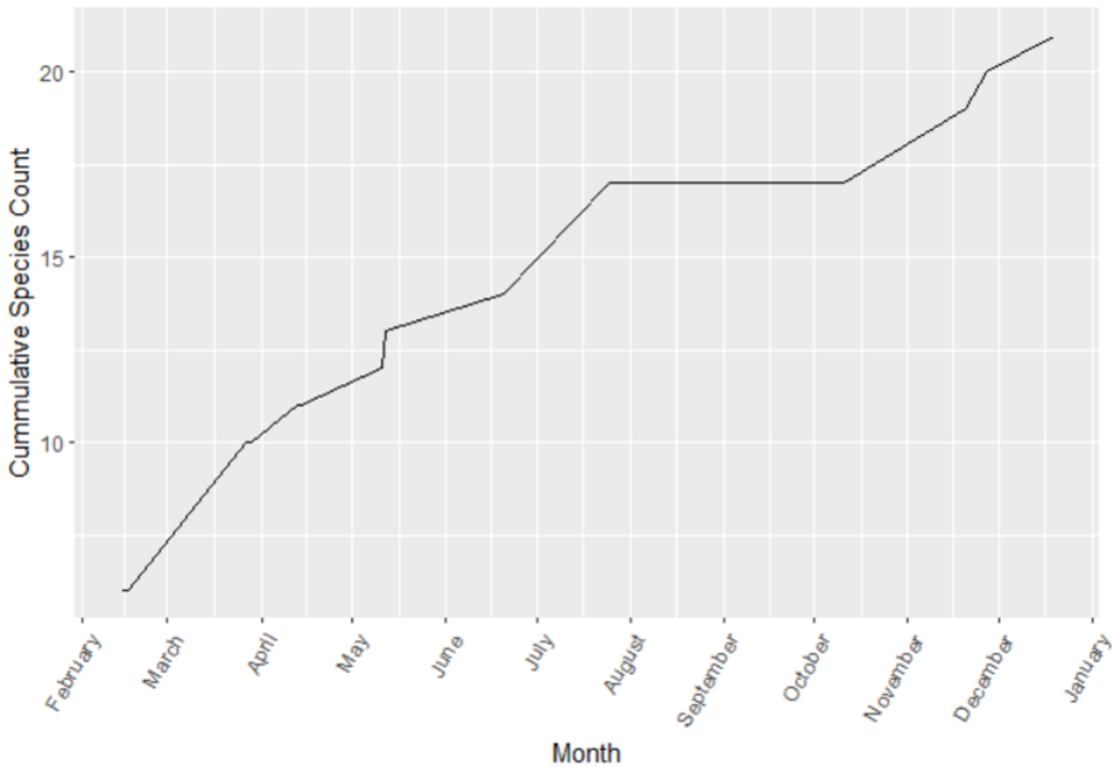

FIGURE 4. CUMULATIVE FISH SPECIES RICHNESS DURING YEAR 1 MONTHLY MONITORING IN THE ORU.

As an index of seasonal abundance, we calculated mean catch per seine haul across all individuals captured by month. Sites were broken out into groups that 1) describe relative distance to the Eel River mouth, 2) have similar gear types and sampling strategies, and 3) are similar habitat types. Those site grouping are “sites near the southern breach” which include large slack water habitats (20,21,22), “interior sites” which are continually wet throughout the low tide cycles and are associated with slack water and off-channel habitat (32,33,34,35), and the third “transition sites” which are in the most north-easternly side of ORU (27,29)(Figure 2). Transition sites make up higher brackish marsh area that is productive forage habitat, is wetted with warm water on low tides and is inundated vegetated salt marsh (+2 feet) at high tide. CPUE increased beginning in June and persisted through August (Figure 5, Table 2). There was another spike at the interior sites and southern breach sites in November. However, that same pattern doesn’t appear for foraging units in the transition sites.

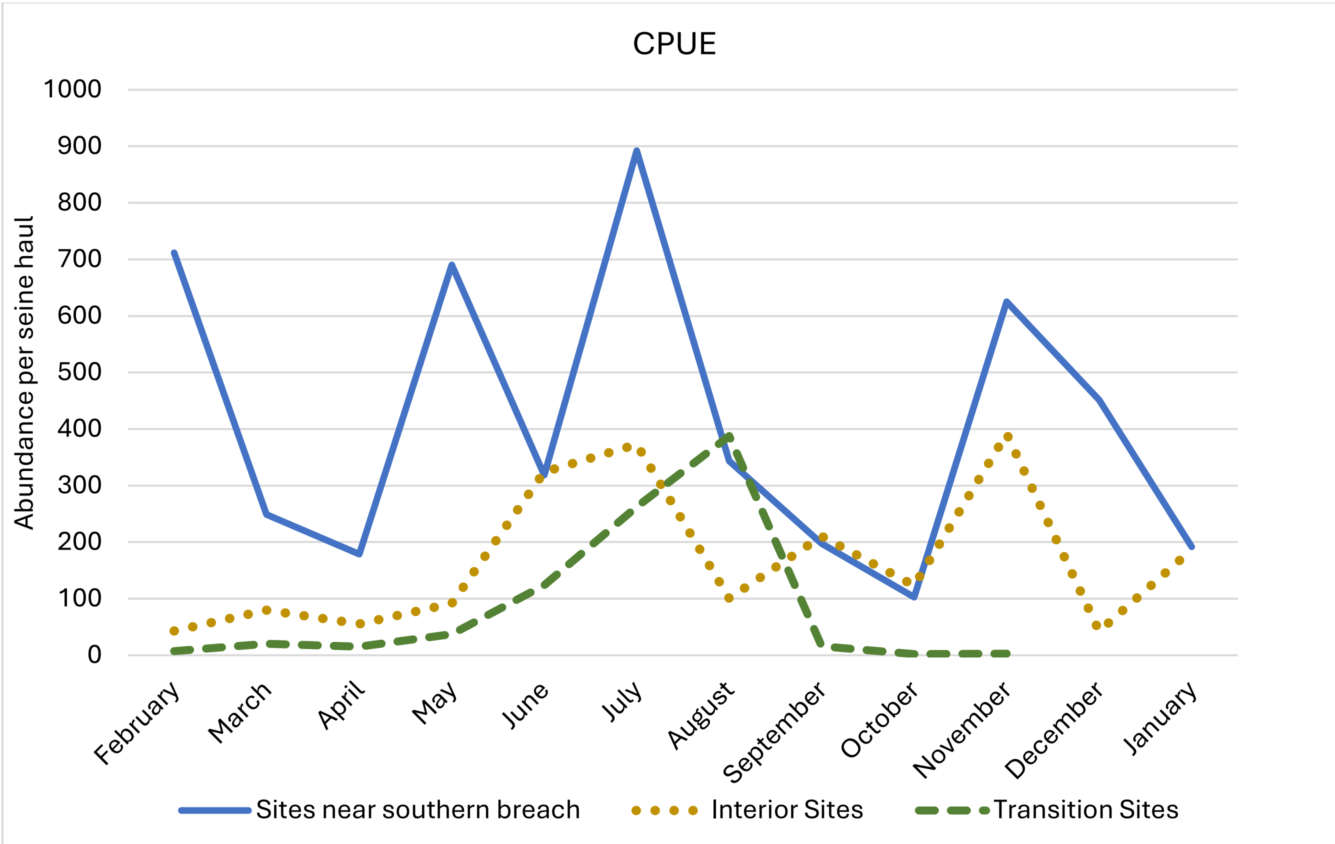

FIGURE 5. SEASONAL RELATIVE ABUNDANCE ACROSS SAMPLED SITES.

TABLE 2. SEASONAL RELATIVE ABUNDANCE BY GROUPED SITE TYPE.

Site	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan
Southern breach	712	249	179	690	319	892	343	198	103	625	452	192
Interior Sites	43	80	55	92	324	373	100	211	123	392	43	187
Transition Sites	7	20	15	38	124	262	388	16	2	3	-	14

Coho Salmon

Coho Salmon juveniles were initially detected during the February 2023 sampling event, marking the first documented occurrence of this species in the ORU. They occurred in eight of the 15 sampling sites, distributed widely across the ORU and representing a variety of habitat types including small (<4m wide x 0.5m deep) and large (>20m wide x 1.5m deep) tidal channels, and off channel habitats ranging in size from 1000m^2 (0.25 acres) to 4600m^2 (1.15 acres)(Figure 4). Seven of the eight sampling sites where Coho Salmon were documented were constructed or made accessible by the restoration project. Coho Salmon were detected contiguously from February through June 2023 with the peak catch occurring in May. No Coho Salmon were captured from July through November 2023 but were encountered again in December of 2023 and January 2024 (Table 3). Mean fork lengths were greatest in April, May, and June (Table 3).

TABLE 31. NUMBER AND MEAN FORK LENGTH OF COHO SALMON BY MONTH.

Month/Year	Number	Mean Fork Length (mm±SD)
February/23	3	85 ± 12
March/23	6	87 ± 19
April/23	4	105 ± 23
May/23	14	103 ± 11
June/23	2	132 ± 6
December/23	1	80 ± 0
January/24	7	77 ± 16
Total	**37**	**84 ± 36**

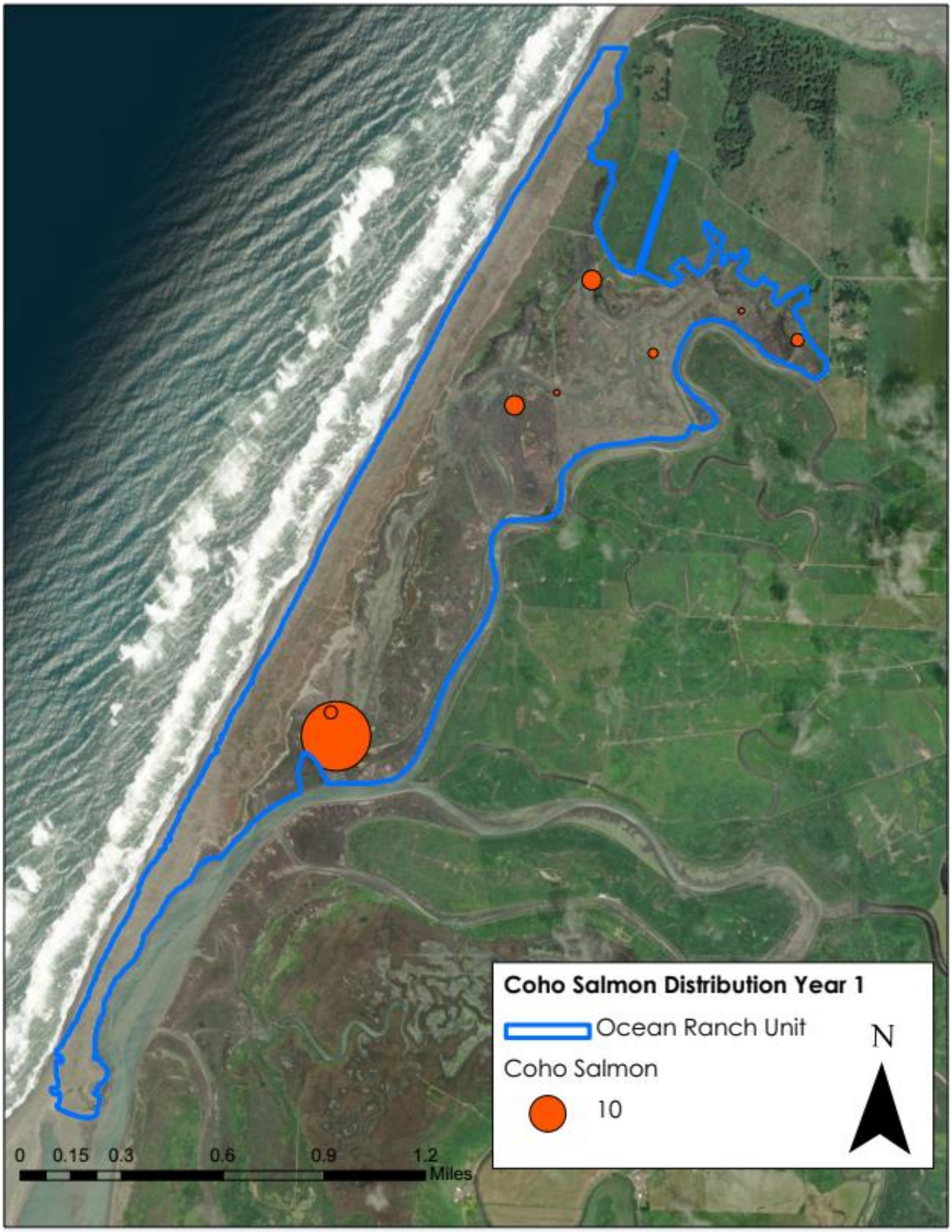

FIGURE 4. COHO SALMON OBSERVATIONS, SCALED BY INDIVIDUAL CAPTURES (I.E. LARGER CIRCLES = GREATER NUMBER OF CAPTURES) ACROSS ALL MONTHS.

Tidewater Goby and Longfin Smelt

Tidewater Goby were first detected during the March 2023 sampling event and were subsequently observed in all months through January 2024 except June (Table 4, Figure 7). Catches of Tidewater Goby remained low until August, when there was a significant peak. Catches after August decreased but generally remained higher than the preceding months (Table 4, Figure 5). Tidewater Goby were detected at 11 of the 15 sampling sites, including all nine features constructed to provide habitat suitable for Tidewater Goby (Figure 6.). Mean fork lengths appear greatest towards the end of the annual sampling period, in November 2023 and January 2024.

Longfin Smelt observations in the ORU during the first year of monitoring were limited with three fish being observed in November 2023 (mean FL 57mm) and three in January 2024 (mean FL 70.3mm) sampling events.

TABLE 4. NUMBER AND MEAN FORK LENGTH OF TIDEWATER GOBY BY MONTH.

Month/Year	Number	Mean Fork Length (mm±SD)
March/23	5	30
April/23	2	32.5 ± 10.6
May/23	2	-
July/23	3	-
August/23	66	31.3 ± 4.6
September/23	16	-
October/23	4	-
November/23	17	42.9 ± 5.2
December/23	6	30
January/24	12	47.5 ± 5.4
Total	**133**	**36.9 ± 8.1**

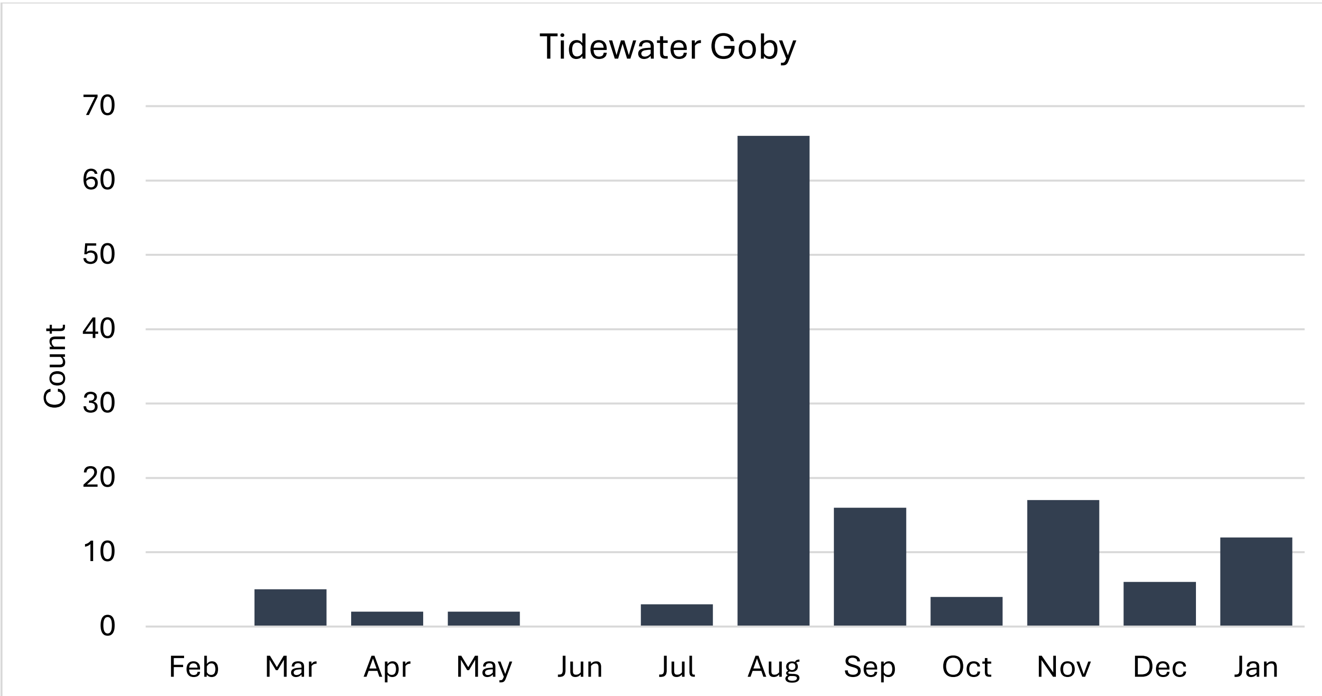

FIGURE 5. CATCHES OF TIDEWATER GOBY BY MONTH IN THE OCEAN RANCH UNIT.

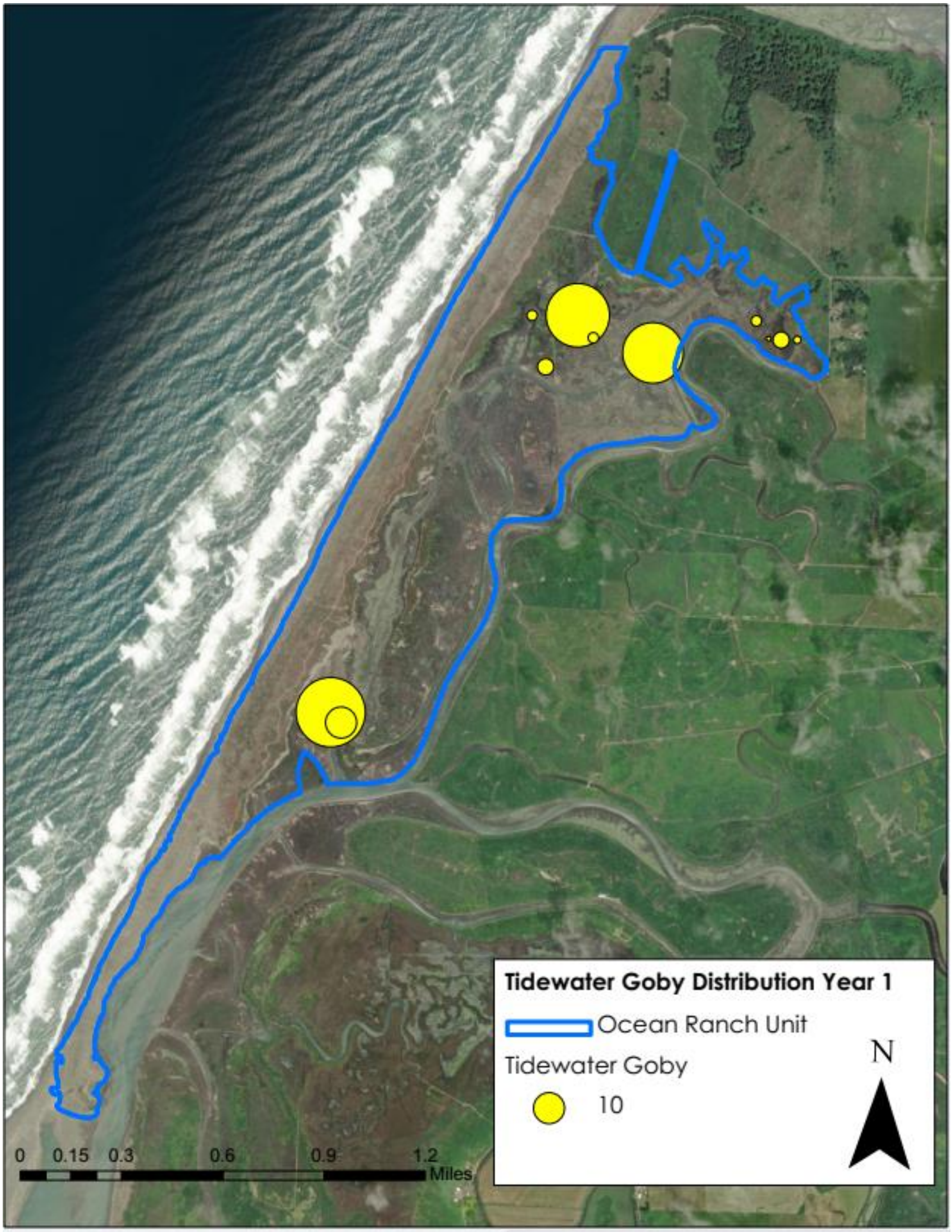

FIGURE 6. TIDEWATER GOBY OBSERVATIONS SCALED BY NUMBER OF INDIVIDUALS CAUGHT SUMMED FOR ALL MONTHS.

Water Quality

Water quality parameters including temperature, dissolved oxygen and salinity were measured during every fish sampling event. Average water temperatures ranged from a low of 8.8˚C in March to a high of 21.2 ˚C in June (Figure 8). Monthly averages for stratified temperatures (top, middle and bottom) varied less than one degree across all sites, indicating significant mixing.

The ORU was fresh water dominated from February through April with salinity not exceeding 4 ppt during that period. March was the lowest recorded salinity (<1 ppt) which coincided with a moderate flood event recorded at the Fernbridge USGS gage, with the Eel River reaching a gage height of 22.32 feet. A couple of late storms brought on small spikes in the gage height in late March and April. Eel River flows began receding at the end of May causing an uptick in salinity (7.5 ppt). Salinity increased to a peak in August of 34 ppt and remained elevated through December (Figure 7). Salinity measurements indicated a thin surface layer of less saline water persisted throughout the summer and into winter when the mid- and low-water column had significantly higher salinity.

Dissolved oxygen had an unusual increase from February through July (Figure 9). We measured increases in water temperature and salinity during the same period which would typically mean a decrease in dissolved oxygen. This may have been a function of drifting YSI calibration.

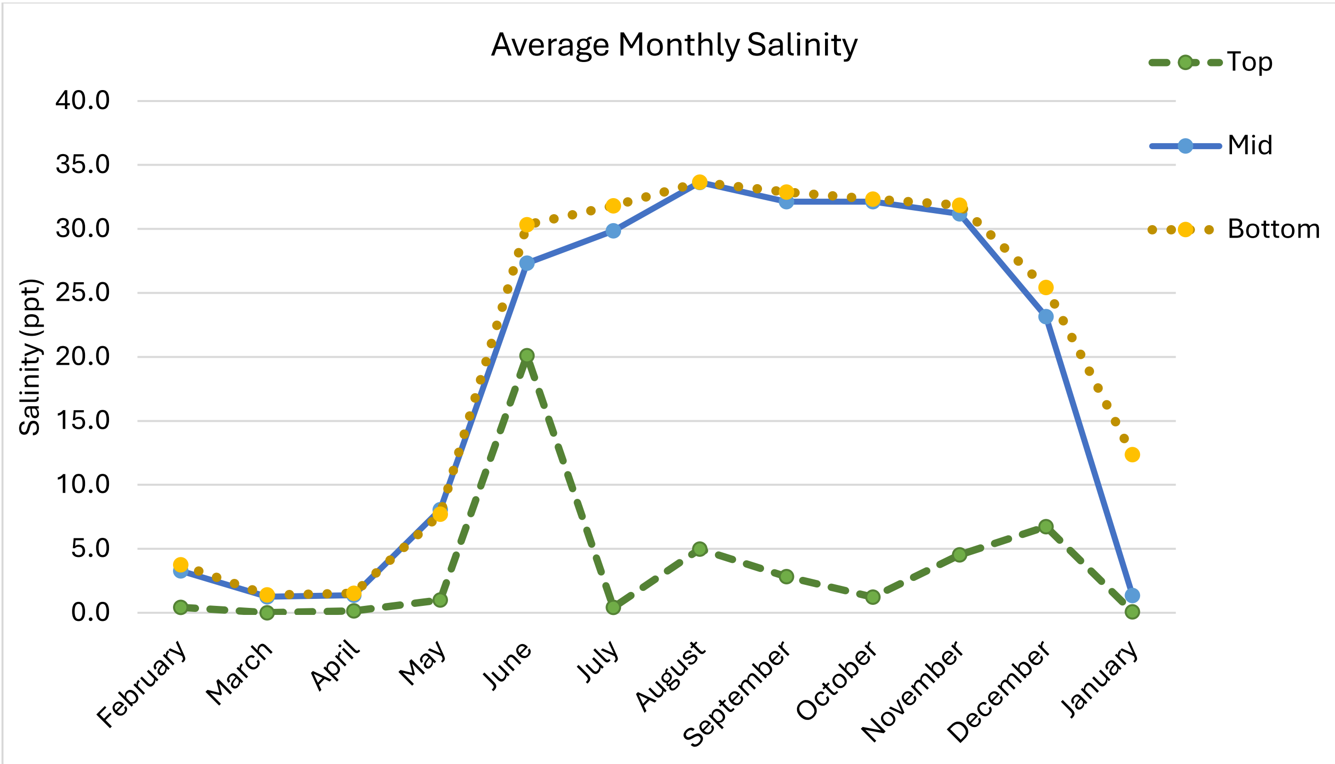

FIGURE 7. MONTHLY MEAN SALINITY(PPT) FEBRUARY 2023 TO JANUARY 2024.

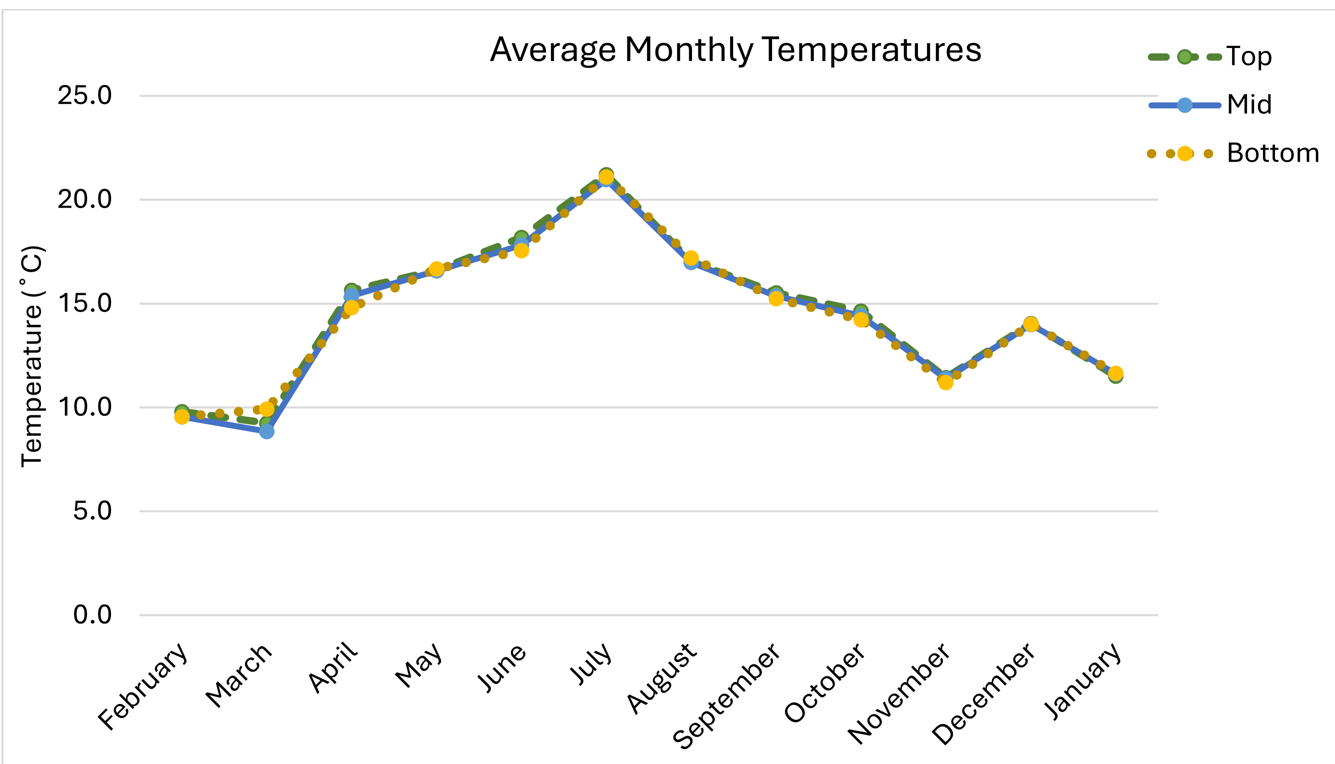

FIGURE 8. MONTHLY WATER TEMPERATURE (ºC)FEBRUARY 2023 TO JANUARY 2024.

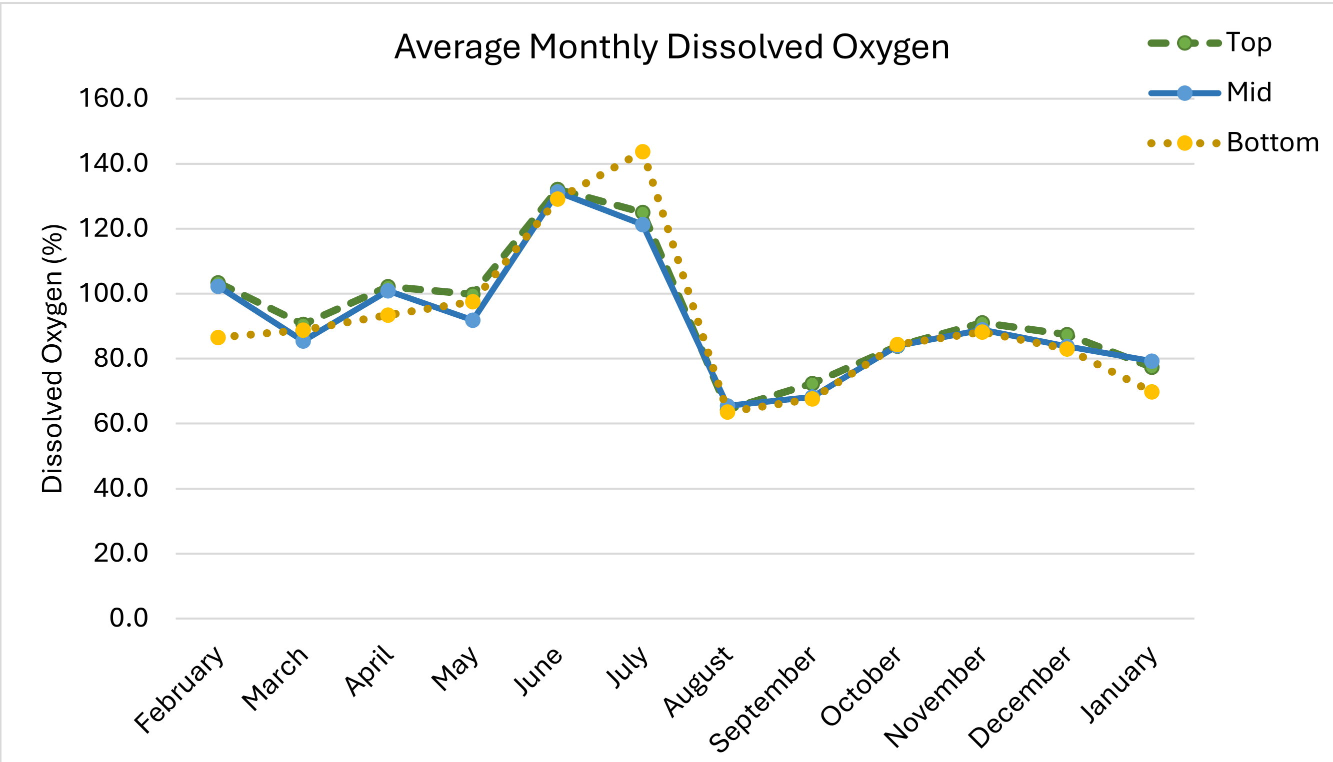

FIGURE 9. MONTHLY DISSOVLED OXYGEN (%) FEBRUARY 2023 TO JANUARY 2024.

DISCUSSION

Fish Assemblage and Diversity

Composition of the ORU fish assemblage documented in Year 1, broadly resembles assemblages observed in the Eel River Estuary and other North Coast estuaries during other sampling efforts (Chamberlain and Barnhart 1993, Cannata and Hassler 1995, Scheiff et al. 2013, Ray 2018a&b). However, native species richness (R) documented in the ORU Year 1 post-restoration monitoring (R = 20) is significantly higher than that observed by Scheiff *et al*. (2013) and Ray (2018a, 2018b) (cumulative R = 13), sampling in the ORU prior to restoration. This is likely partly a function of differences in sampling methodology, with the current effort sampling more often across a broader range of habitat types. However, many of the habitat types did not exist or were not accessible to fish prior to restoration, suggesting increased habitat diversity and capacity is promoting increased species diversity within the ORU fish assemblage.

In properly functioning estuaries, fish communities are structured by seasonal gradients in salinity and temperature. With restored full tidal exchange, hydrological connectivity throughout the site was greatly improved. The ORU generally exhibited a low salinity and low temperature environment in the winter and spring, dominated by freshwater flows from the Eel River. In May, there was a transition to a higher salinity and temperature environment dominated by marine influences as Eel River flows receded. Many estuarine species can tolerate wide ranges in temperature and salinity across seasonal gradients. Three-spined Stickleback and Pacific Staghorn Sculpin, both highly euryhaline and eurythermal species, were resident throughout the ORU during the sampling period and were reproducing at the site. Tidewater Goby, also adapted for annual estuarine residence, were encountered in most months, albeit at much lower abundance, and were documented to be reproducing in newly colonized habitats. We also observed reproductive adults (gravid females) and early juvenile stages of several other fish species, including Shiner Perch, Bay Pipefish (*Syngnathus californiensis)*, and Starry Flounder (*Platichthys stellatus*), suggesting the restored ORU provides both spawning and nursery habitat for these species. Juvenile Osmerid spp., considered likely to be predominantly Surf Smelt based on extensive sub-sample identification, were present in all months but at significantly lower abundance in July, August, and September. Surf Smelt are a species of cultural importance to North Coast indigenous communities and, along with other forage species, such as Pacific Herring and Topsmelt, are a critical component of coastal ecosystems, providing an important trophic linkage from primary producers to secondary and tertiary consumers.

In addition to species that were encountered at the ORU across a wide range of environmental conditions, many species in the community occurred seasonally, including Pacific Herring, Shiner Perch, and Topsmelt. Rearing juveniles of these species were present at relatively high abundance in the ORU during the summer and fall, when temperature and salinity was higher. Conversely, juvenile Coho Salmon used the ORU during the winter and spring when temperature and salinity was low, and the environment was dominated by freshwater flows from the Eel River. Young-of-the-year invasive Sacramento Pikeminnow, were also present in the freshwater dominated conditions of winter and spring (February – May 2023 and Jan 2024). These fish are likely flushed into the estuary during high flow events where they can persist until the system transitions to more marine conditions. It is unknown if these juveniles perish when the estuary transitions or if they can migrate further upstream to more suitable freshwater conditions.

Coho Salmon

Coho Salmon were initially detected in the ORU only two months after access was opened to the restored habitats. Fish were documented in a variety of habitat units and consistently from February through June 2023, with additional captures in December 2023 and January 2024, indicating use by two consecutive cohorts. It is well documented that juvenile Coho Salmon often emigrate from natal tributaries to overwinter in habitat lower in the watershed, including the freshwater/estuary ecotone (e.g., Jones *et al.* 2014). Given the seasonality and size class of the Coho Salmon captured in December, January, and February (Table 3) it is likely these subyearling fish are using the restored habitat of the ORU for overwinter rearing. The ORU maintained a mostly freshwater environment throughout the winter and spring of the Year 1 monitoring period, enhancing rearing opportunities for Coho Salmon (Figure 9). Annual variation in river flow likely has implications for the area and duration of rearing habitat available for Coho Salmon in the ORU and other areas of the estuary.

There was a notable increase in Coho Salmon catches during the month of May and fork lengths were the largest in April, May, and June (Table 3), with most of these fish classified as yearling smolts. While some of these fish may have reared in the ORU, the May timing corresponds with when smolts rearing in tributaries typically emigrate downstream to the ocean, suggesting fish from higher in the watershed are also using the restored ORU for estuarine foraging during outmigration. No Coho Salmon were observed between July and November. This is likely a function of life history phenology (i.e., most yearling fish emigrate to the ocean by the end of June), and environmental factors, with both salinity and temperature increasing substantially in the ORU during this period (Figures 9 &10).

The first year of fish monitoring documented extensive use of restored habitat in the ORU by rearing Coho Salmon. Coho Salmon used a variety of habitat types, and two life history types were observed, with both subyearling and yearling fish using the restored estuary. Habitat types used by juvenile Coho Salmon included small and large tidal channels and small and large off-channel habitat features. Seven of the eight habitat units being used by Coho Salmon were constructed or made accessible by the restoration project. Restoring estuaries increases the habitat capacity of watersheds for rearing salmonids. However, functioning estuaries also increase habitat diversity, which can promote life history diversity, leading to greater resiliency and productivity of salmonid populations at the watershed and regional scales.

Other Salmonids

The only other salmonid species detected in the ORU was a single steelhead trout "half-pounder", a life history variant that returns to freshwater in the fall after a spring and summer in the ocean. This life-history is generally not observed in the tidal marsh channels of the estuary and is more commonly found in the river-dominated portions of the upper estuary and above (Cannata and Hassler 1995). Half-pounders are typically actively foraging when they return to the freshwater environment, which is likely what this species was occupied with in the ORU.

No juvenile Chinook Salmon were observed in the ORU during the Year 1 monitoring period. The lack of detection may reflect limited use of the ORU by Chinook Salmon during the sampling period or may be an artifact of sampling bias. Most of the sampling occurs at low tide, whereas generally juvenile Chinook Salmon are more likely to enter and exit tidal habitats with the tide (Hering et al. 2010). We took an adaptive approach and targeted a subset of sampling events on high tides during July and August, the time of the year when juvenile Chinook Salmon have previously been observed using the lowest portions of the Eel River estuary (Cannata and Hassler 1995). Additionally, we deployed our fyke-net in a secondary channel during outgoing tide in June but captured no salmonids. Monitoring efforts targeting Chinook Salmon will continue in future efforts.

Tidewater Goby and Longfin Smelt

Tidewater Goby have an annual lifecycle and are generally not migratory, with all life stages occurring within the same habitat. Reproduction also occurs year-round, making it common to encounter multiple size classes; however, distinct peaks in reproduction can occur in the early-spring and late-summer. Tidewater Goby were first detected in the March 2023 sampling event at sites (ID 29, 31) (Figure 2) in close proximity to likely colonization sources. Tidewater Goby were not observed in newly constructed habitat features situated further away (e.g., ID 32, 33, 21, 22) (Figure 2) from source populations until July 2023. However, by September 2023 they had been observed throughout the ORU in all nine features constructed to provide suitable habitat for Tidewater Goby, as well as additional suitable habitats with improved access. Observations of Tidewater Goby in the catch were higher in the second half of the sampling period. As breeding fish become established in the new habitat we anticipate observing increases in Tidewater Goby abundance in subsequent years of monitoring.

Little is known about Longfin Smelt life history and habitat use in the Eel River estuary. However, in a survey of 16 north coast estuaries, Brennan et al. (2022), targeting the larval life stage, detected more larval Longfin Smelt in the Eel River estuary in 2020 than any other estuary sampled, which may represent the largest population of Longfin Smelt outside of San Francisco Bay. Longfin smelt are an anadromous estuarine species that generally have a two-year lifecycle. Based on the mean fork lengths, the Longfin Smelt captured in November 2023 (mean FL 57mm) and January 2024 (mean FL 70mm) are in their first winter, using the ORU tidal marsh habitats for foraging. Continued monthly sampling may provide more insight into the use of the ORU by Longfin Smelt as the site evolves over time. Restoration of tidal wetlands with connectivity to freshwater sources that can buffer early larval life stages from high salinities, such as in the Eel River estuary, is essential for the persistence of this species.

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REFERENCES

Brennan, C.A., Hassrick, J.L., Kalmbach, A., Cox, D.M., Sabal, M.C., Zeno, R.L, Grimaldo, L.F., Acuña, S. 2022. Estuarine Recruitment of Longfin Smelt (*Spirinchus thaleichthys*) north of the San Francisco Estuary. San Francisco Estuary and Watershed Science 20, 3.

California Department of Fish and Game. 2010. Lower Eel River Watershed Assessment. Coastal Watershed Planning and Assessment Program. Department of Fish and Game.

Cannata, S., Hassler, T. 1995. Juvenile Salmonid Utilization of the Eel River Estuary. California Cooperative Fishery Research Unit Humboldt State University.

Chamberlain RH, Barnhart RA. 1993. Early use by fish of a mitigation salt marsh, Humboldt Bay, California. Estuaries. Vol. 16, No.4, p.769-783.

Hering, D. K., Bottom, D. L., Prentice, E. F., Jones, K. K., & Fleming, I. A. (2010). Tidal movements and residency of subyearling Chinook salmon (*Oncorhynchus tshawytscha*) in an Oregon salt marsh channel. *Canadian Journal of Fisheries and Aquatic Sciences*, *67*(3), 524-533.

Jones KK, Cornwell TJ, Bottom DL, Campbell LA, Stein S. 2014. The contribution of estuary resident life histories to the return of adult Coho Salmon *Oncorhynchus kisutch* in Salmon River, Oregon, USA. Journal of Fish Biology. Jul;85(1):52-80.

Loomis. 2023. Dewatering and Fish Rescue Report. California Department of Fish and Wildlife Field Note.

Ray J. 2018a. Fish Assemblage of the Ocean Ranch Unit Tidal Wetlands. California Department of Fish and Wildlife Field Note.

Ray J. 2018b. Presence/Absence of Tidewater Goby (*Eucyclogobius newberryi*) in the Eel River Wildlife Area, Ocean Ranch Unit, 2017. California Department of Fish and Wildlife Field Note.

Scheiff, A., M. M. Gilroy, M. Wallace. 2013. McNulty Slough, Thence Eel River Estuary Fish and Water Quality Sampling January 2008 through June 2009. California Department of Fish and Wildlife Document Library.

Scheiff, A., M. M. Gilroy. 2013. Tidewater goby and Water Quality Sampling Ocean Ranch Unit, Eel River Wildlife Area Summer 2012. California Department of Fish and Wildlife Document Library.

APPENDIX I

YEAR 1 SAMPLING EVENTS AND GEAR TYPES.

Month	Date	Number of sites visited	Number of Sein Hauls Completed	Minnow Traps Deployed	Fyke-Style Channel Net Deployed
February	2/14/2023	7	11	2	
	2/15/2023	3	5		
	2/16/2023	1	5		
March	3/27/2023	13	23		
	3/29/2023	1	7		1
April	4/13/2023	6	14		
	4/14/2023	7	11		
May	5/11/2023	10	19		
	5/12/2023	4	8		1
June	6/20/2023	12	22	2	
July	7/25/2023	14	25		
August	8/21/2023	8	14		
	8/23/2023	4	14		
September	9/21/2023	4	6		
	9/29/2023	9	16		
October	10/11/2023	10	15		
November	11/20/2023	5	5		
	11/27/2023	6	12	2	
December	12/19/2023	7	9		
	12/20/2023	2*	4		
January	1/18/2024	12	18		
	1/19/2024	2	6		

APPENDIX II

TOTAL MONTHLY CATCH FEBRUARY 2023 – JANUARY 2024.

Common Name	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Total
California roach	-	2	-	2	-	-	-	-	-	-	-	7	**11**
Coastrange sculpin	-	-	-	-	-	-	-	-	-	2	-	-	**2**
Three-spined stickleback	54	495	300	3121	5237	8309	2471	2395	58	2390	28	930	**25788**
Tidewater goby	-	5	2	2	-	3	66	16	4	17	6	12	**133**
Sacramento pikeminnow	41	45	43	55	-	-	-	-	-	-	-	25	**209**
Prickly sculpin	-	-	-	-	-	366	289	47	13	19	21	493	**1248**
Coho Salmon	3	6	4	14	2	-	-	-	-	-	1	7	**37**
steelhead trout	-	-	-	-	-	-	-	-	-	-	1	-	**1**
Arrow goby	3	11	-	-	-	-	9	6	-	4	3	49	**85**
Bay pipefish	-	-	-	2	5	54	52	-	4	3	1	1	**122**
Longfin smelt	-	-	-	-	-	-	-	-	-	3	-	3	**6**
Pacific Staghorn Sculpin	1302	1124	597	392	196	278	125	51	30	87	102	804	**5088**
Saddleback gunnel	-	1	-	2	1	46	12	1	-	-	-	10	**73**
Night smelt	-	-	-	-	-	-	-	-	-	-	-	1	**1**
Pacific Herring	4	5	3	1	9721	536	224	2	2	-	2	-	**10500**
Pacific sardine	-	-	-	-	3	-	-	-	-	-	-	**-**	**3**
Shiner perch	-	-	1	1	174	756	8	9	-	-	1	**-**	**895**
Starry flounder	-	-	-	1	4	6	11	-	3	1	-	5	**31**
Osmerid spp.	3295	1332	1891	656	331	90	121	131	627	1133	1912	1001	**12520**
Topsmelt	-	-	-	-	-	378	1276	651	581	1	-	-	**2887**
Northern anchovy	-	-	-	-	-	1	-	-	-	39	10	-	**50**
Tidepool snailfish	-	-	-	-	-	-	-	-	-	1	-	-	**1**

Unidentified goby spp.	-	-	-	1	-	-	3	10	-	3	4	12	**33**
Unidentified sculpin spp.	-	-	-	-	6	20	34	1	3	2	2	3	**71**
Dungeness crab	-	-	-	-	-	-	6	303	43	52	27	7	**438**
Green shore crab	-	-	4	2	12	269	539	6	2	-	1	11	**846**
Crangon spp.	38	149	23	78	3	598	3304	2659	2550	4368	277	2781	**16828**
Ctenophore	-	-	-	-	569	-	-	3	26	-	-	**-**	**598**
Total	**4740**	**3175**	**2868**	**4330**	**16264**	**11710**	**8550**	**6291**	**3946**	**8125**	**2399**	**6162**	**78560**