RUSSIAN RIVER ESTUARY FISH AND MACRO-INVERTEBRATE STUDIES, 2005




Sonoma County Water Agency
2150 West College Avenue
Santa Rosa, California 95401

Prepared by
David Cook – Senior Environmental Specialist

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INTRODUCTION

The Sonoma County Water Agency (Agency), along with other government entities, is currently undertaking a Section 7 consultation to evaluate the potential effects of proposed water-related operation and maintenance activities in the Russian River watershed on threatened fish species and their habitat. Section 7 consultation under the Endangered Species Act, administered by National Marine Fisheries Service (NMFS), is required for federal projects that may impact listed anadromous fish species. The Russian River watershed supports threatened stocks of steelhead (*Oncorhynchus mykiss*), Chinook salmon (*Oncorhynchus tshawytscha*), and coho salmon (*Oncorhynchus kisutch*). During the Section 7 consultation process with NMFS, the proposed Russian River Estuary Flow-Related Habitat Project, also referred to as the Flow Proposal, was developed.

Under the proposed Russian River Estuary Flow-Related Habitat Project, releases from Warm Springs Dam at Lake Sonoma and Coyote Valley Dam at Lake Mendocino would be modified to improve rearing and migration conditions for salmonids in the Russian River, Dry Creek, and the Russian River Estuary (Estuary). This proposed project includes an Estuary Management Plan that would change the current summer management of the Estuary from a tidally influenced open-mouth system to a closed-mouth lagoon with predominantly freshwater to improve rearing habitat for salmonids (Entrix 2004). These changes must still undergo review and approval by NMFS, as well as review under the California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA). Studies of the Estuary may be used during the preparation of CEQA/NEPA documents for the proposed Russian River Estuary Flow-Related Habitat Project.

This report summarizes results of fish and macro-invertebrate studies of the Estuary conducted during 2003 to 2005. The purpose of the study was to inventory species and determine their distribution and relative abundance in the Estuary. Survey techniques for this study where developed during 2003 (Cook 2004). Background information and results presented in Cook (2004 and 2005) have been incorporated into this report.

Background

Current Estuary Management

The Estuary periodically closes throughout the year as a result of a sandbar forming at the mouth of the Russian River. Closures are most frequent in the late-spring through fall. Currently, when the Estuary is closed, increasing water levels eventually flood adjacent lands. Historically, local or government entities artificially breached the sandbar to lower water levels and prevent property damage. During 1992 and 1993, a study evaluated the impacts of artificially breaching the Russian River mouth and developed a management plan (Heckel 1994). The study recommended maintaining the Estuary as an open-mouth system using mechanical breaching to reduce adverse environmental effects and protect private property from flooding. However, this recommendation was based on existing summer flows of the Russian River required under the State Water Resources Control Board’s Decision 1610 (D1610) that, in part, specifies minimum instream summer flows for the Russian River. The Estuary management plan was adopted by the Sonoma County Board of Supervisors in 1995 and the Agency assumed responsibility for its implementation. Currently, the sandbar is mechanically breached using a bulldozer, on average, 5 to 7 times per year when water levels in the Estuary are between 4.5 ft and 7.0 ft (as read at the Jenner gage located at the Jenner visitor's center).

Proposed Estuary Management

The proposed Estuary Management Plan is described in detail in the Draft Biological Assessment (Entrix 2004) and is summarized below.

> "The objective of the Estuary management proposal is to improve habitat for listed salmonid species while preventing flooding of local properties. To improve summer rearing habitat in the Estuary, the proposed project would eliminate artificial breaching of the sandbar during the summer months. Artificial breaching may be required in the spring or fall, and in some dry winters, to manage storm flow inflows to the Estuary to prevent flooding of local property.
>
> Estuaries and lagoons in the Central California Coast and Northern California Steelhead Evolutionary Significant Units (ESUs) provide important summer rearing habitat for steelhead and Chinook salmon. Summertime breaching of sandbars has been found to severely alter steelhead habitat conditions in lagoons, and summertime breaching can negatively affect salmonids. Infrequent artificial breaching, especially during low-flow summer months, impairs water quality because salinity stratification repeatedly results in periods of higher water temperatures and low dissolved oxygen (DO) levels. Fluctuations in temperature, DO, and salinity affect salmonid habitat, primary production, and the abundance of aquatic invertebrates upon which young salmonids feed. Smith (1990) found that when a sandbar is left closed over the summer months, good water quality develops when the system is converted to freshwater and stable habitat conditions form. [In addition, Cannata (2004) studied 2 rivers in Mendocino County and found a higher abundance of steelhead in the Navarro estuary that converts to a freshwater lagoon during summer, while the tidal Albion estuary had a lower abundance of steelhead.] Habitat conditions for salmonids in the Estuary would be improved by eliminating artificial breaching in the summer.
>
> Under the proposed action, there would be 2 management scenarios, 1 for Low-flow Estuary Management and 1 for Storm-flow Estuary Management. The Estuary would be managed with the goal of maintaining a closed system (lagoon) with freshwater habitat during the low-flow (summer) season. This action is expected to improve summer rearing habitat by allowing the lagoon to freshen and by stabilizing salinity and DO conditions, which would also increase and stabilize the invertebrate food base for salmonids. The frequency of breaching and the amount of freshwater inflow are 2 major factors that influence water quality in a lagoon or estuary system. Under the Flow Proposal [Entrix 2004], flow to the Estuary would be low enough to avoid artificial breaching in the summer, but high to freshen the lagoon after the sandbar first closes. Under Storm-flow Estuary Management, artificial breaching would be conducted to manage the Estuary as an open system during the wet season to minimize flooding of local property.

> Under D1610, the Estuary cannot be managed as a closed system during *normal* water supply conditions because required minimum flows at Hacienda [near Guerneville] provide inflow rates to the Estuary that are too high to avoid flooding if the sandbar is not breached. Therefore, the proposed Estuary management action could only be implemented in concert with reduced flows such as those in the Flow Proposal. Implementation of the Flow Proposal allows dry season inflow to the Estuary to be substantially lower than permitted under D1610."

METHODS

Study Area

The Estuary study area consisted of the tidally influenced portion of the Russian River from the sandbar at the Pacific Ocean to the confluence with Austin Creek, located 11.7 km (7.3 mile) upstream from the coast (Figure 1). However, tidal action has occurred as far as Monte Rio located an additional 16 km (9.9 miles) upstream (Heckel 1994). The Estuary is as narrow as 23 m (75 feet) near the upstream end and gradually widens to over 76 m (249 feet) near the mouth. Water depths vary in the Estuary but generally increase closer to the mouth; however, deep pools, >10 m (33 ft), occur throughout the Estuary. As shown on Figure 1, the Estuary was divided into 3 sections, including the lower Estuary (sandbar to upper Penny Island), middle Estuary (upper Penny Island to Sheephouse Creek), and upper Estuary (Sheephouse Creek to Austin Creek).

Estuarine environments typically have salinity levels that range from seawater (>28 ppt) found near the ocean to freshwater (<1 ppt) found at stream inflows. Brackish water occurs where seawater and freshwater mix. Also, a common characteristic of some estuarine systems is the periodic stratification of water where the heavier seawater occurs at the bottom and the lighter freshwater or brackish water floats at the surface. Currents, tidal/wave action, stream flows, and wind contribute to water layers mixing.

Salinity in the Estuary changes under a variety of conditions, including season, tidal cycle, river mouth (open or closed), and proximity to the coast. During the spring, summer, and early fall a broad gradient of salinities occur. Typically, salinity levels decrease with distance upstream from the Russian River mouth. The lower Estuary is composed of seawater on the bottom and brackish water near the surface. The middle Estuary is a mix of freshwater/brackish and seawater layers. The upper Estuary is strongly influenced by freshwater flows of the Russian River.

Fish Surveys

A beach deployed purse seine was used to sample fish species and determine their relative abundances and distributions, especially for salmonids. Seining is an effective way to collect fish that occur near shore. A purse seine 30-m-long (100-foot-long) and 3-m-deep (10-feet-deep) with pull ropes attached to both ends was used to sample fish. The seine was composed of nylon knotless netting. Floats on the top and metal rings on the bottom of the net positioned the seine

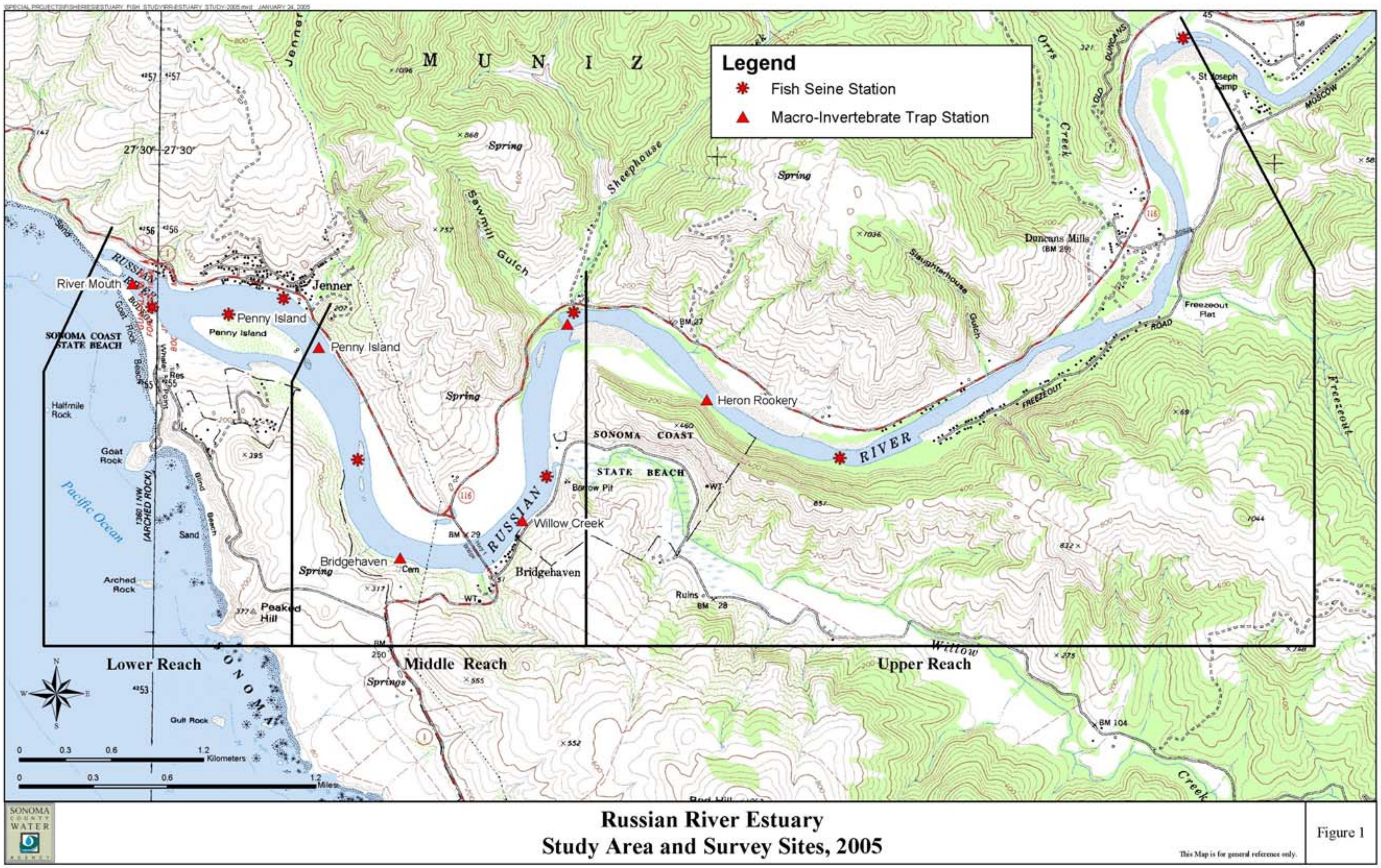

Figure 1: Russian River estuary study area and survey sites, 2005

vertically in the water. The purse seine was deployed with a boat to pull an end offshore and then around in a half-circle while the other end was held onshore. Once the ends of the seine were brought together at the shore the purse line was pulled to close, or “purse”, the net to prevent fish from escaping underneath. The net was then hauled onshore by hand. Captured fish were placed in an aerated bucket for sorting, identifying, and counting prior to release. A few voucher specimens (non-salmonids) were preserved in ethanol to verify identification. Captured salmonids were anesthetized with Alka-seltzer tablets and then measured, weighed, and examined for general condition, including life stage (i.e., parr, smolt). Salmonids were identified as wild or hatchery stock indicated by a clipped adipose fin. Tissue and scale samples were collected from some steelhead. Fish were allowed to recover in aerated buckets prior to release.

Eight sample stations were located throughout the Estuary in a variety of habitat types based on substrate type (i.e., mud, sand, and gravel), depth, and tidal and creek tributary influences (Figure 1). These stations were identified during 2003 studies (Cook 2004). Three seine pulls were deployed during the sampling at each station. Stations were surveyed approximately every 3 weeks and during different tidal cycles from 31 May through 6 October, 2005. The gage at Jenner was used to determine water elevation and incoming and outgoing tides. Habitat characteristics at seining stations are as follows:

- River Mouth – located on the sand bar separating the Russian River from the Pacific Ocean, sandy substrate with a steep slope, high tidal influence.
- Penny Island – located in shallow water with a mud and gravel substrate, high tidal influence.
- Jenner Gulch – located at the confluence with a small creek, gravel substrate with a moderately steep slope, influenced by tides and creek flows.
- Patty Rock (previously referred to as “Rocky Bar”) – located on a large gravel bar adjacent to deep water, moderate tidal influences.
- Willow Creek - located in shallow waters at the confluence with a creek, gravel and mud substrate, influenced by creek flows and moderate tidal action.
- Sheephouse Creek - located at the confluence with a creek, gravel substrate with a moderate steep slope, influenced by creek flows and moderate tidal action.
- Heron Rookery - located on a gravel bank adjacent to deep water, moderate tidal influences.
- Austin Creek - located at the confluence with a perennial creek, gravel substrate with a moderate steep slope, freshwater influence from the creek.

Macro-invertebrate Surveys

Surveys were conducted to inventory macro-invertebrate species present in the Estuary and to determine their relative abundance and distribution. Surveys focused on marine species in the lower and middle Estuary (Figure 1). Six permanent trap stations were distributed between the Russian River mouth and upstream 4 mi (6.4 km) in a variety of habitat types based on substrate type (e.g., mud, sand, gravel, rock). Trapping was conducted approximately every 2 to 3 weeks from 15 June to 14 September, 2005. Each station included 1 shrimp trap and 1 crab trap baited with fish parts. Traps were deployed during the morning and retrieved the following morning. Captured invertebrates were identified to species, carapace width measured, and released. Dungeness crabs with carapace width of <90 mm were considered juvenile and adult were ≥ 90 mm.

Water Quality

Water quality data were collected at fish seine and macro-invertebrate trap stations during each sampling event. A hand held YSI meter with a probe at the end of a cable was used to obtain temperature (Celsius, C), salinity (parts per thousand, ppt), and DO (milligrams per liter, mg/l). At fish seine stations water quality was collected at 0.5 m (1.6 ft) intervals at the approximate center of the seine sample area. A Secchi disc was used to measure water turbidity. At macro-invertebrate trap stations water quality data was collected 30 cm (1 ft) above the bottom.

RESULTS

This report includes findings from data collected in 2004 (Cook 2005) and 2005, and preliminary results from 2003 (Cook 2004). This study and future studies will be used to evaluate the proposed Russian River Estuary Flow-Related Habitat Project, which may change the Estuary from an open-mouth tidal estuarine system to a closed-mouth freshwater lagoon system during summer months.

Fish Distribution and Abundance

Common Species

A total of 8,440 fish consisting of 23 species were recorded in the Estuary during 2005 (Table 1). In comparison, fish surveys conducted from 1992 to 1993 and from 1996 to 2000 found 18 to 28 species/year (see Martini-Lamb 2001). A total of 49 species were detected during the 7 years of these studies. The Estuary study in 2003 and 2004 (Cook 2004 and 2005) found 22 and 31 fish species, respectively. Surveys during 2003 to 2005 found 13 fish species previously undetected during studies in the 1990s. Five of these new fish species were found in 2005. These new fish detections included 4 freshwater species common to the Russian River basin (bluegill [*Lepomis macrochirus*], largemouth bass [*Micropterus salmonoides*], black crappie [*Pomoxis nigromaculatus*], and Sacramento blackfish [*Orthodon microlepidotus*]) and 1 marine species (juvenile giant/striped kelpfish [*Heterostichus/Gibbonsia* sp.]).

The distribution of fish in the Estuary is, in part, based on a species preference for or tolerance to salinity (Figure 2). Fish commonly found in the lower Estuary were marine and estuarine species including topsmelt (*Atherinops affinis*), surf smelt (*Hypomesus pretiosus*), staghorn sculpin (*Leptocottus armatus*), and starry flounder (*Platichthys stellatus*). The middle Estuary had a broad range of salinities and a diversity of fish tolerant of these conditions. Common fish in the middle Estuary included species in the lower Estuary and shiner surfperch (*Cymatogaster aggregata*), three-spine stickleback (*Gasterosteus aculeatus*), and prickly/coastrange sculpin (*Cottus asper/aleuticus*). Freshwater dependent species, such as the Sacramento sucker (*Catostomus occidentalis*) and California roach (*Hesperoleucus symmetricus*) were predominantly distributed in the upper Estuary. Anadromous fish, such as steelhead (*Oncorhynchus mykiss*) and American shad (*Alosa sapidissima*), that are tolerant of both freshwater and seawater, occurred throughout the Estuary. In 2005, fish diversity at stations ranged from 9 species to 15 species, and the highest species diversity was 23 species at Jenner Gulch Station in 2004 (Figure 2). Stations with more species were probably due to a higher

Table 1: Fish species caught in the Russian River estuary, 2003-2005

						2005 Captures/Seine Pull								Total
Family	**Scientific Name**	**Common Name**	**2003**	**2004**	**2005**	**Mout**	**Penn**	**Jenn**	**Rock**	**Willo**	**Sheep**	**Heron**	**Aust**	**Catch**
Atherinidae	*Atherinops affinis*	topsmelt	X	X		21.1	19.3	28.5	44.4	31.3	9.8	12.1	0.0	1331
Atherinidae	*Atherinops californiensis*	jacksmelt	X			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
Carangidae	*Trachurus symmetricus*	jack mackerel	X			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
Catostomidae	*Catostomus occidentalis*	Sacramento sucker	X	X	X	0.0	0.1	0.3	0.1	8.8	1.4	8.0	37.1	446
Centrarchidae	*Lepomis cyanellus*	green sunfish		X		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
Centrarchidae	*Lepomis macrochirus*	bluegill			X	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.6	8
Centrarchidae	*Micropterus salmonoides*	largemouth bass			X	0.0	0.0	0.1	0.0	0.1	0.1	0.1	3.5	32
Centrarchidae	*Pomoxis nigromaculatus*	black crappie			X	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	1
Clinidae	*Heterostichus/ Gibbonsia sp*	giant/striped kelpfish			X	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	1
Clupeidae	*Alosa sapidissima*	American shad	X	X	X	0.04	0.00	0.00	0.54	0.08	1.00	0.21	1.50	81
Clupeidae	*Clupea harengus*	Pacific herring	X	X	X	0.0	0.63	3.04	0.25	0.04	0.00	0.00	0.00	95
Clupeidae	*Etrumeus teres*	round herring	X			0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Clupeidae	*Sardinops sagax caeruleus*	Pacific sardine		X		0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Cottidae	*Artedius lateralis*	smoothhead sculpin		X		0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Cottidae	*Cottus asper/aleuticus*	prickly/coastrange sculpin	X	X	X	7.63	8.79	4.13	6.54	21.42	10.21	17.13	9.21	2041
Cottidae	*Enophrys bison*	buffalo sculpin		X		0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Cottidae	*Leptocottus armatus*	staghorn sculpin	X	X	X	1.08	2.17	0.00	0.58	0.54	0.00	0.00	0.00	105
Cottidae	*Oligocottus maculosus*	tidepool sculpin		X		0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Cottidae	*Scorpaenichthys marmoratus*	cabezon		X		0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Cottidae	*Sebastes spp*	rockfish (juveniles)	X	X		0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Cyprinidae	Cyprinid	unidentified larvae		X	X	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.04	1

Family	Scientific Name	Common Name	2003	2004	2005	2005 Captures/Seine Pull Mout	Penn	Jenn	Rock	Willo	Sheep	Heron	Aust	Total Catch
Cyprinidae	*Hesperoleucus symmetricus*	California roach	X	X	X	0.0	0.0	0.0	0.0	0.0	0.21	0.92	7.79	214
Cyprinidae	*Lavinia exilicauda*	hitch		X		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
Cyprinidae	*Orthodon microlepidotus*	Sacramento blackfish			X	0.0	0.04	0.0	0.0	0.0	0.0	0.0	0.0	1
Cyprinidae	*Ptychocheilus grandis*	Sacramento pikeminnow	X	X	X	0.0	0.0	0.0	0.0	0.0	0.04	0.29	1.38	41
Embiotocidae	*Cymatogaster aggregata*	shiner surfperch	X	X	X	0.0	0.0	0.0	0.0	43.04	0.46	0.04	0.0	1045
Embiotocidae	*Hysterocarpus traskii pomo*	Russian River tuleperch	X	X	X	0.0	0.0	0.0	0.0	0.0	1.83	0.21	11.17	317
Engraulididae	*Engraulis mordax*	northern anchovy	X	X		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
Gasterosteidae	*Gasterosteus aculeatus*	threespine stickleback	X	X	X	0.0	0.13	0.0	0.04	7.33	5.92	8.08	1.29	547
Hexagrammidae	*Hexagrammos sp*	greenling (juv) species		X		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
Hexagrammidae	*Ophiodon elongatus*	lingcod		X		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
Liparididae	*Liparis sp*	snailfish species		X		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
Osmeridae	*Hypomesus pretiosus*	surf smelt	X	X	X	1.71	2.50	0.50	0.0	0.04	0.0	0.0	0.0	114
Pholididae	*Apodichthys flavidus*	penpoint gunnel	X	X		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
Pholididae	*Pholis ornata*	saddleback gunnel	X	X		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
Pleuronectidae	*Platichthys stellatus*	starry flounder	X	X	X	2.38	16.25	2.67	3.00	23.54	2.92	9.46	0.92	1467
Salmonidae	*Oncorrynchus kisutch*	coho salmon		X	X	0.04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1
Salmonidae	*Oncorrynchus mykiss*	steelhead	X	X	X	0.38	0.0	1.50	0.38	1.46	1.00	1.08	12.42	437
Salmonidae	*Oncorrynchus tshawytscha*	Chinook salmon		X	X	0.71	0.33	0.38	1.54	0.21	0.96	0.17	0.13	106
Syngnathidae	*Syngnathus leptorhyncus (griseolineatus)*	bay pipefish	X	X	X	0.0	0.0	0.13	0.08	0.04	0.08	0.0	0.0	8
TOTAL			**22**	**31**	**23**									**8440**

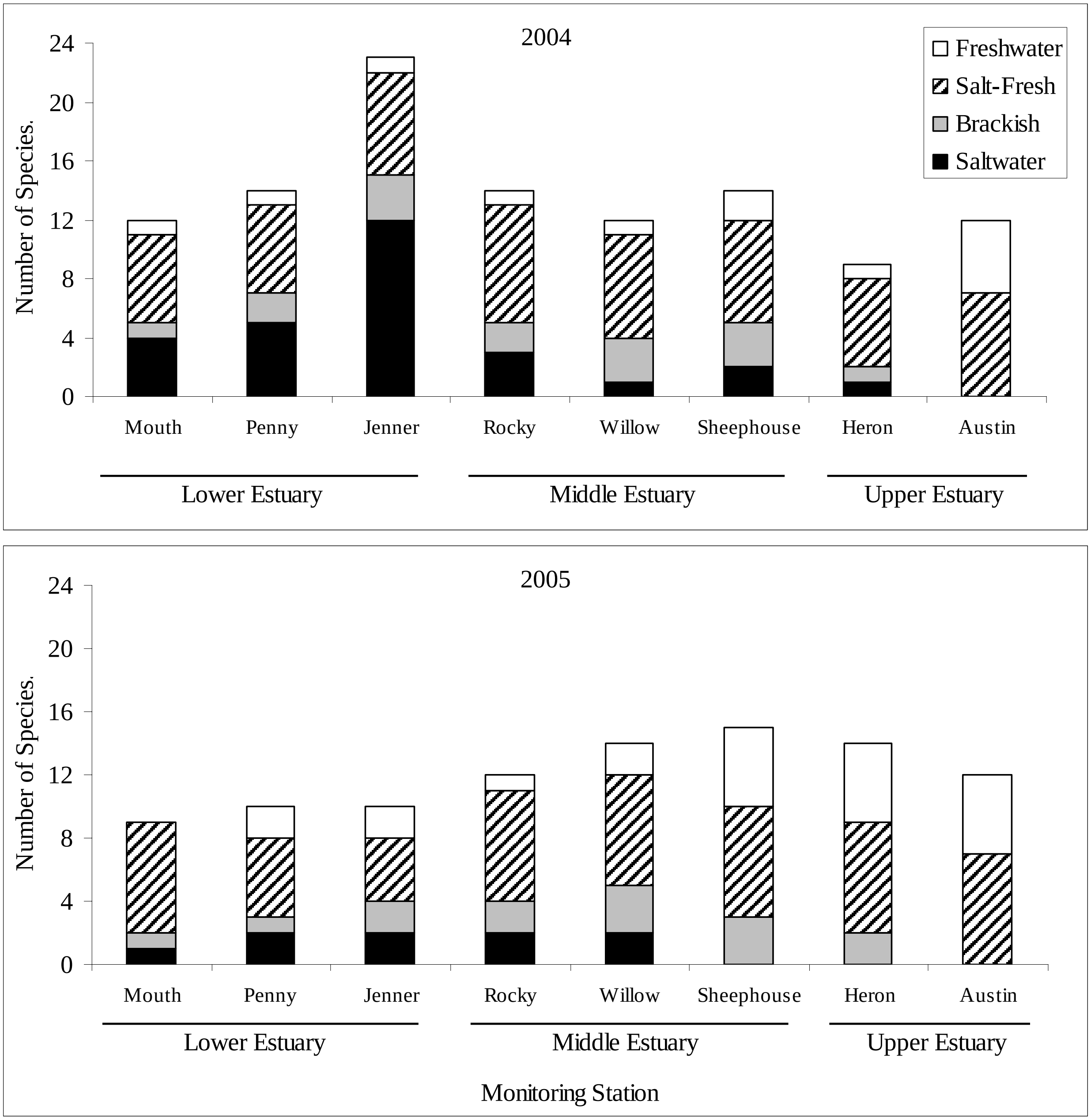

Figure 2: Distribution of fish based on tolerance to salinity during 2004-2005. Fish groups include: Freshwater species with low tolerance to salinity; Salt-Fresh species are primarily anadromous; Brackish species complete their lifecycle in estuaries; Saltwater species are predominantly marine.

diversity of habitat features and fluctuating salinity levels that changed habitat conditions from freshwater during the spring to brackish later in the season when freshwater flows decreased. There was a higher diversity of freshwater fish species throughout the Estuary and fewer marine species in 2005 than observed in 2004.

In general, there was an increase in fish abundance in an upstream direction (Figure 3). The highest relative abundance of fish was found at Jenner Gulch Station with a capture rate of 328 fish/pull in 2004 and the highest in 2005 was at Willow Creek Station with 113 fish/pull (Figure 3). A possible explanation for this fish abundance pattern is the higher diversity of habitat features at these 2 stations. High captures of fish in Jenner in 2004 may have been an anomaly because high numbers were not recorded in 2005. Habitats at Willow Creek are diverse and include mudflat, gravel bar, and emergent marsh.

Salmonid Species

In general, 2004 appeared to be a stronger year for salmonid recruitment and development than in 2005. Capture rates in 2005 for steelhead (2.28 fish/pull) and Chinook salmon (0.55 fish/pull) were lower than in 2004 (steelhead 2.70 fish/pull and Chinook salmon 0.87 fish/pull). A total of 438 steelhead and 105 Chinook salmon were captured in the Estuary in 192 seine pulls during 2005. Although the multi-year residence times typical of young steelhead complicates assessing growth patterns, the size of captured steelhead parr and smolts were larger in 2004 than in 2005. For example, at the Austin Creek Station steelhead lengths in 2004 were 151.9 mm and in 2005 steelhead were 106.5 mm (Figure 4). Steelhead at Austin Creek Station were significantly larger in 2004 than in 2005 (t-test: $t = 13.387$, df = 458, $p < 0.001$). Only 1 hatchery steelhead was captured during 2005 compared to 7 hatchery steelhead in 2004. The largest wild steelhead was 320 mm fork length caught at Sheephouse Creek Station on 24 August 2004 and the largest in 2005 was 270 mm fork length from Jenner Gulch Station. The single-year age class of fall run Chinook salmon in the Russian River allows a more direct evaluation of growth rates. Chinook salmon smolt sizes gradually increased during the summer study period (Figure 5). Average fork lengths of Chinook salmon smolts were significantly larger in 2004 than in 2005 ($\bar{x}_{2004} = 103.4$ mm, $s = 10.0$, $n = 147$; 2005: $\bar{x}_{2005} = 90.7$ mm, $s = 9.6$, $n = 105$; t-test: $t = -10.204$, df = 230, $p < 0.001$).

The distribution of salmonids in the Estuary varied by species, habitat, and season (Table 2). Chinook salmon smolts were distributed throughout the Estuary with captures at every sample station, except Heron Rookery Station in 2004 (Figure 6). Chinook salmon smolt captures were highest at the River Mouth Station in 2004 and Patty Rock Station in 2005. In comparison, steelhead distribution was primarily in the middle and upper Estuary (Figure 7). In general, steelhead numbers progressively increased upstream. Austin Creek Station consistently had the highest abundance of steelhead with >68% of all steelhead captured annually at this station. As discussed below in the Estuary Water Quality Section, Austin Creek Station was the only station not inundated by seawater during the 2 years of study. Although there are several factors influencing the distribution of fish, steelhead were more frequently captured at stations located at the confluence with tributaries than non-tributaries (Figure 8). Chinook salmon showed an opposite pattern of habitat use where non-tributary stations had more captures; however, this habitat pattern was not as strong for Chinook salmon as for steelhead. The abundance of Chinook salmon peaked during early-June and none were captured after July (Figure 9). Steelhead were

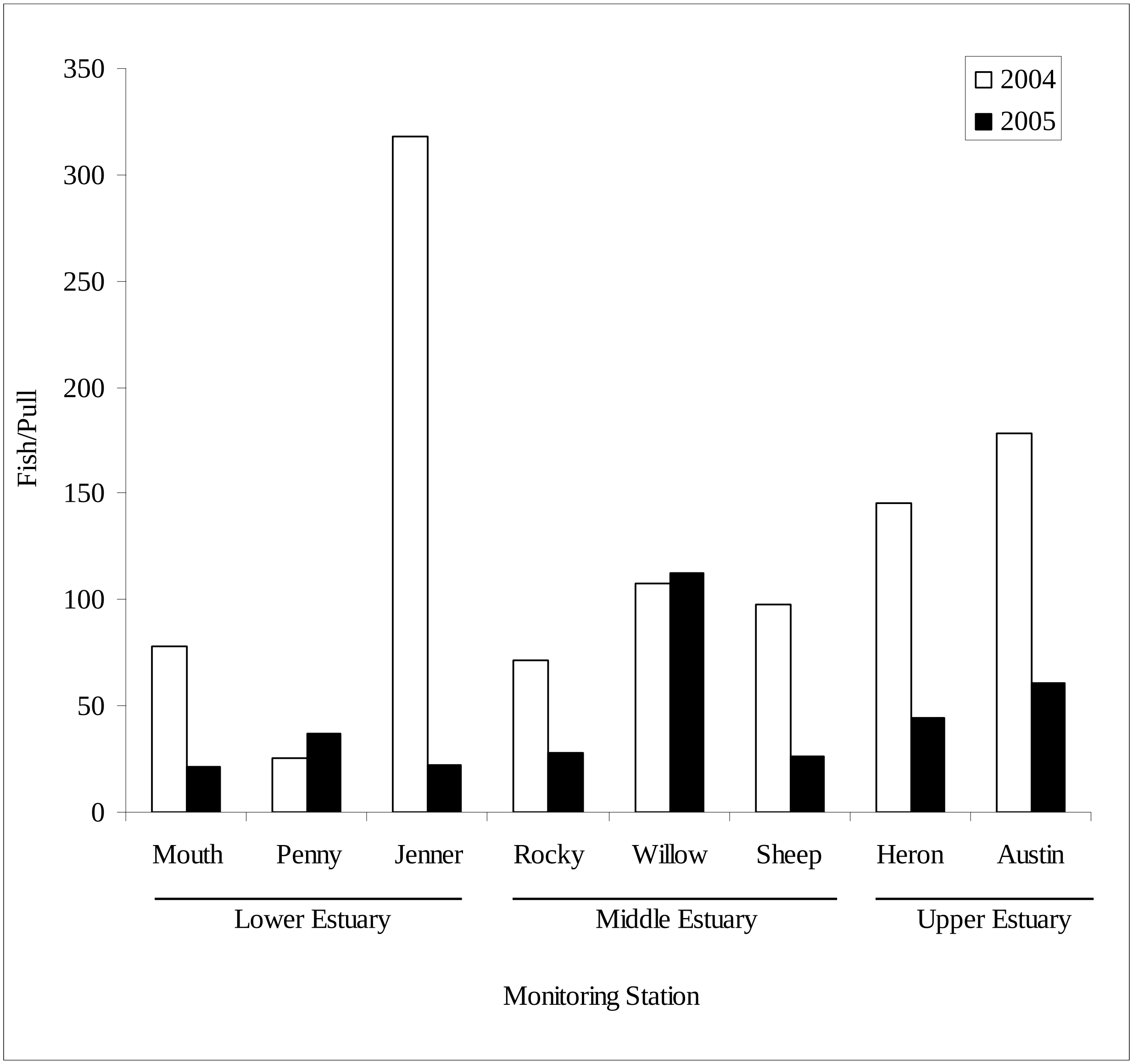

Figure 3: Mean number of fish caught per seine pull at 8 sample stations during 2004-2005. Annual seine pulls at each station included 21 pulls in 2004, except Jenner Gulch Station had 24 pulls, and 24 pulls in 2005.

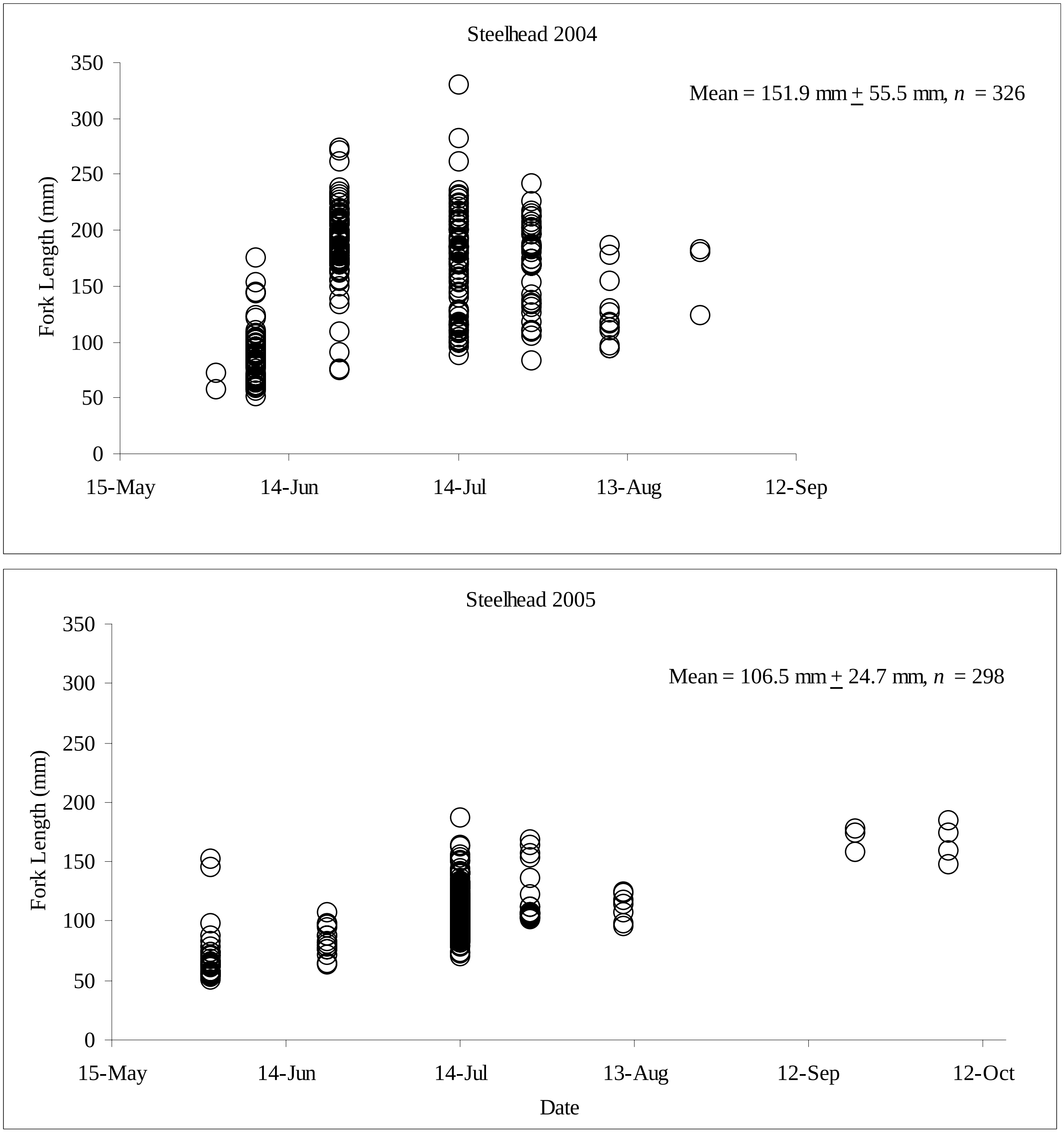

Figure 4: Comparison of steelhead lengths at Austin Creek Station, 2004-2005. Steelhead parr and smolts were captured during standard seine surveys.

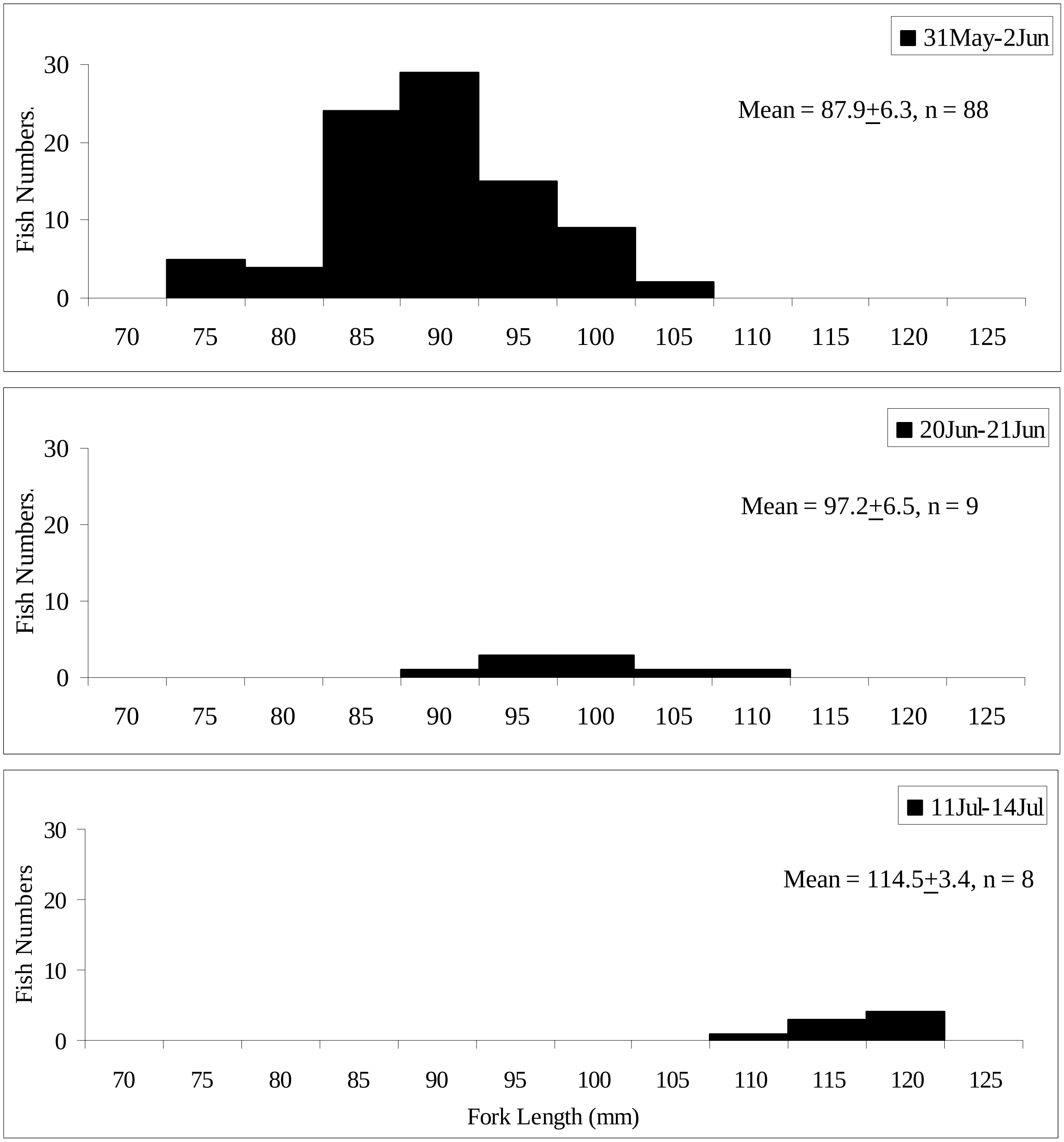

Figure 4: Chinook salmon length histograms, Estuary, 2005. Seine surveys included 8 complete samplings at 8 permanent stations. Chinook salmon were not recorded during 5 complete surveys from August to October.

Table 2. Steelhead and Chinook salmon captures in the Estuary, 2005. Captures are from 3 beach seine pulls per sample period. The location of stations are shown on Figure 1.

Station	Location	31May-2Jun	20-22Jun	11-14Jul	25- 27Jul	9-11 Aug	29-31 Aug	19-21 Sep	3-6 Oct	**Total**
		Survey Period								
		Steelhead								
Mouth	Non-trib	7	2							9
Penny	Non-trib									0
Jenner	Tributary	1	2	3	4	21	3	1	2	37
Patty	Non-trib					9				9
Willow	Tributary	4	3	16	8	4				35
Sheep	Tributary	12	3			1	5	3		24
Heron	Non-trib	22	4							26
Austin	Tributary	32	15	219	18	7		3	4	298
Total		**78**	**29**	**238**	**30**	**42**	**8**	**7**	**6**	**438**
		Chinook salmon								
Mouth	Non-trib	10		7						17
Penny	Non-trib	8								8
Jenner	Tributary	5	2	1						8
Patty	Non-trib	37								37
Willow	Tributary	5								5
Sheep	Tributary	17	6							23
Heron	Non-trib	4								4
Austin	Tributary	2	1							3
Total		**88**	**9**	**8**	**0**	**0**	**0**	**0**	**0**	**105**

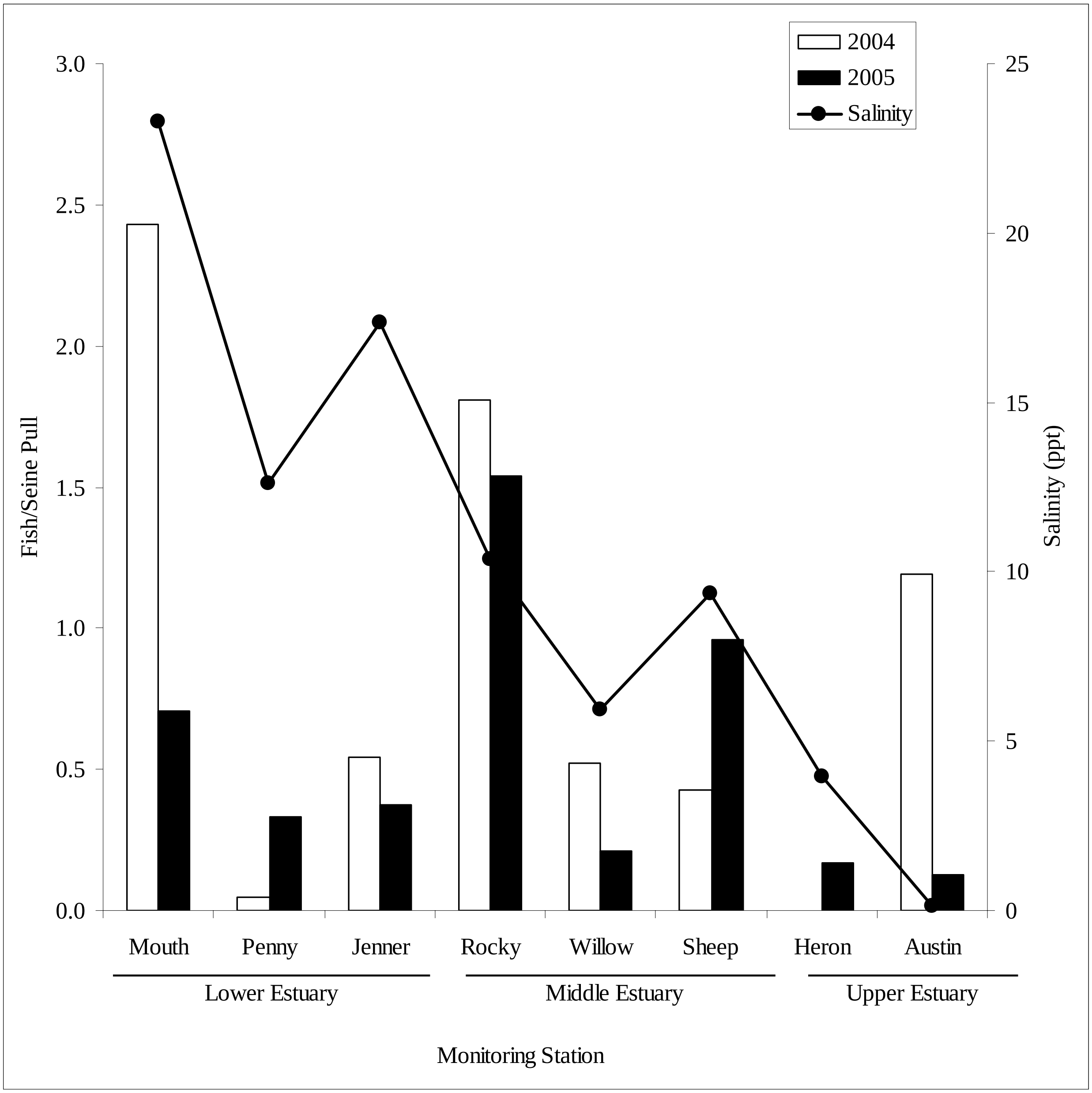

Figure 5: Distribution of Chinook salmon at 8 sample stations in the Estuary, 2004-2005. Salinities are averages collected from the water column at each station.

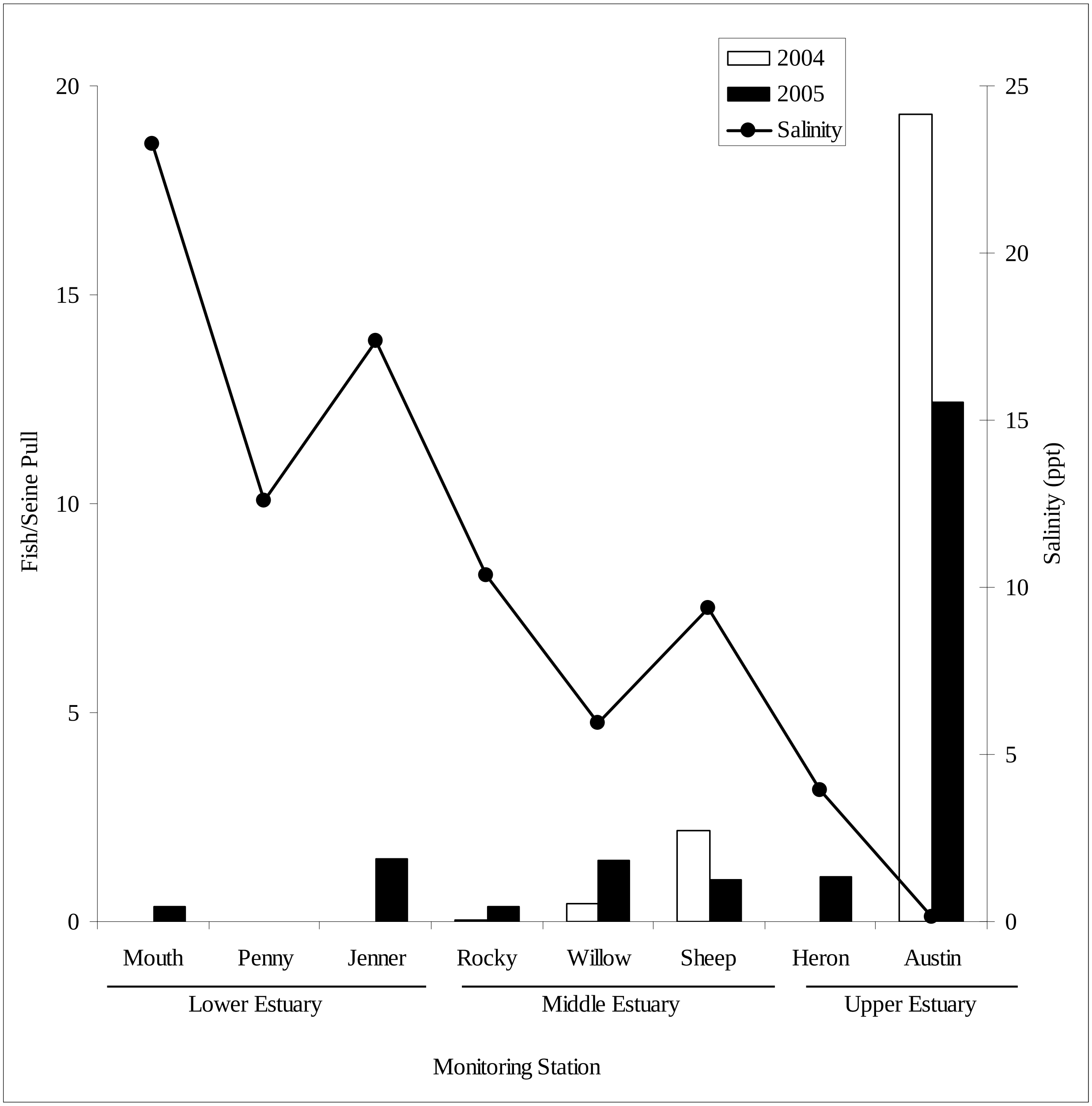

Figure 6: Distribution of steelhead at 8 sample stations in the Estuary, 2004-2005. Salinities are averages collected from the water column at each station.

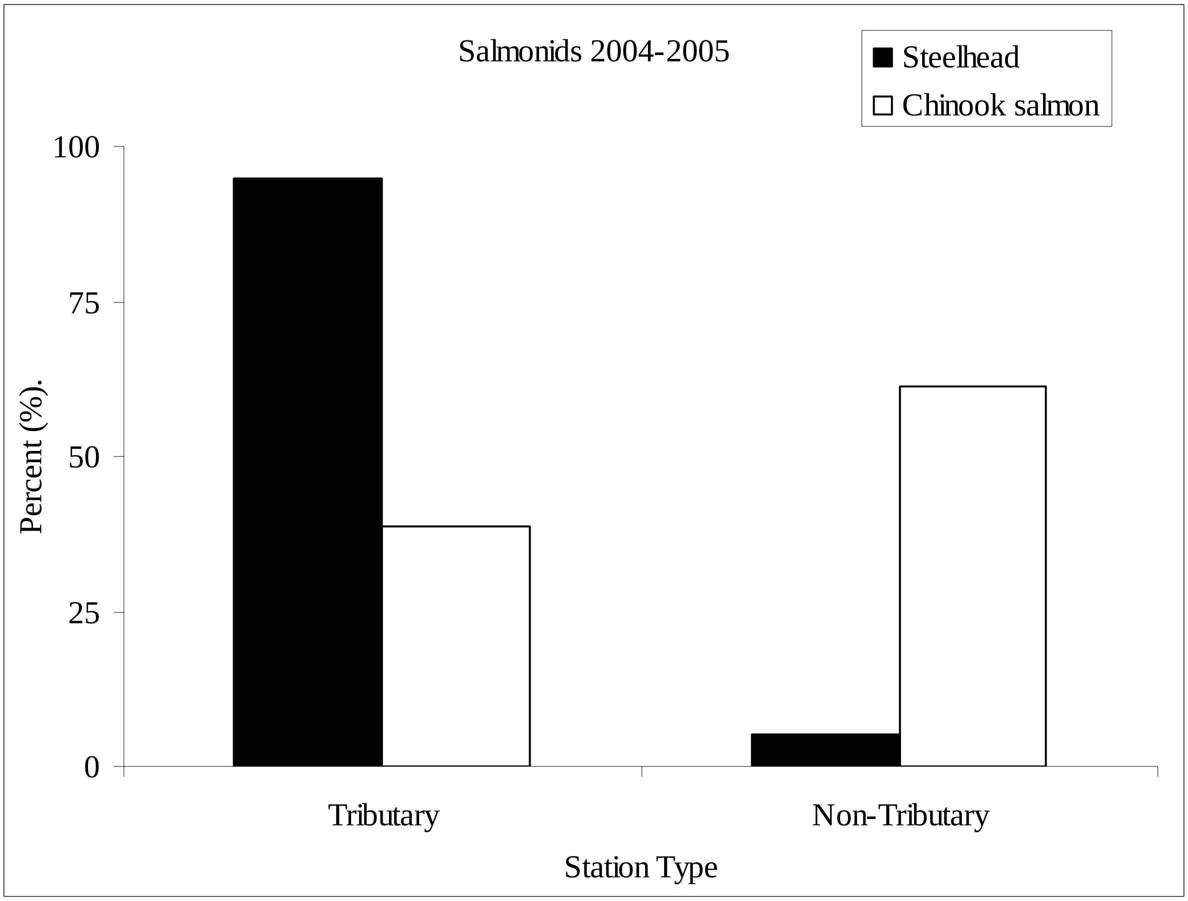

Figure 8: Salmonid occurrence at the confluence of tributary and non-tributary stations in the Estuary, 2004-2005. Sample stations included 4 tributary and 4 non-tributary stations.

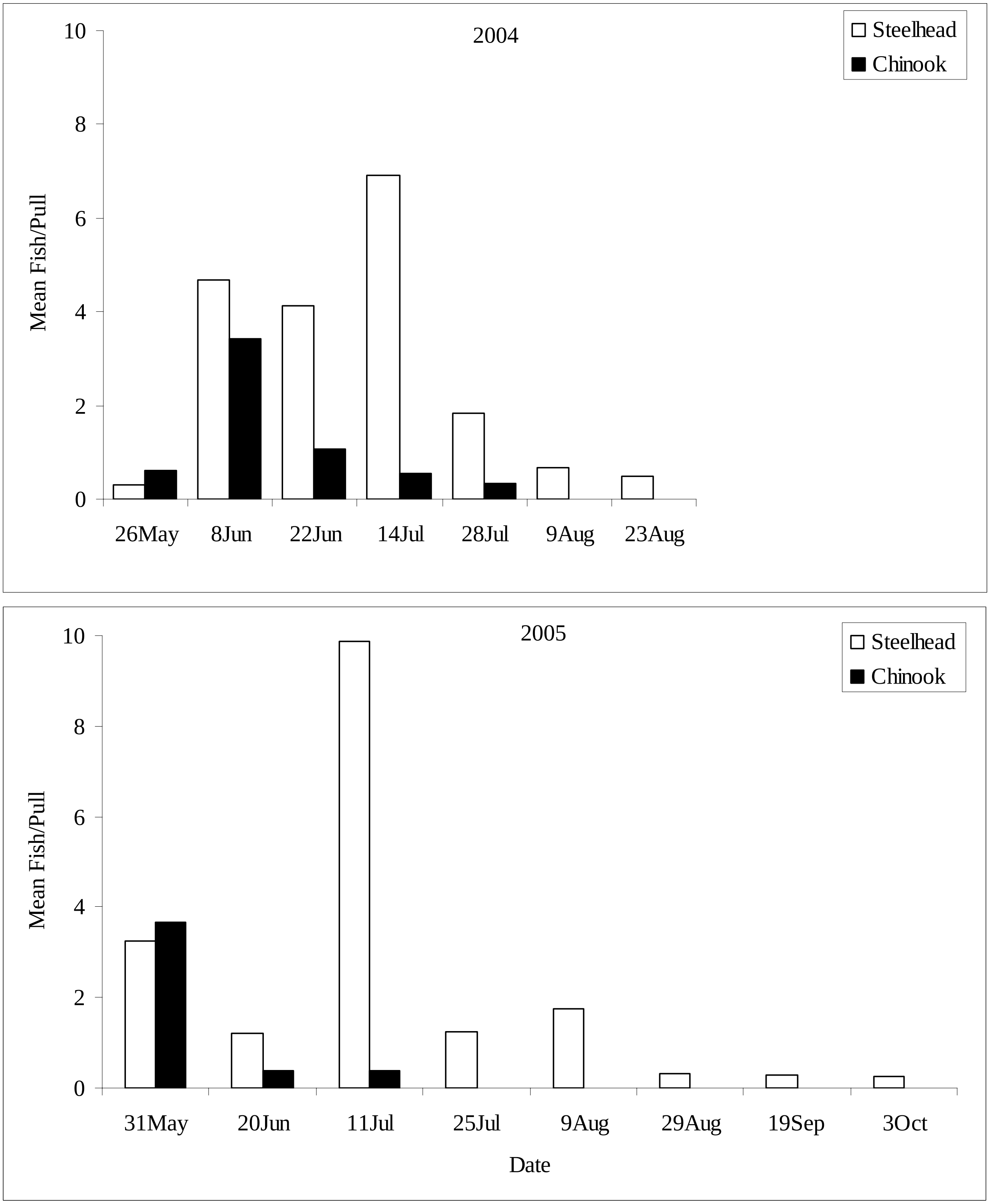

Figure 7: Seasonal abundances of steelhead and Chinook salmon, 2004-2005. Sampling includes 8 stations in the Estuary.

captured throughout summer and their captures peaked in mid-July. This late-summer decrease in numbers suggests that smolts departed from the Estuary and either died, migrated to the ocean, or moved upstream.

Macro-Invertebrate Distribution and Abundance

Three marine crab species and 1 freshwater crayfish species were recorded during 2 years of trapping. Only Dungeness crab (*Cancer magister*) was trapped in 2004. In 2005 three European green crabs (*Carcinus maenus*) and 1 hairy rock crab (*Cancer jordani*) were trapped in addition to Dungeness crab. Fish seining surveys incidentally captured red swamp crayfish (*Procambarus clarkii*) and signal crayfish (*Pacifastacus leniusculus*) at the Austin Creek Station and yellow shore crab (*Hemigrapsus oregonensis*) at the River Mouth Station. Both crayfish species are abundant, but not native to the Russian River watershed. Bay shrimp (*Crangon stylirostris*) were detected at all fish seining stations except Austin Creek.

Dungeness crab prefers sandy to sandy-mud bottoms and range from the intertidal zone to depths greater than 100 m. Adult Dungeness crab spawn in the open ocean. The shrimp-like larvae are planktonic and drift with offshore currents (Morris et al. 1980). Larvae metamorphose into juvenile crabs from April to June and have a similar appearance as adults. Juveniles are bottom dwellers and rear in nearshore coastal waters, including estuaries (Wild and Tasto 1983). At least 2 years of age is required for sexual maturity.

Dungeness crab captures differed substantially between 2004 and 2005 (Figure 10). A total of 26 adult Dungeness crabs were trapped in 2005 and these captures all occurred in August and September (Figure 10). In contrast, 45 adults were trapped in 2004 from May through September. Although adults were absent in spring and early summer 2005, their numbers were similar during both study years in August and September. Adult sizes differed significantly between years during August and September (Carapace width: $\bar{x}_{2004}$ = 148.5 mm, s = 14.9, n = 24; $\bar{x}_{2005}$ = 136.1 mm, s = 15.6, n = 24; t-test: t = 2.817, df = 46, p = 0.007). No juvenile Dungeness crabs were trapped in 2005. In 2004, juvenile crabs were abundant with 1,131 captures from traps deployed from the river mouth to Bridgehaven area. Also, fish seining surveys found juvenile crabs as far upstream as the Sheephouse Creek Station.

Estuary Water Quality

Water quality data was collected at fish and macro-invertebrate stations during each survey (Figure 1). Water conditions were similar in 2004 and 2005, and water quality measurements are included in Cook (2005). The DO, salinity, and temperature results at fish stations during 2005 are shown on Figures 11 through 18. The Estuary showed stratification of water conditions at all stations, except at Austin Creek Station where the conditions were unstratified freshwater. In stratified areas, 2 layers were found and the delineation of layers usually occurred between 0.5 m (1.6 ft) and 1.5 m (4.9 ft) below the water surface. In general, the surface layer had more freshwater influence, warmer temperatures, and similar DO levels. The bottom water layer was primarily cooler seawater with a range of DO levels.

The surface layer consisted of fresh to brackish water with salinities that decreased upstream and temperature that increased upstream. The River Mouth Station had the highest surface salinity in the Estuary at 32.0 ppt on 21 July 2005, although surface salinities were as low as 1.2 ppt at this

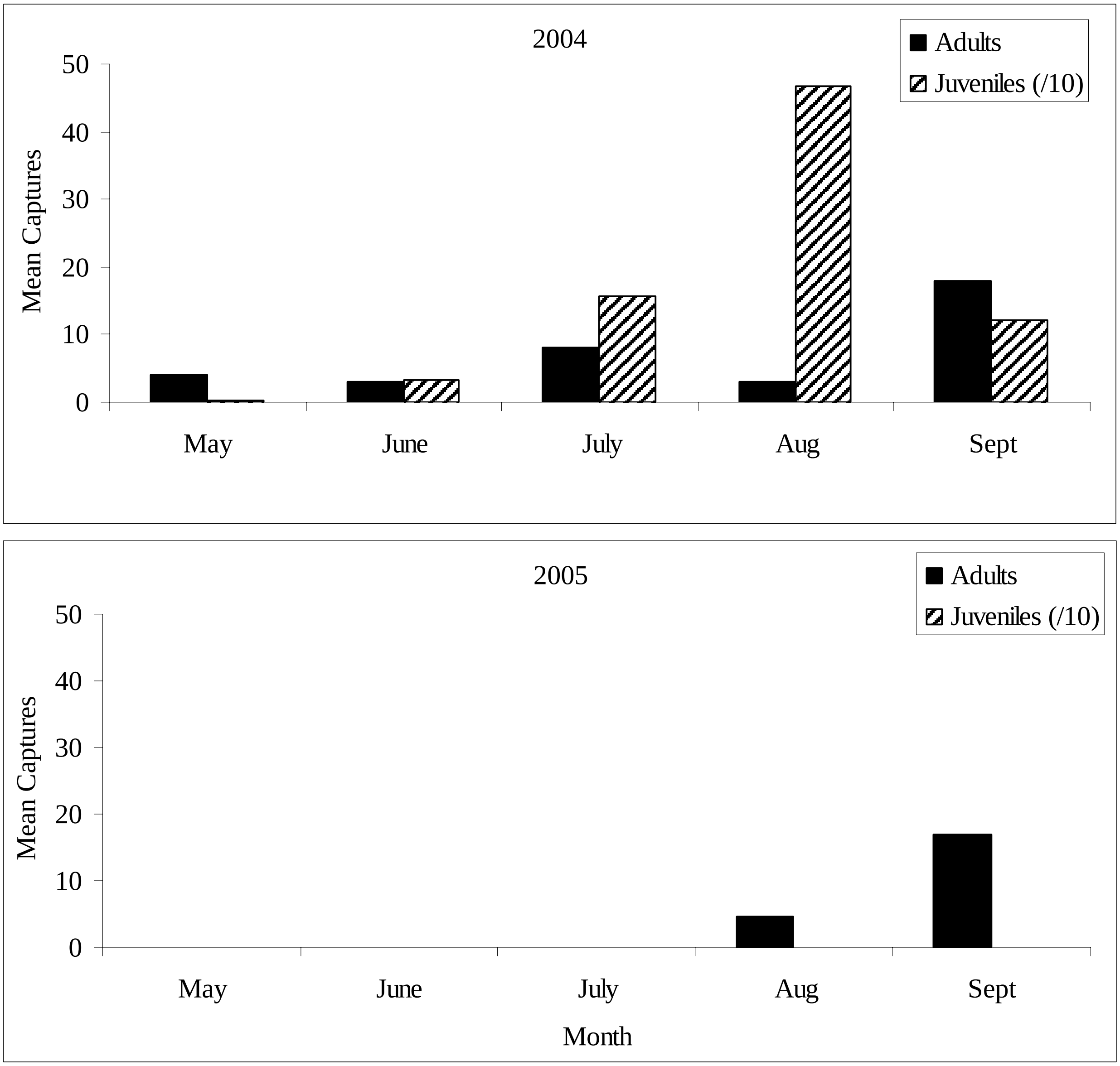

Figure10: Monthly average captures of Dungeness crab in the Estuary during 2004-2005. Each of the 6 trapping stations consisted of 1 crab trap and 1 shrimp trap. Trapping events included 8 in 2004 and 5 in 2005. Juveniles are young of the year crabs. Adults have carapace widths >90 mm. In 2005, 2 crabs with carapace widths of 67 mm and 83 mm were probably aged >1 year and were included in the Adult category.

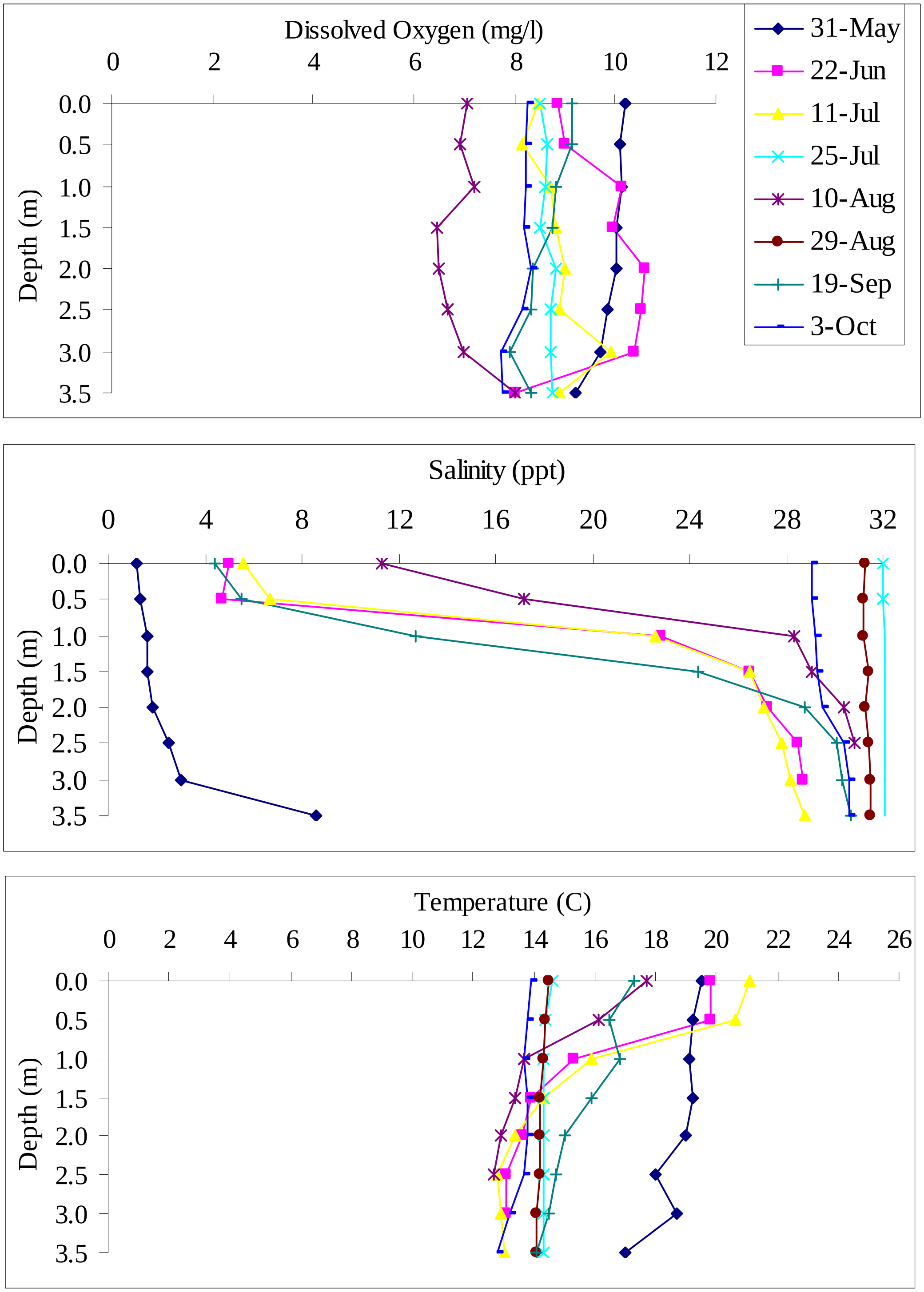

Figure 11: Water quality conditions during fish seining at the River Mouth Station, 2005.

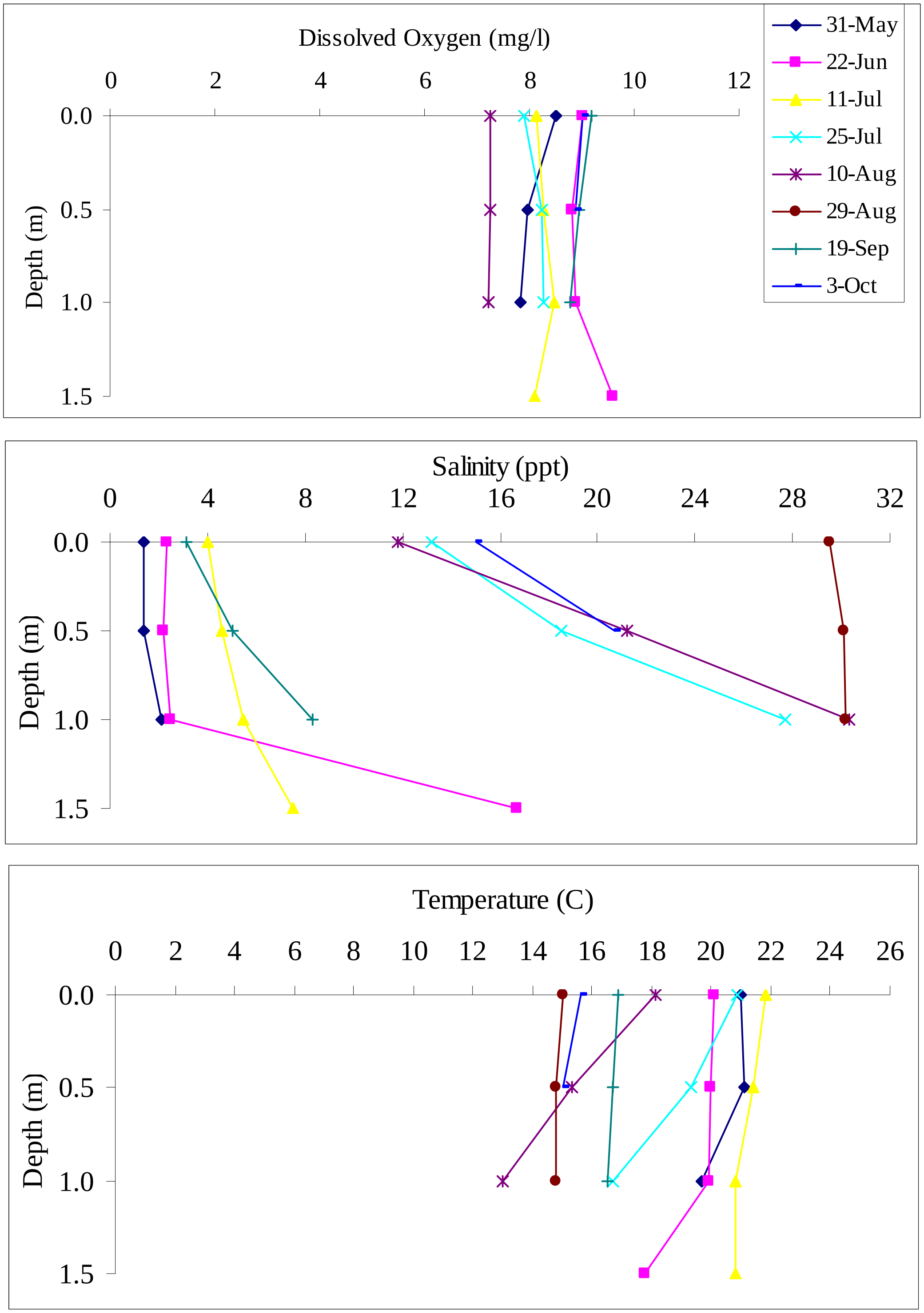

Figure 12: Water quality conditions during fish seining at the Penny Island Station, 2005.

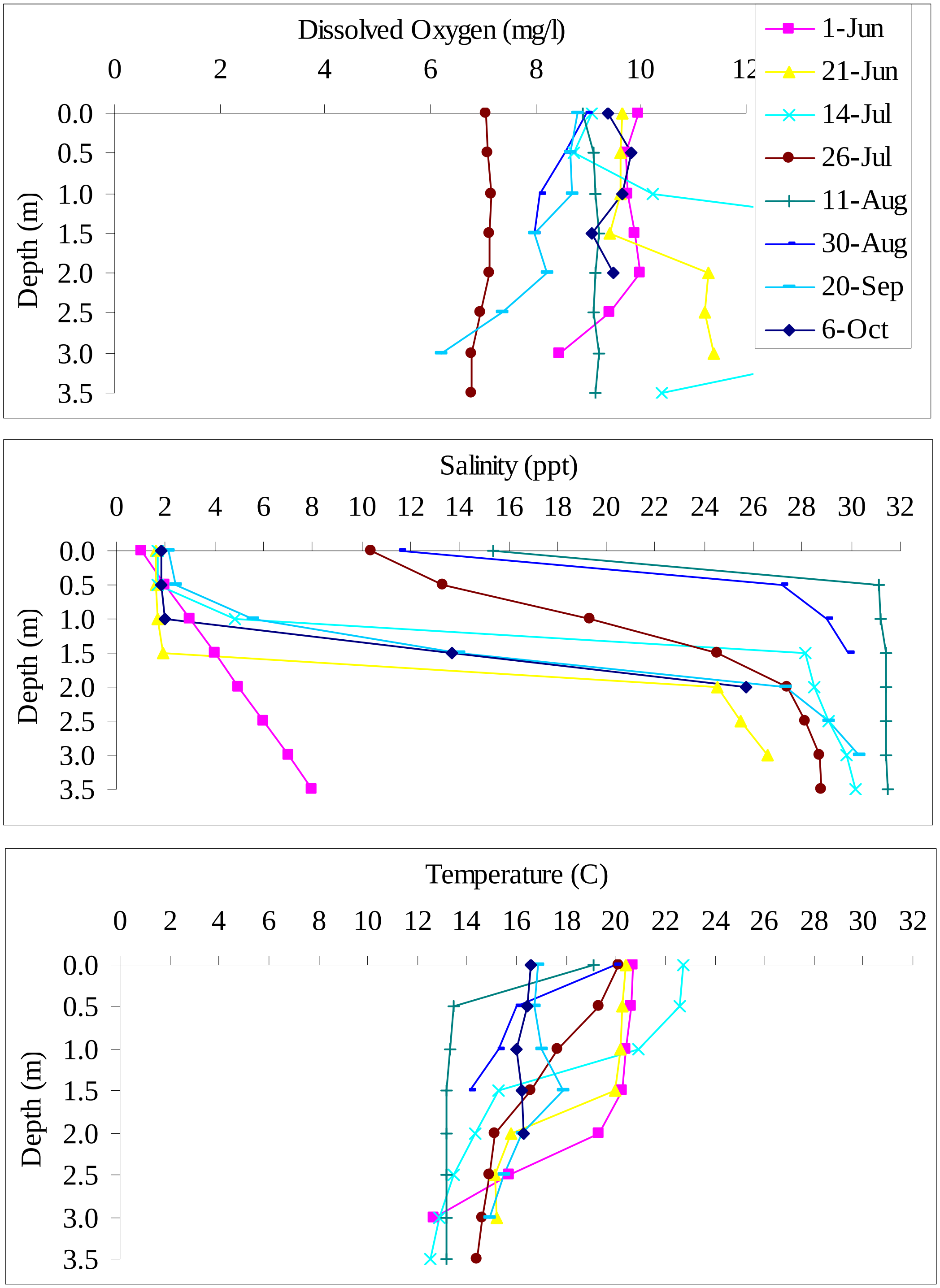

Figure 13: Water quality conditions during fish seining at the Jenner Gulch Station, 2005.

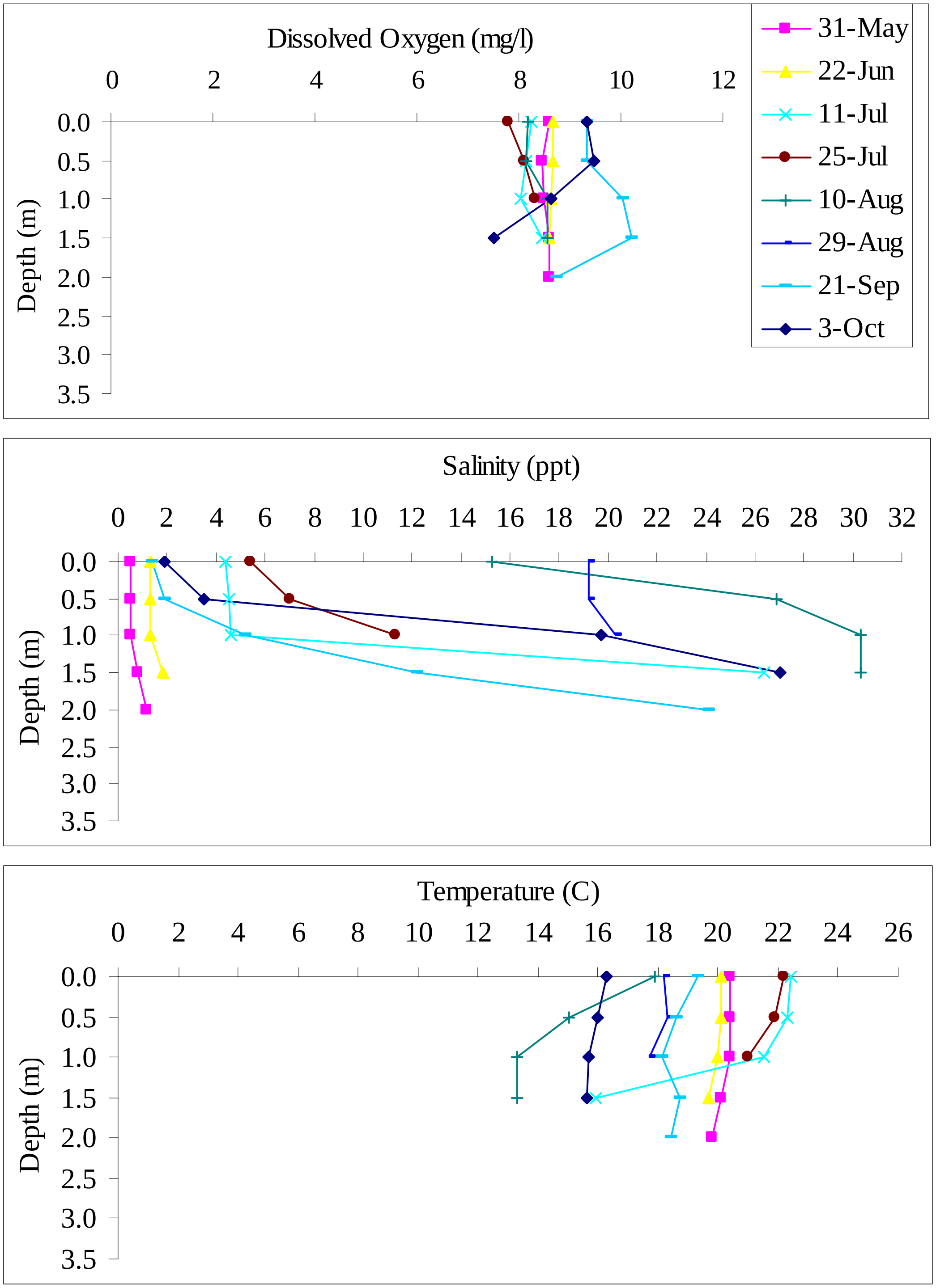

Figure 14: Water quality conditions during fish seining at the Patty Rock Station, 2005.

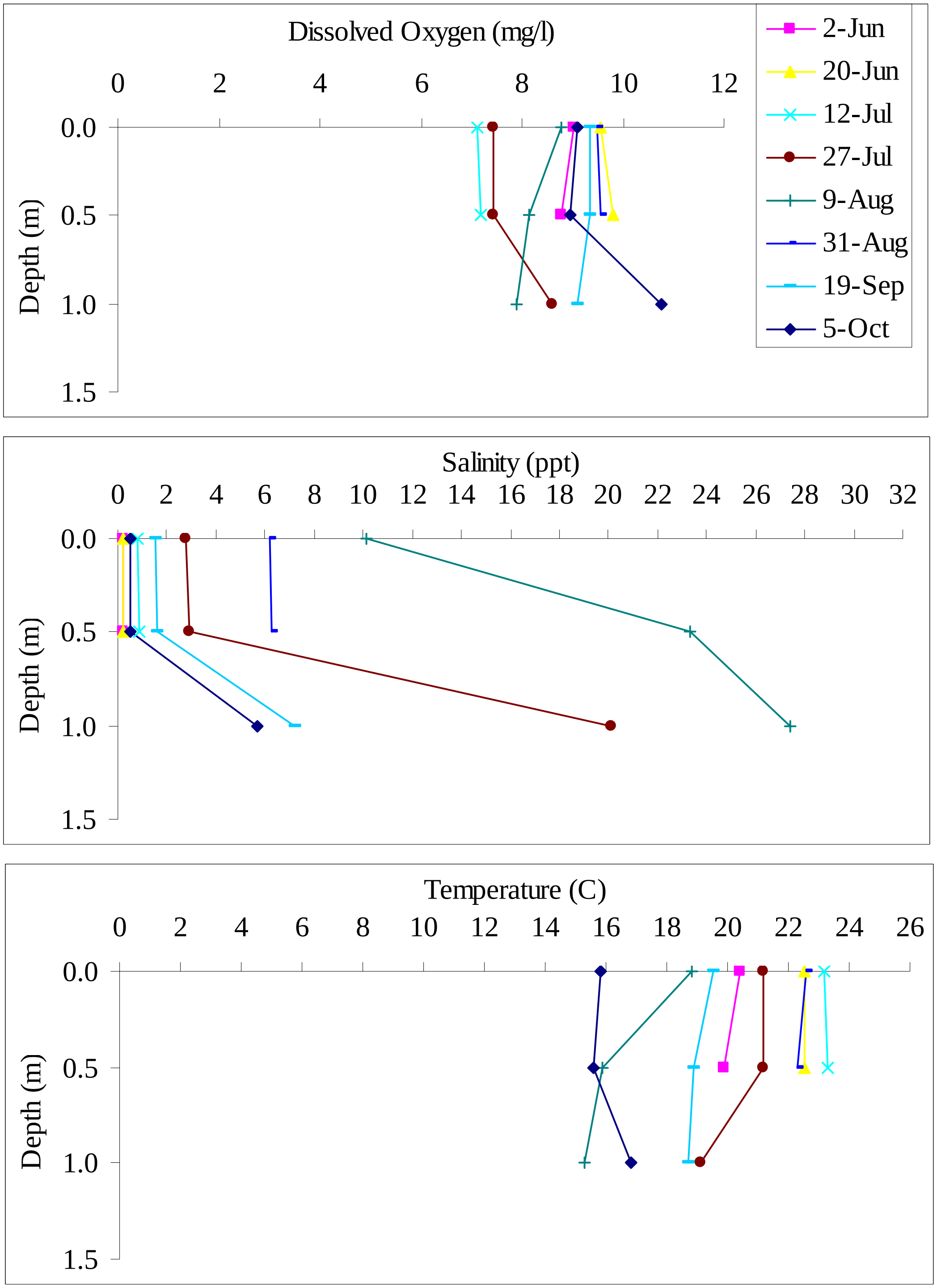

Figure 15: Water quality conditions during fish seining at the Willow Creek Station, 2005.

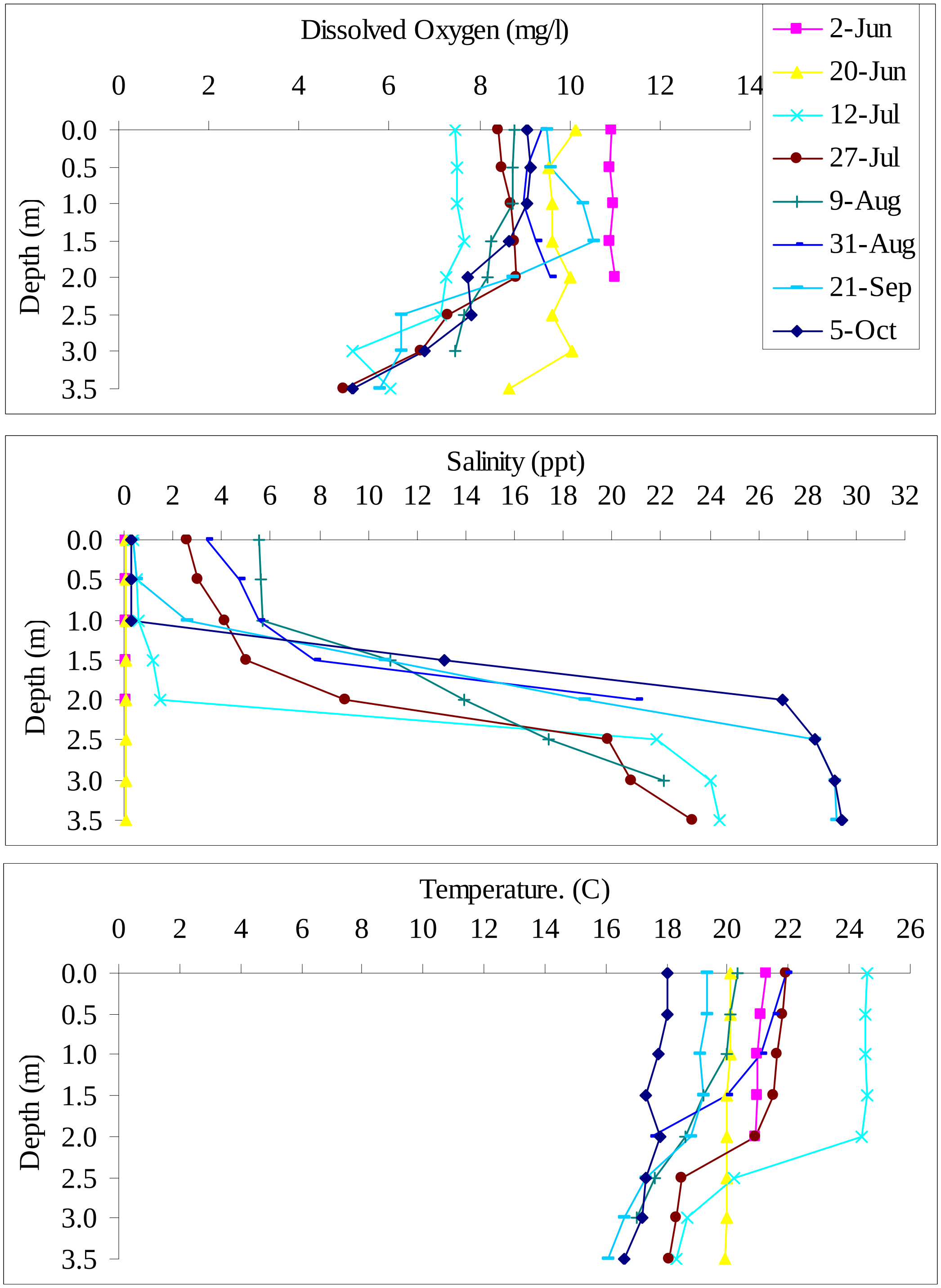

Figure 16: Water quality conditions during fish seining at the Sheephouse Creek Station, 2005.

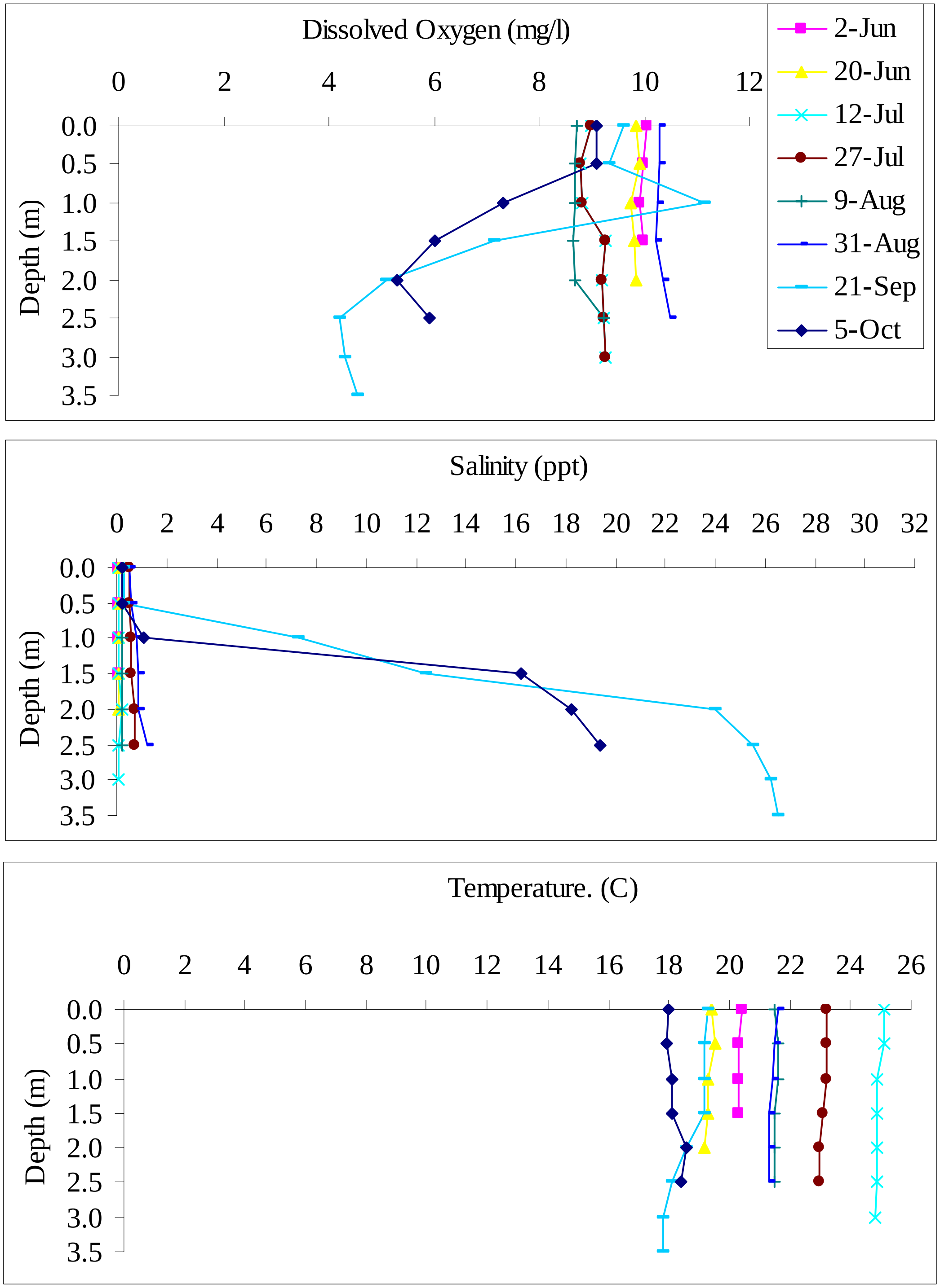

Figure 17: Water quality conditions during fish seining at the Heron Rookery Station, 2005.

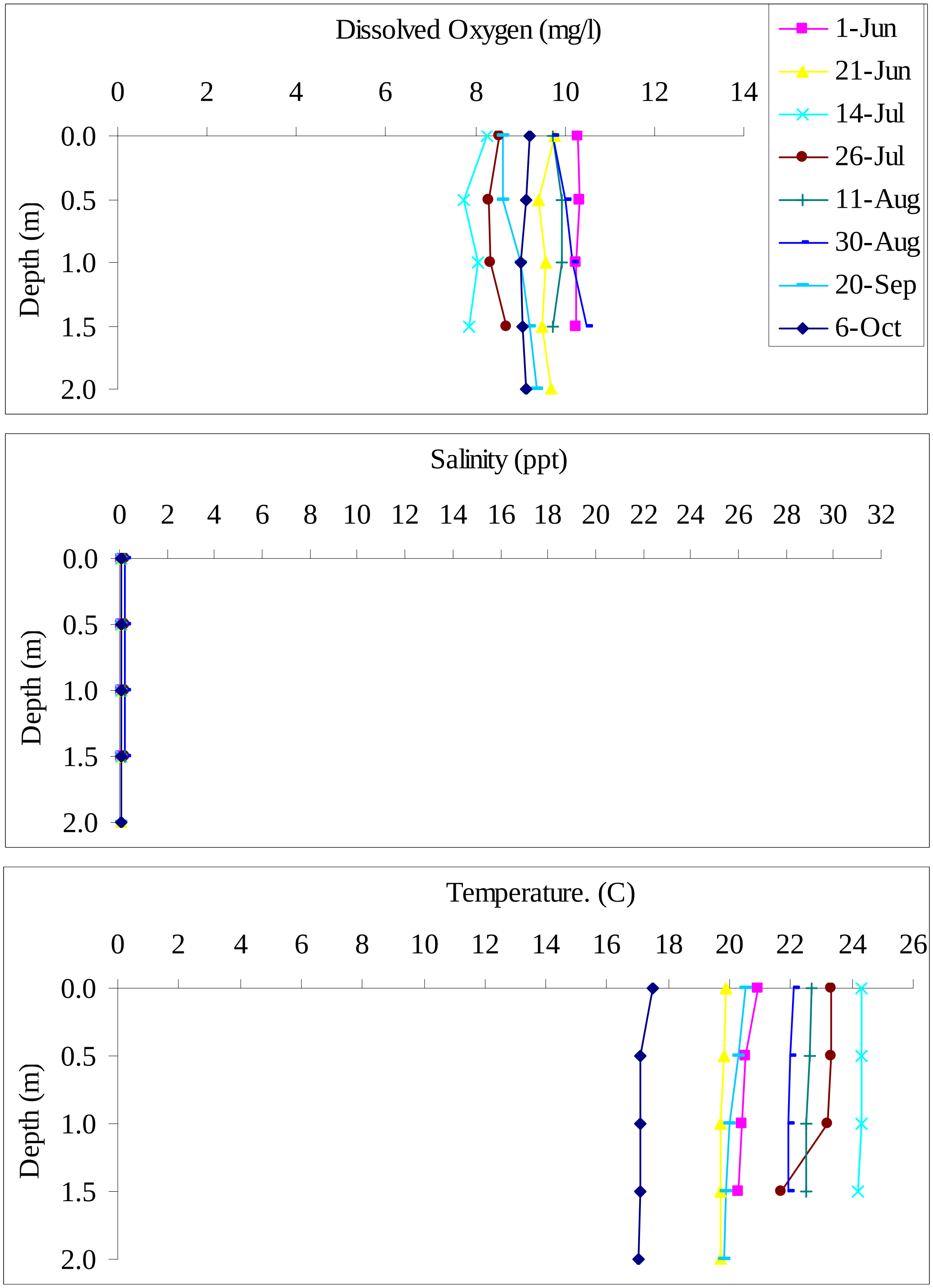

Figure 18: Water quality conditions during fish seining at the Austin Creek Station, 2005

station. Surface brackish water prevailed as far upstream as Sheephouse Creek Station, while surface salinities at the Heron Rookery and Austin Creek stations, located in the upper Estuary, were very low at < 1 ppt. Temperatures at the surface were generally warmer than the bottom layer and increased upstream. Surface temperatures at the River Mouth Station ranged from 13.7 °C to 21.1 °C (56.7 °F to 70.0 °F) and at the Austin Creek Station temperatures were warmer at 17.1 °C to 24.3 °C (62.8 °F to 75.4 °F). DO levels near the surface were usually above 6 mg/l and typically between 7 mg/l and 10 mg/l. This variation in DO was probably related to changing wind and wave action, and tidal cycles.

The bottom strata of water in the Estuary was composed of cooler seawater with salinities usually >24 ppt at stations with depths greater than 2 m. This pattern was observed at all sample stations, except Austin Creek Station that was unstratified freshwater. Stratification was less apparent at Penny Island, Patty Rock, and Willow Creek stations because the depths were shallower than the usual depth of stratification. Bottom temperatures at the River Mouth Station at 12.8 °C to 17.0 °C (55.0 °F to 62.6 °F) were 5 °C to 8 °C cooler than at the Heron Rookery bottom temperatures that ranged from 17.8 °C to 24.8 °C (64.0 °F to 76.6 °F). DO levels at stratified stations varied at the bottom considerably by survey date and station. The lowest DO level was recorded at Heron Rookery at 4.2 mg/l and this station had DO levels twice below 6 mg/l. Sheephouse Creek Station had 4 events when DO levels were below 6 mg/l. Sample stations downstream of Sheephouse Creek Station (River Mouth to Willow Creek stations) always had DO levels >6 mg/l, suggesting that tidal action was sufficient to circulate oxygenated seawater from the ocean to the lower Estuary. There were no river mouth closures and related anoxic conditions, due to poor water circulation, in the Estuary during the 2005 study period. Anoxic conditions in the bottom strata of the Estuary were observed during a mouth closure in 2004 (Cook 2005).

In general, the water conditions observed near the bottom at macro-invertebrate trap stations showed a pattern similar to the fish stations (see Figures 11-18; Figure 19). Most trap stations were located in the center of the Estuary and were typically deeper than at fish stations, which were situated along the shoreline. The depths at trap stations range from 3.0 m to 14.0 (9.8 ft to 45.9 ft). In general, DO, salinity, and temperature gradually increased from 16 June to 20 July, 2005. This pattern is probably related to the decrease in spring river flows into the Estuary, upstream intrusion of seawater, and seasonal increases in temperature. After 20 July conditions remained stable throughout the summer sample period. DO levels ranged from 1.7 mg/l to 12.0 mg/l but were usually above 4.7 mg/l.

DISCUSSION

The results of the 2003-2005 study found a total of 40 fish species from marine, estuarine, and riverine origins. The detection of 5 new fish species in 2005 previously undetected during past field studies (see Cook 2004 and 2005; Martini-Lamb 2001) indicates that the fish fauna of the Estuary remains understudied. The distribution of species was influenced by the salinity gradient in the Estuary that is typically seawater near the mouth of the Russian River and freshwater at the upstream end. Exceptions to this distribution pattern were anadromous fish that occurred throughout the Estuary regardless of salinity levels. Four newly identified species in 2005 are

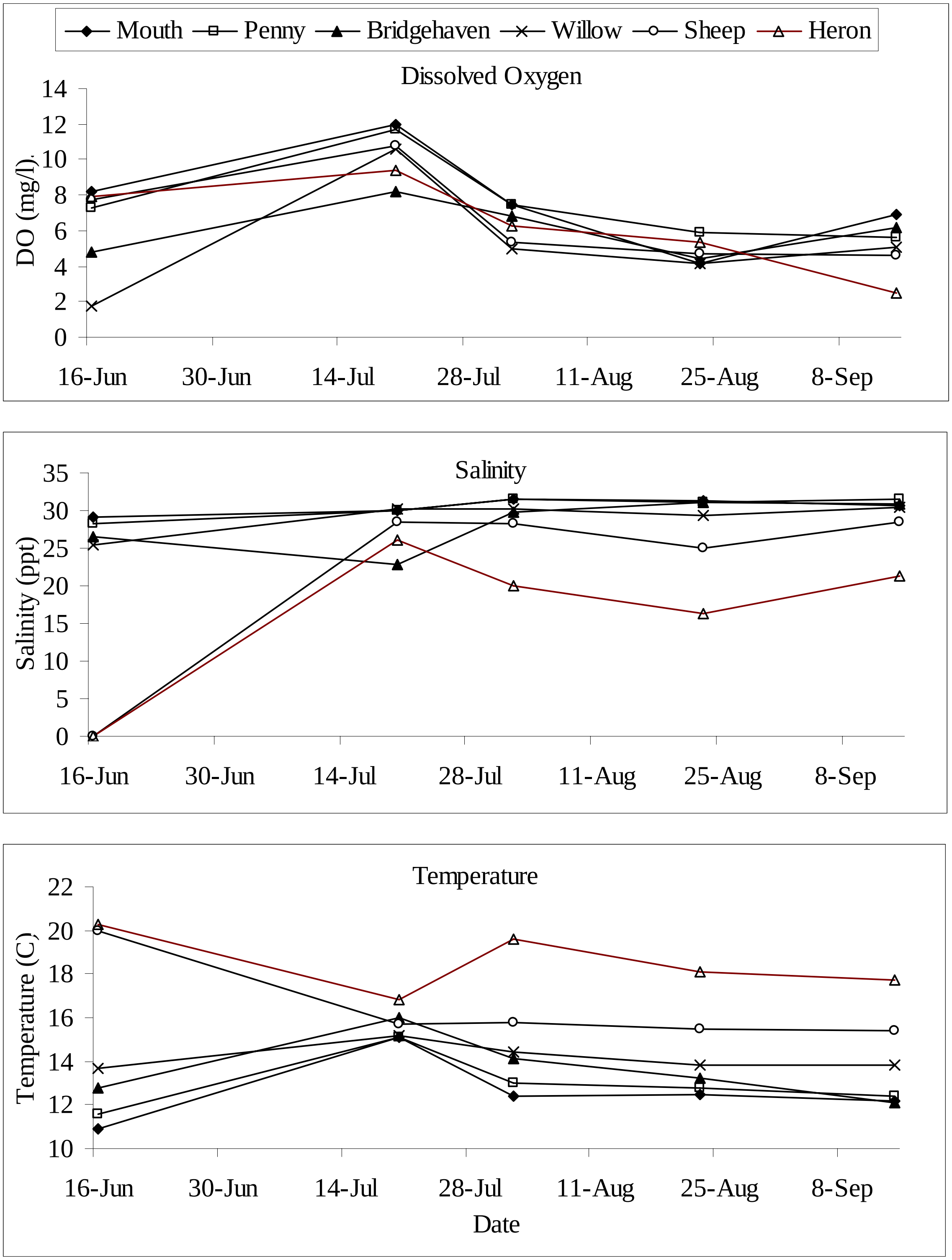

Figure 19: Bottom water quality conditions collected at macro-invertebrate trap stations in the lower Estuary, 2005. The locations of trap stations are shown on Figure 1.

restricted to freshwater habitats and probably originated from the Russian River upstream of the Estuary. These fish probably dispersed to the Estuary due to an unusually large rain event in late May that increased flows and freshwater conditions in the Estuary during the early sample season.

The distribution and abundance of salmonids rearing in the Estuary differed spatially, temporally, and by species. Although Chinook salmon smolts were more frequently found in non-tributary habitats, they occurred throughout the Estuary in all habitat types sampled. Also, Chinook salmon smolts spent less than half the summer rearing in the Estuary. In comparison, steelhead were found during the entire summer and were restricted to the middle and upper Estuary. Steelhead were usually found at the confluences with tributaries. A possible explanation for this distribution is that creek mouths are sources of cool, freshwater that steelhead use as refuge. Cannata (2003) and Smith (1990) found that freshwater lagoons are more productive rearing habitat for salmonids than estuaries. However, additional studies on growth rates and habitat use of salmonids in the Estuary should be conducted to further assess trends.

The Austin Creek Station consistently had relatively high abundances of fish, including steelhead, during 2004 and 2005. This station was not inundated by seawater during the study and received cool freshwater from the perennial Austin Creek. Due to the lack of saline influences this station is more characteristic of freshwater tributaries of the Russian River and not an estuarine environment.

The 2004 data indicated that the Estuary is a nursery for juvenile Dungeness crabs; however, no juveniles were caught in 2005. This bust or boom pattern can be explained by atypical winter ocean temperatures and currents in 2005. These ocean conditions probably affected larval Dungeness crab survival and migration to inshore areas and estuaries. A similar pattern occurred in the San Francisco Bay, which is an important nursery for young Dungeness crab, where no juveniles were recorded in 2005 (pers. comm. Kathy Hieb, California Department of Fish and Game).

The European green crab is an invasive species that was first introduced to the San Francisco Bay in the 1980s and since has invaded other Pacific Coast estuaries. This crab has decimated fisheries on the east coast. The capture of 3 individuals in 2005 is the first known occurrence in the Estuary and this species may become established with unknown consequences to the native fishery. Further studies of the abundance and distribution of this species in the Estuary would be helpful in managing this species and conserving natives.

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