RUSSIAN RIVER ESTUARY FISH AND MACRO-INVERTEBRATE STUDIES, 2004

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 Oceanic and Atmospheric Administration Fisheries Service (NOAA Fisheries), 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 NOAA Fisheries, 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 NOAA Fisheries, 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 first-year results of fish and macro-invertebrate studies of the Estuary conducted during 2004. 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 presented in Cook (2004) has 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, five to seven 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 two 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 two management scenarios, one for Low-flow Estuary Management and one 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 two 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 sand bar 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 (sand bar 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

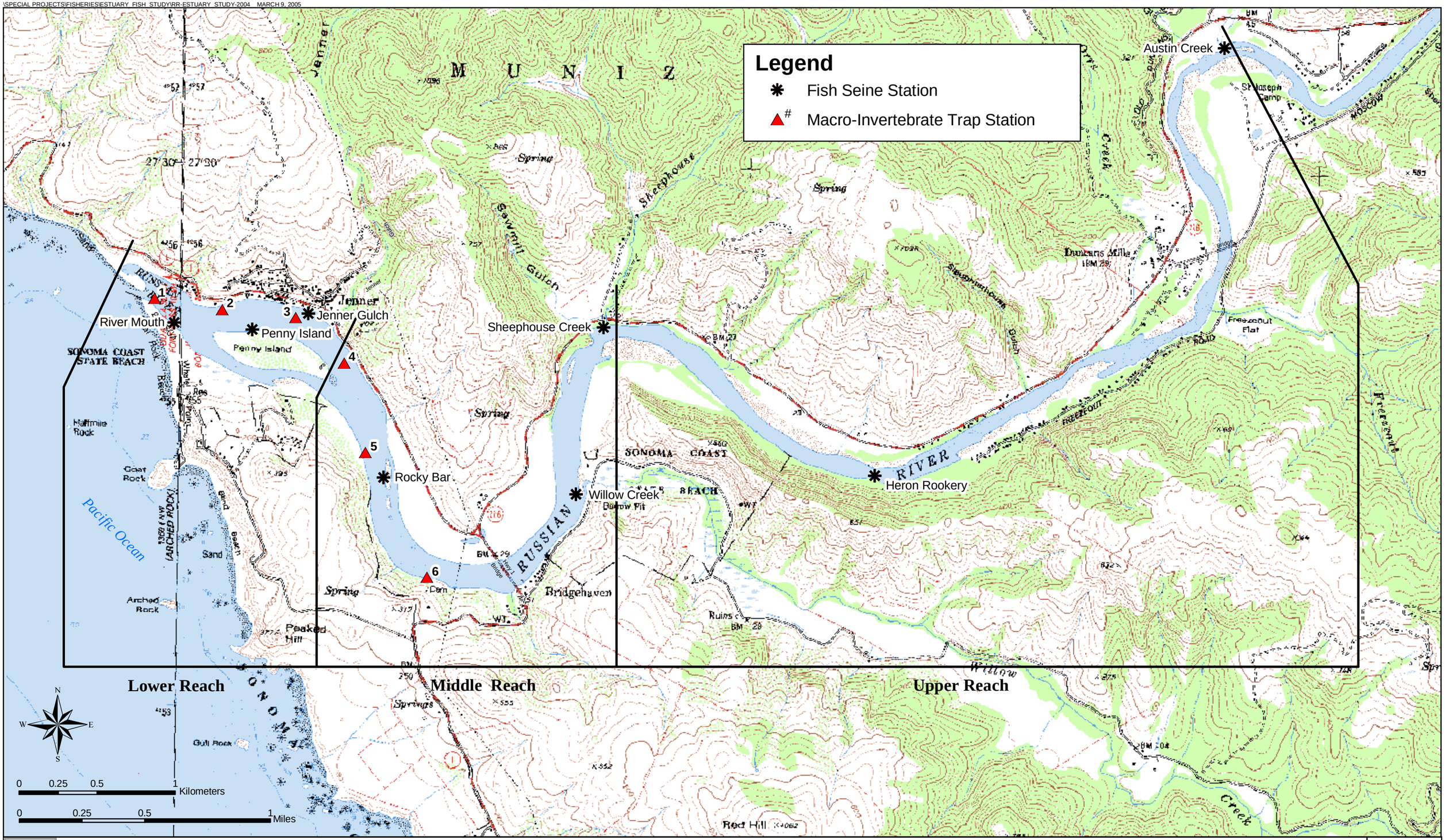
vertically in the water. The purse seine was deployed with a crew of four using a boat to pull one end offshore and then around in a half-circle while the other end was held onshore. Once the ends of the seine were brought together at the shore the purse line was pulled and the net was hauled onshore by hand. A rope through the metal rings when drawn closed, which "pursed" the seine and prevented fish from escaping underneath the net. 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 for later 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 on 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 two weeks and during different tidal cycles from 24 May through 26 August, 2004. 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.
- 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 Estuary. Six trap stations were located between the Russian River mouth and the Highway 1 bridge at Bridgehaven in a variety of habitat types based on substrate type (e.g., mud, sand, gravel, rock) (Figure 1). Trapping was conducted approximately every two weeks from 18 May to 1 September, 2004. Each station included one shrimp trap and one crab trap baited with fish parts. Deployed traps were retrieved after two days. Captured invertebrates were identified to species,



Russian River Estuary
Study Area and Survey Sites, 2004

This Map is for general reference only.

Figure 1

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 2004 study report includes preliminary first-year results. 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
A total of 31 fish species were caught in the Estuary during 2004 (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 seven years of these studies. The Estuary study in 2003 (Cook 2004) found 21 fish species, including four new species previously undetected, and the 2004 study found an additional four new species.

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 several rockfish (*Sebastes* spp). The middle Estuary had a broad range of salinities and a diversity of fish tolerant of these conditions. Common fish in the middle Estuary were shiner surfperch (*Cymatogaster aggregata*), three-spine stickleback (*Gasterosteus aculeatus*), and starry flounder (*Platichthys stellatus*). Freshwater dependent species, such as the Russian River tuleperch (*Hysterocarpus traskii pomo*), Sacramento sucker (*Catostomus occidentalis*), and California roach (*Hesperoleucus symmetricus*) were distributed in the upper Estuary with only freshwater species occurring at the Austin Creek station. Anadromous fish, such as steelhead (*Oncorhynchus mykiss*) and American shad (*Alosa sapidissima*), that are tolerant of both freshwater and seawater, occurred throughout the Estuary. The Jenner Gulch station had the highest fish diversity at 23 species, probably due to a higher diversity of habitat features at this station. Twelve species were marine species usually found in seawater. The River Mouth and Penny Island stations, located closer to the ocean, had fewer marine species than Jenner Gulch.

The highest relative abundance of fish was found at Jenner Gulch station with a capture rate of 328 fish/pull (Figure 3). A possible explanation for this fish abundance pattern is the higher diversity of habitat features at this station. Upstream of the Jenner Gulch station fish abundance decreased to 72 fish/pull at Rocky Bar station and then gradually increased with the second highest capture rate of 178 fish/pull at Austin Creek station.

Table 1: Fish species caught in the Russian River estuary

			Present		Mean Fish Captures/seine pull							
Family	**Scientific Name**	**Common Name**	**2003[1]**	**2004**	**Mouth**	**Penny**	**Jenner**	**Rock**	**Willow**	**Sheep**	**Heron**	**Austin**
Atherinidae	*Atherinops affinis*	Topsmelt	X	X	1.62	3.52	3.67	5.86	4.38	0.67		
	Atherinops californiensis	Jacksmelt*	X									
Carangidae	*Trachurus symmetricus*	Jack mackerel*	X									
Catostomidae	*Catostomus occidentalis*	Sac. sucker	X	X	0.19	0.19	0.48	2.76	19.95	2.14	92.00	50.76
Centrarchidae	*Lepomis cyanellus*	Green sunfish		X								0.05
Clupeidae	*Alosa sapidissima*	American shad*	X	X		0.05	0.52	0.86	0.71	3.52	13.14	5.52
	Etrumeus teres	Round herring*	X									
	Micropterus dolomieui	Pacific herring	X	X	0.76	0.14	108.48	2.71	0.43	0.43	0.14	
	Sardinops sagax caeruleus	Pacific sardine*		X				0.14				
Cottidae	*Artedius lateralis*	Smoothhead sculpin		X			0.04					
	Cottus asper	Prickly sculpin	X	X	0.71	6.10	89.37	12.00	36.38	27.57	9.10	25.43
	Enophrys bison	Buffalo sculpin		X	1.57		0.07					
	Leptocottus armatus	Staghorn sculpin	X	X	3.52	8.05	3.67	2.67	1.62	0.43	0.05	
	Oligocottus maculosus	Tidepool sculpin*		X		0.05						
	Scorpaenichthys marmoratus	cabezon		X			0.04					
	Sebastes spp	rockfish (juv)	X	X	0.43	0.05	8.22					
Cyprinidae	*Hesperoleucus symmetricus*	California roach	X	X								9.62
	cyprinid	unidentified larvae		X								0.14
	Lavinia exilicauda	Hitch*		X						0.43		
	Ptychocheilus grandis	Sac. pikeminnow	X	X								0.29
Embiotocidae	*Cymatogaster aggregata*	Shiner surfperch	X	X		0.05	1.78		17.43	5.52		
	Hysterocarpus traskii pomo	Russian River tuleperch	X	X	0.05		0.04	0.05			0.10	30.67
Engraulididae	*Engraulis mordax*	Northern anchovy	X	X			0.04					

			Present		Mean Fish Captures/seine pull							
Family	**Scientific Name**	**Common Name**	**2003[1]**	**2004**	**Mouth**	**Penny**	**Jenner**	**Rock**	**Willow**	**Sheep**	**Heron**	**Austin**
Gasterosteidae	*Gasterosteus aculeatus*	Threespine stickleback	X	X	0.43	0.43	48.04	36.86	10.19	39.43	20.05	25.62
Hexagrammidae		Greenling (juv) species		X			0.04					
Hexagrammidae	*Ophiodon elongatus*	Lingcod		X			0.19					
Liparididae	*Liparis sp*	Snailfish species*		X								
Osmeridae	*Hypomesus pretiosus*	Surf smelt	X	X	46.62	0.81	11.56	0.81		0.14		
Pleuronectidae	*Platichthys stellatus*	Starry flounder	X	X	19.43	6.00	10.37	4.95	15.76	14.52	10.52	9.48
Pholididae	*Apodichthys flavidus*	Penpoint gunnel	X	X			0.04					
	Pholis ornata	Saddleback gunnel	X	X		0.05	0.52					
Salmonidae	*Oncorhynchus mykiss*	Steelhead	X	X				0.05	0.43	2.19		19.43
	Oncorhynchus tshawytscha	Chinook salmon		X	2.43	0.05	0.96	1.81	0.52	0.43		1.10
Syngnathidae	*Syngnathus leptorhyncus (griseolineatus)*	Bay pipefish	X	X			0.26	0.05	0.19	0.19	0.19	
		Total Species	**22**	**31**								

[1] Species observed during 2003 surveys (Cook 2004)

*Species previously unidentified in the Estuary (Martini-Lamb 2001)

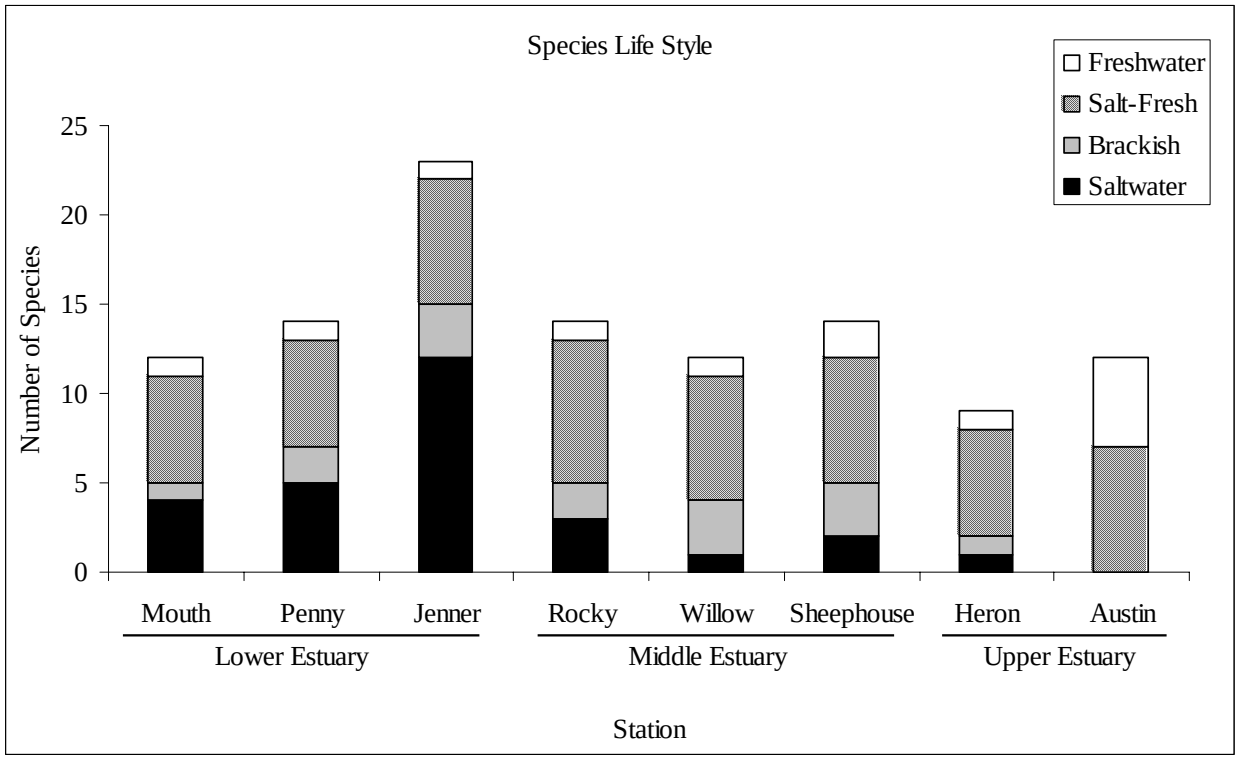


Figure 2: Fish species abundance based on salinity tolerance.

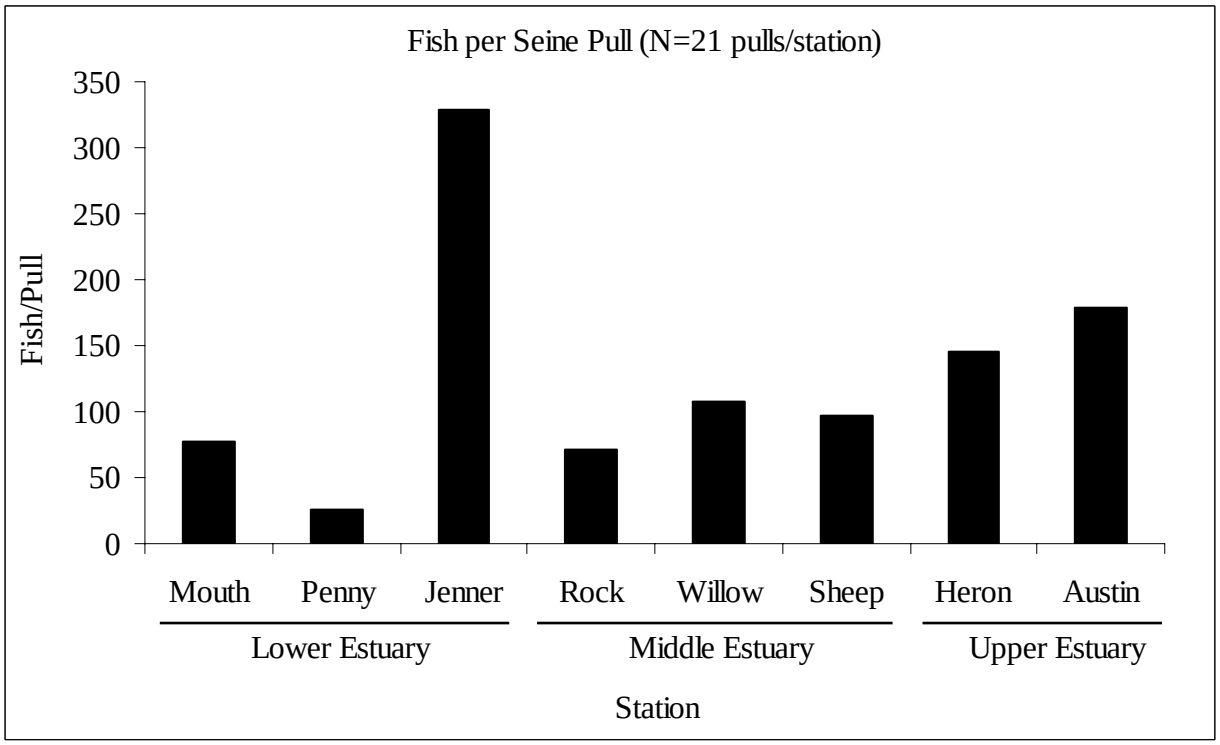


Figure 3: Mean number of fish caught per seine pull at stations. Each station had 21 seine pulls.

A total of 462 steelhead and 148 Chinook salmon were captured in the Estuary from 24 May through 26 August 2004. Captured steelhead were parr and smolts with an average fork length of 147 mm $\pm$ 55.2 (SD), n = 377. In general, steelhead sizes increased during early summer until 14 July and then decreased until the end of the study on 26 August (Figure 4). This late-summer decrease in size suggests that larger smolts departed from the Estuary and either migrated to the ocean or moved upstream. Out of 381 steelhead inspected, seven (1.8%) smolts had a clipped adipose fin indicating a hatchery origin. The largest steelhead was a hatchery fish with a fork length of 330 mm caught on 14 July at Austin Creek station. The largest wild steelhead was 320 mm caught at Sheephouse Creek station on 24 August 2004. Chinook salmon smolt sizes gradually increased during the summer study period and had an average fork length of 103.3 mm $\pm$ 10.0 (SD), n = 142 (Figure 5).

The distribution of salmonids in the Estuary varied by species, habitat, and season. Chinook salmon were distributed throughout the Estuary with captures at every sample station except the Heron Rookery station (Figure 6). Captures were highest at the River Mouth station with 51 smolts. In comparison, steelhead distribution was limited to the middle and upper Estuary. Steelhead numbers progressively increased upstream. One steelhead was captured at Rock Bar station and 408 steelhead were captured at the Austin Creek station comprising 87.9% of all steelhead captures. In addition, the distribution of both species differed by habitat feature (Figure 7). Steelhead were captured almost exclusively (99.8%) at the confluence with tributaries, while 38.4% of Chinook salmon were at tributaries. The abundance of Chinook salmon peaked during early-June and none were captured after 28 July (Figure 8). Steelhead were captured throughout summer and their numbers peaked in mid-July.

Macro-Invertebrate Distribution and Abundance

Dungeness crab (*Cancer magister*) was the only macro-invertebrate trapped during our surveys. Trapping occurred from 18 May through 1 September, 2004. Fish seining surveys incidentally captured red swamp crayfish (*Procambarus clarkii*) and signal crayfish (*Pacifastacus leniusculus*) at the Austin Creek station. Both species are 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 two years of age is required for sexual maturity.

Dungeness crab was captured at all trap stations but adult crabs were captured in far fewer numbers then juveniles (Figures 1 and 9). Forty-five adults were trapped compared to 1,313 juveniles. The distribution of juveniles extended from the mouth to the Bridgehaven area and in general their numbers increased upstream. During fish seining surveys juvenile crabs were found as far upstream as the Sheephouse Creek station. Juvenile crab body size doubled during the summer. Juveniles on 16 June had an average carapace width of 30.7 mm $\pm$ 8.3 (n = 46) and a

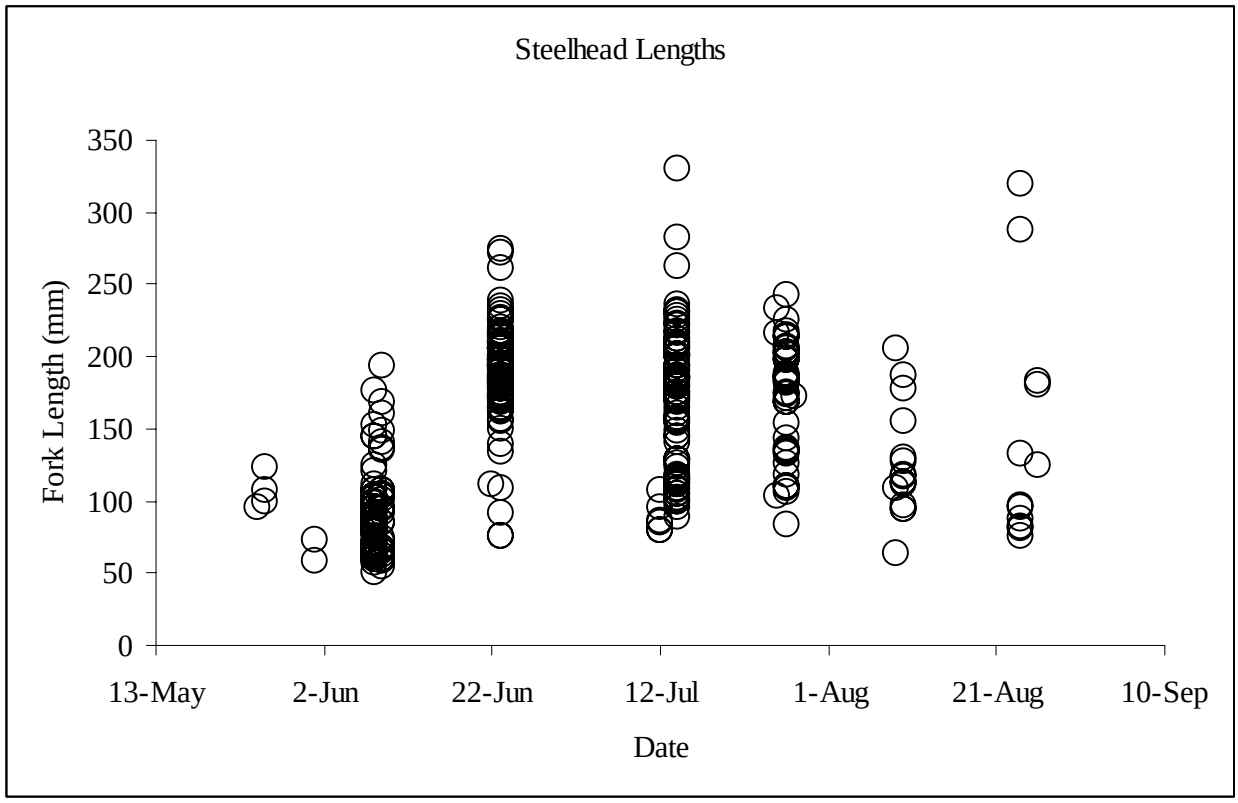


Figure 4: Distribution of steelhead lengths.

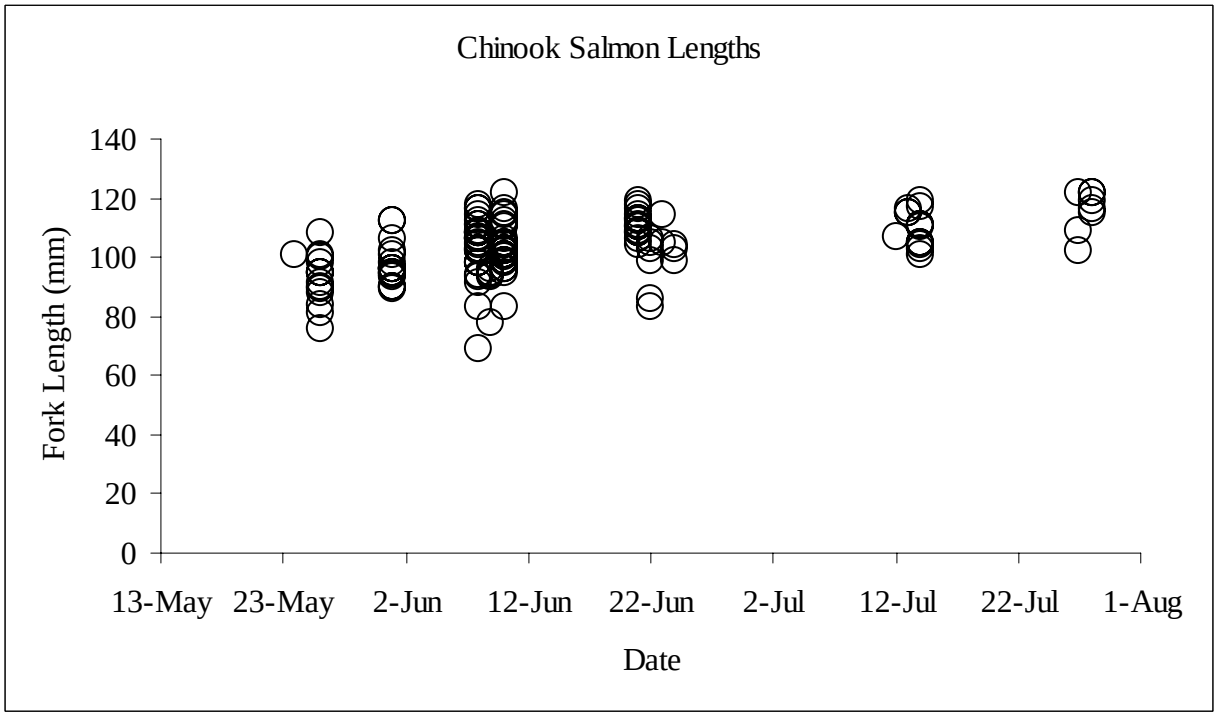


Figure 5: Distribution of Chinook salmon lengths.

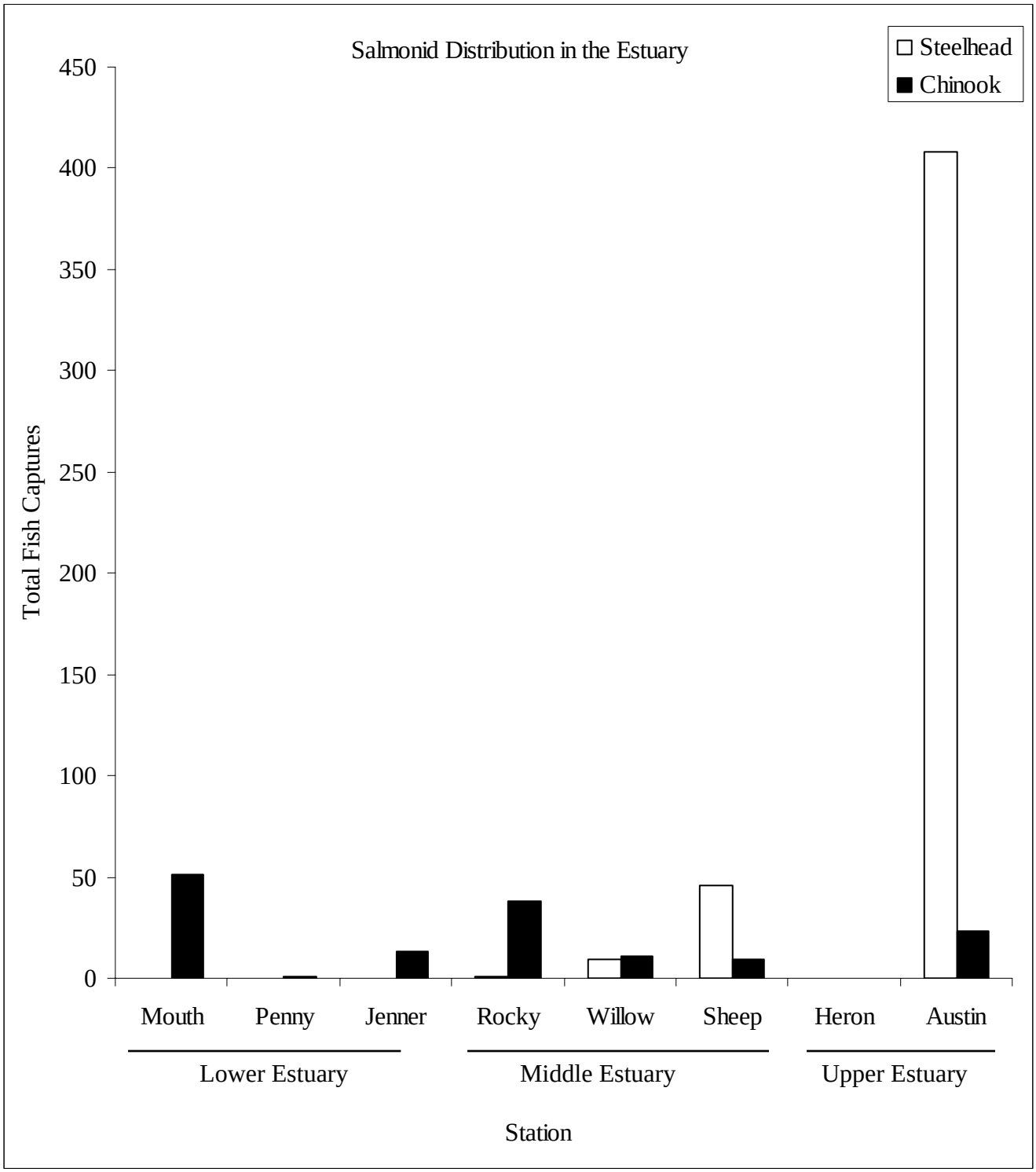


Figure 6: Distribution of salmonids in the Estuary. Total fish captures during the study are shown.

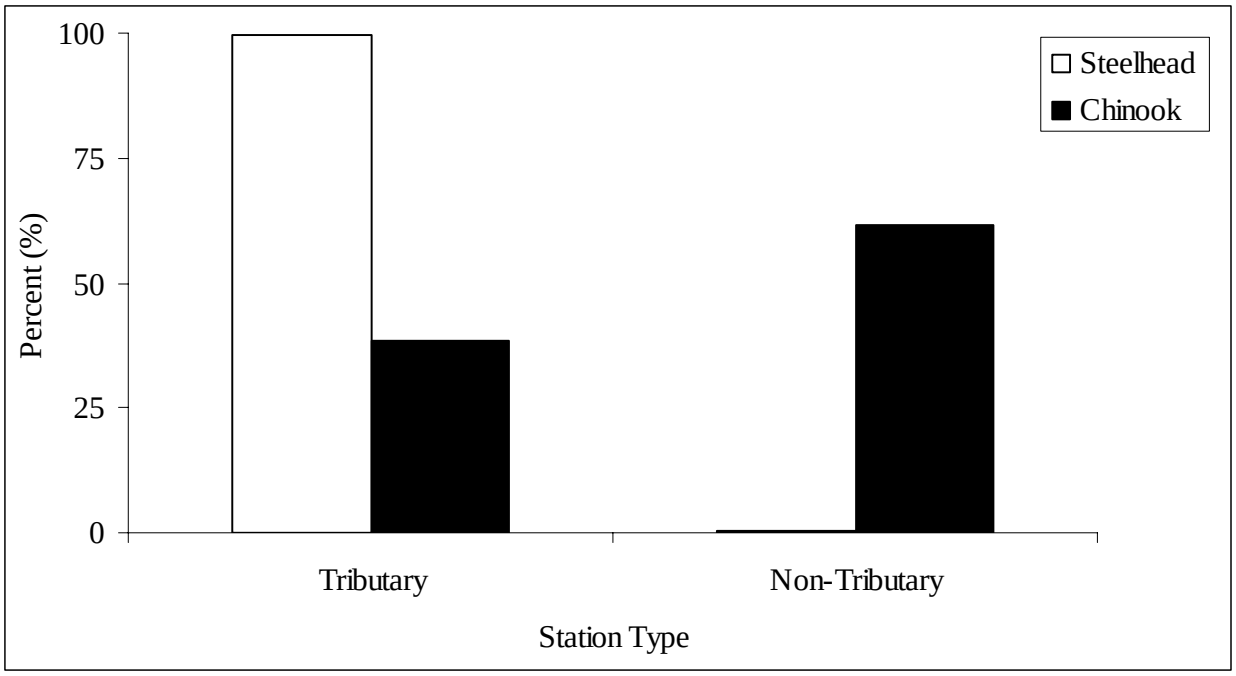


Figure 7: Salmonid occurrence at the confluence of tributary (n = 4) and non-tributary (n = 4) stations.

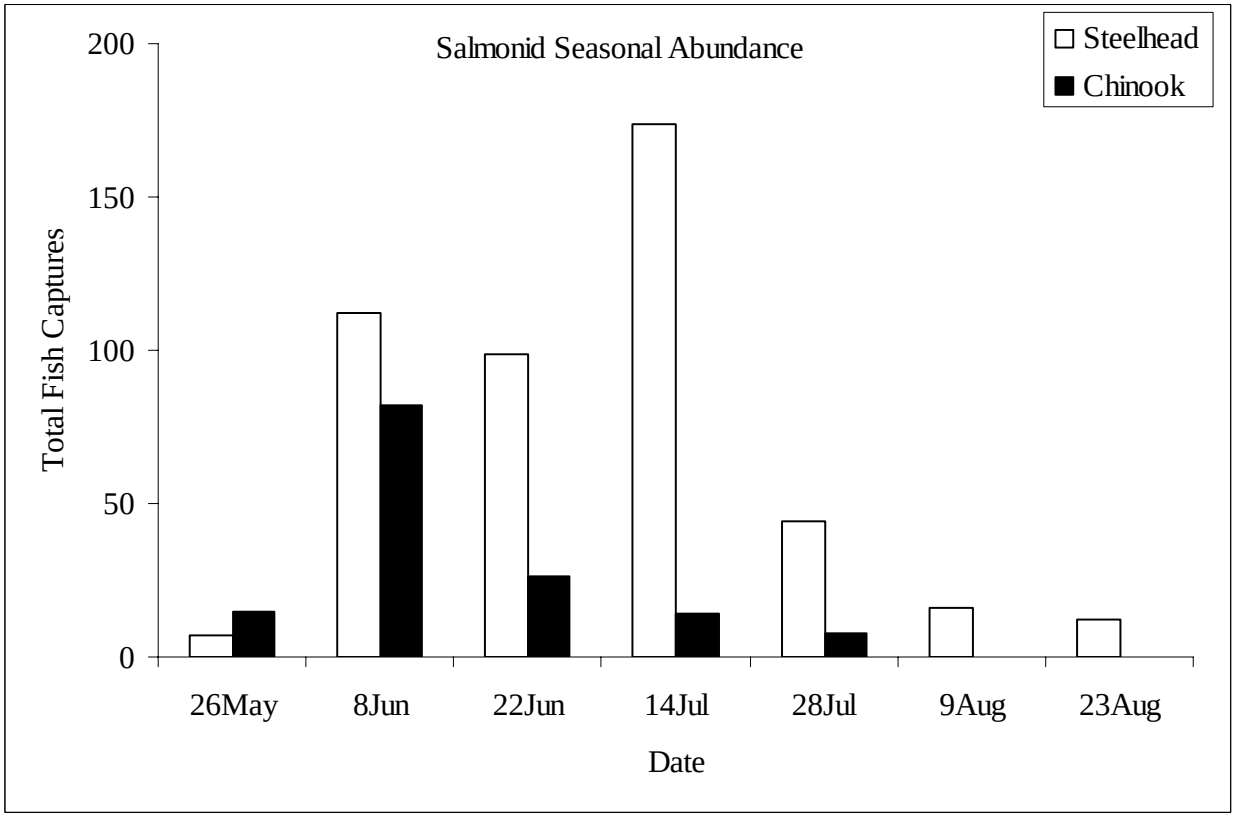


Figure 8: Seasonal abundance of steelhead and Chinook salmon in the Estuary. Total fish captures during the study are shown.

carapace width of 65.9mm ± 9.2 (n = 119) on 1 September. Adults occurred from the Russian River mouth to the upper Penny Island area and their numbers decreased upstream (Figure 9). Adults had an average carapace width of 143.3 mm ± 9.7 (n = 43).

The abundance of Dungeness crab varied by age class and season (Figure 10). Adult numbers were always low in the Estuary but gradually increased throughout the summer. In contrast, juvenile numbers substantially increased during the summer with a peak of 551 on 5 August, which coincided with anoxic conditions resulting from a mouth closure. The Russian River mouth closed on July 25 and reopened on August 6. On August 3 traps were deployed and then retrieved on August 5. Many of the captured juvenile crabs were lethargic probably from the low DO levels at the bottom of the Estuary caused by the mouth closure. This peak was followed by a decline in juvenile numbers.

Estuary Water Quality

Water quality data was collected at fish and macro-invertebrate stations during each survey (Figure 1). The DO, salinity, and temperature results at fish stations during the study 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, two layers were found and the delineation of layers usually occurred at 0.5 m (1.6 ft) to 1.5 m (4.9 ft) below the water surface. In general, the surface layer had more freshwater influence, warmer temperatures, and a variety of DO levels. The bottom water layer was primarily cooler seawater.

The surface layer consisted of brackish water with salinities that decreased upstream and temperature that increased upstream. On 23 August, the River Mouth station had the highest surface salinity in the Estuary at 27.9 ppt, although most surface salinities were <16 ppt at this station. Salinities at the Heron Rookery station, located in the upper Estuary, were very low at < 2 ppt and the unstratified Austin Creek station had freshwater with salinities <0.1 ppt. Temperatures at the surface were generally warmer than the bottom layer and increased upstream. Surface temperatures at the River Mouth station ranged from 14.2 °C to 19.8 °C (57.6 °F to 67.6 °F) and at the Heron Rookery station temperatures were 4 °C to 6 °C (39 °F to 43 °F) warmer (19.8 °C to 23.9 °C [67.6 °F to 75.0 °F]). DO levels varied considerably near the surface but were usually above 6 mg/l. This variation in DO was probably related to changing wind and wave action, and tidal cycles.

The bottom layer of water in the Estuary was composed of cooler seawater with salinities usually >24 ppt at stations with depths greater than 2 m. Stratification was less apparent at Penny Island and Willow Creek stations because the depths were shallower than the usual depth of stratification. Bottom temperatures at the River Mouth station at 11.1 to 15.1 °C were 6 to 8 °C cooler than at the Heron Rookery bottom temperatures that ranged from 19.7 to 22.9 °C. DO levels varied at the bottom considerably by survey date and station. The lowest DO levels were often recorded when the Russian River mouth was closed from 25 July to 6 August and there was no tidal circulation in the Estuary. DO was as low as 2.39 mg/l recorded at a depth of 3.5 m at the Jenner Gulch station during the closed-mouth period.

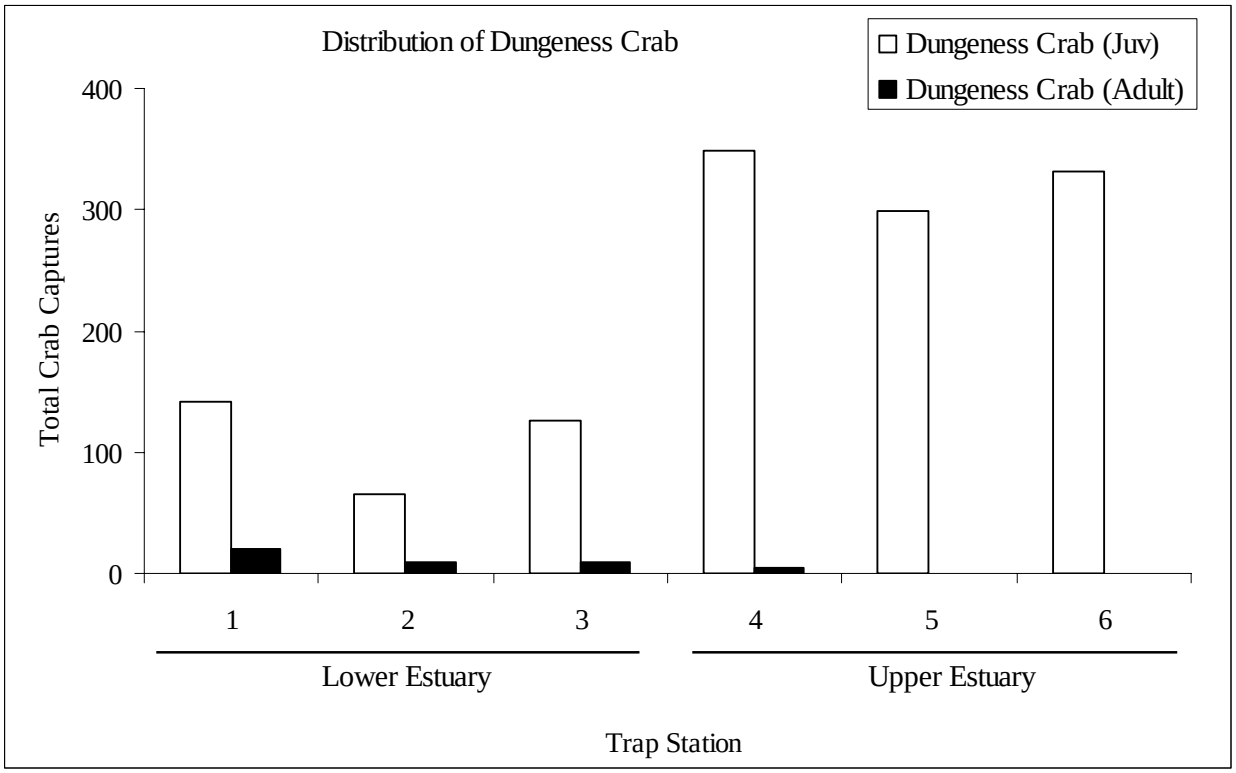


Figure 9: Distribution of Dungeness crab in the Estuary from the Russian River mouth to Highway 1 Bridge (Bridgehaven).

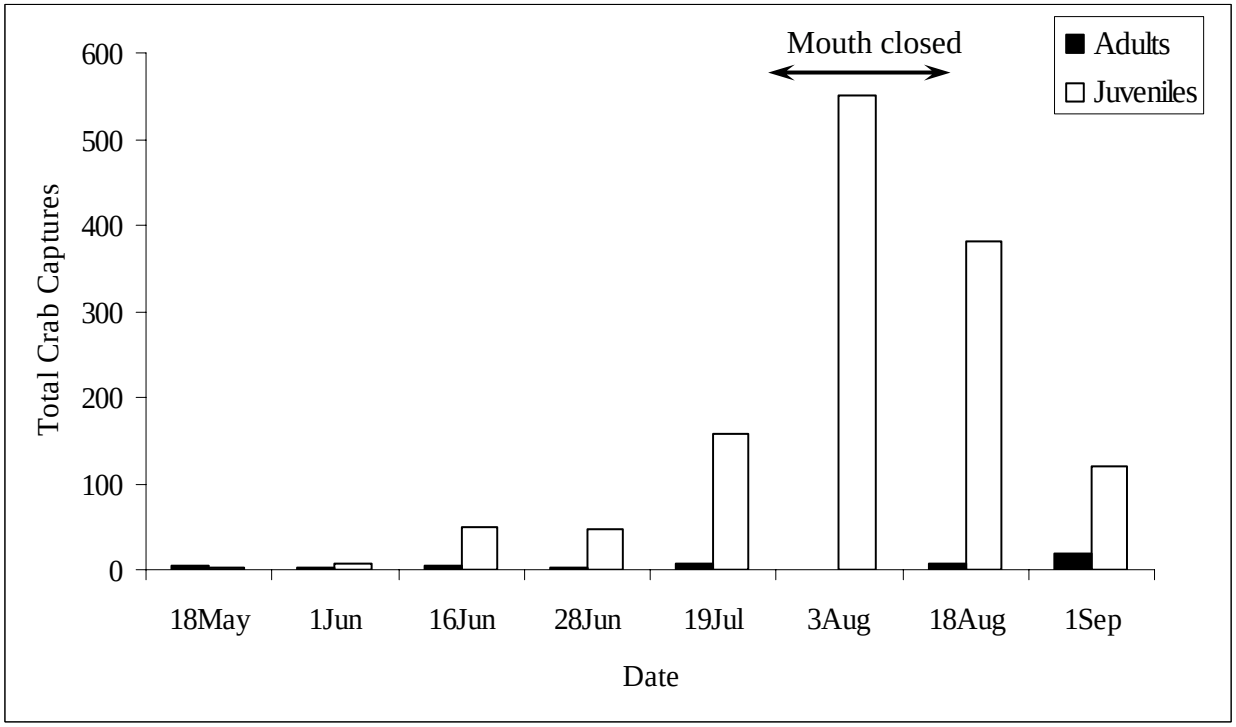


Figure 10: Seasonal abundance of Dungeness crab in the Estuary.

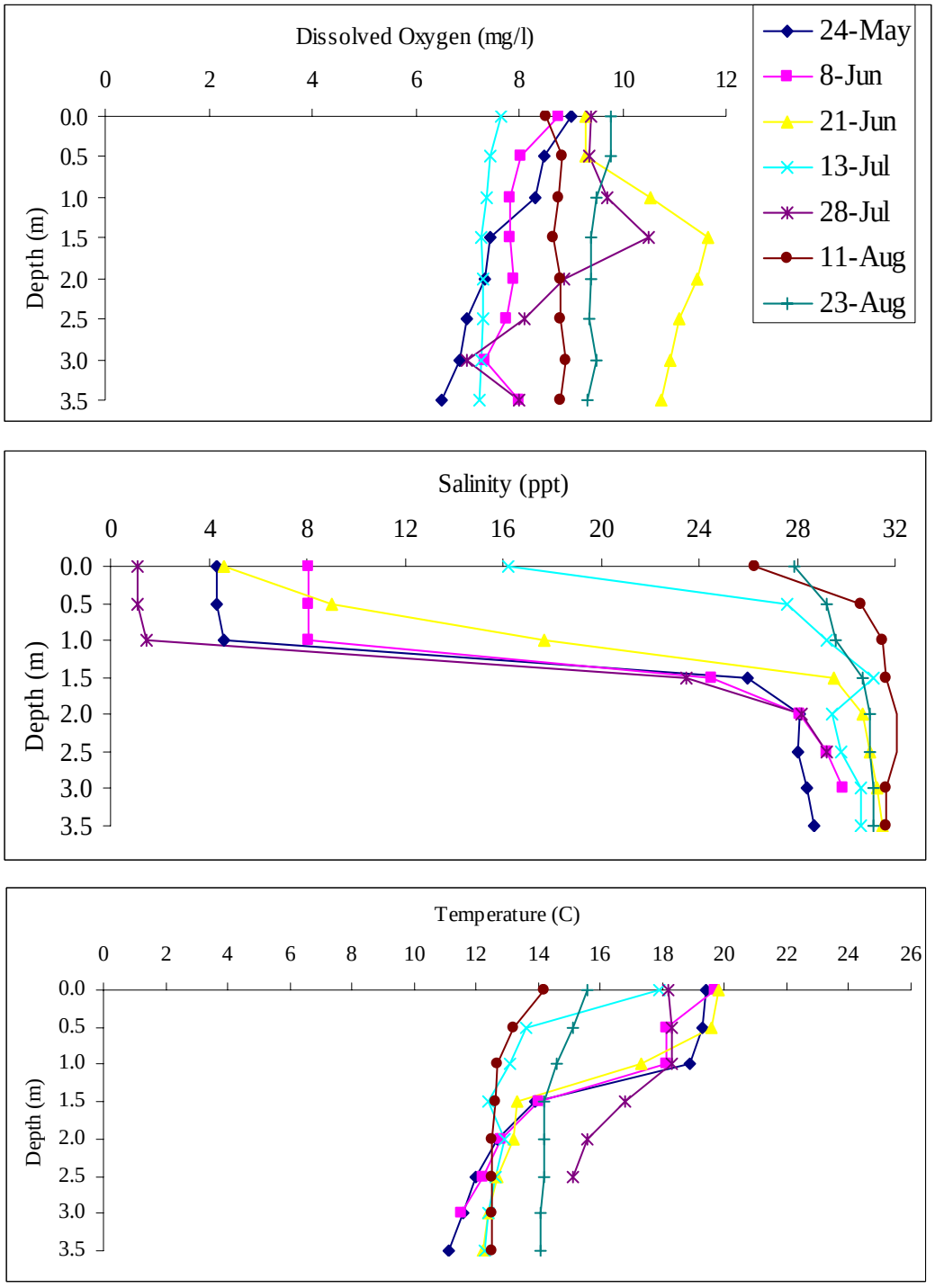


Figure 11: Water quality conditions at the River Mouth station, 2004

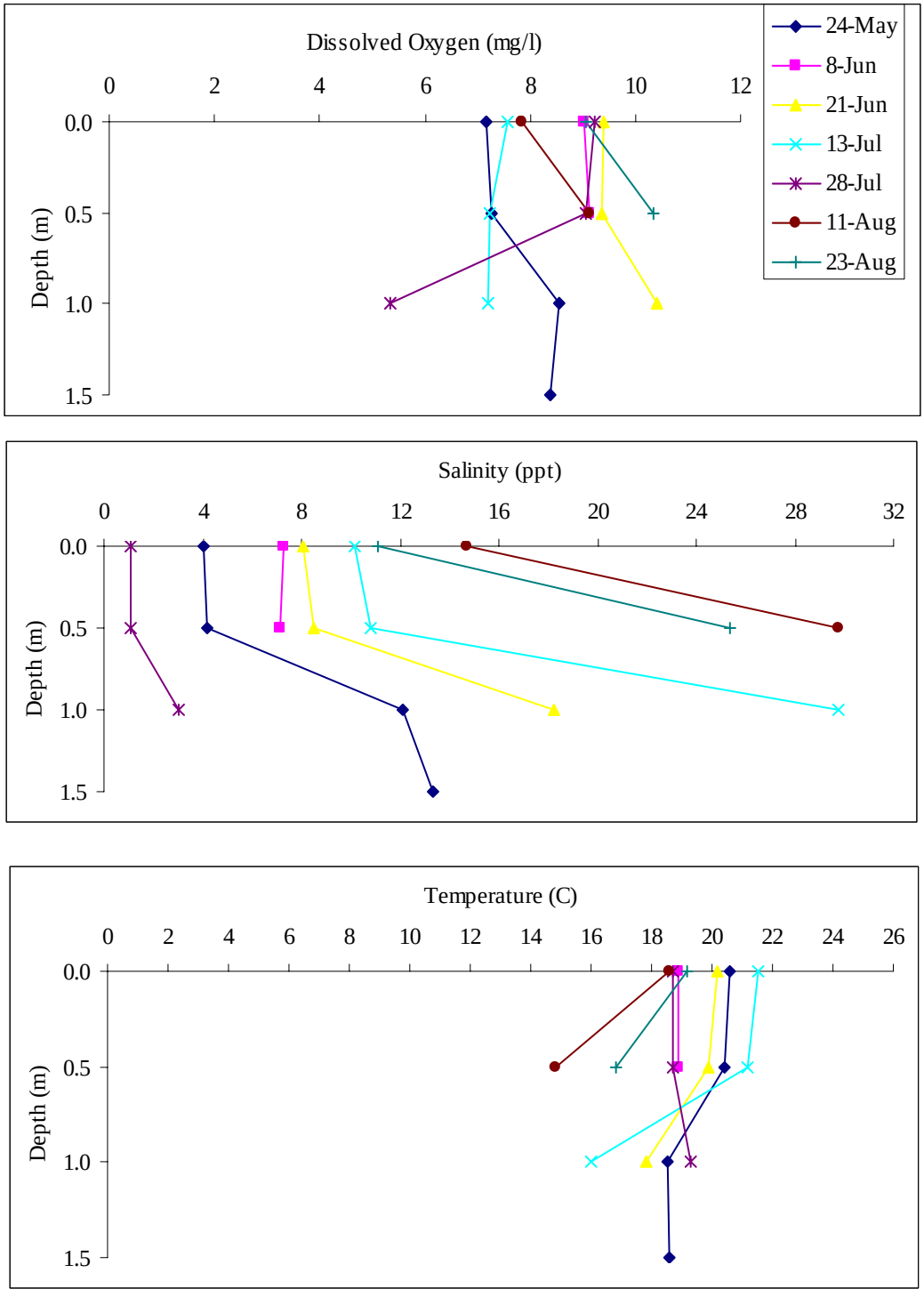


Figure 12: Water quality conditions at the Penny Island station, 2004

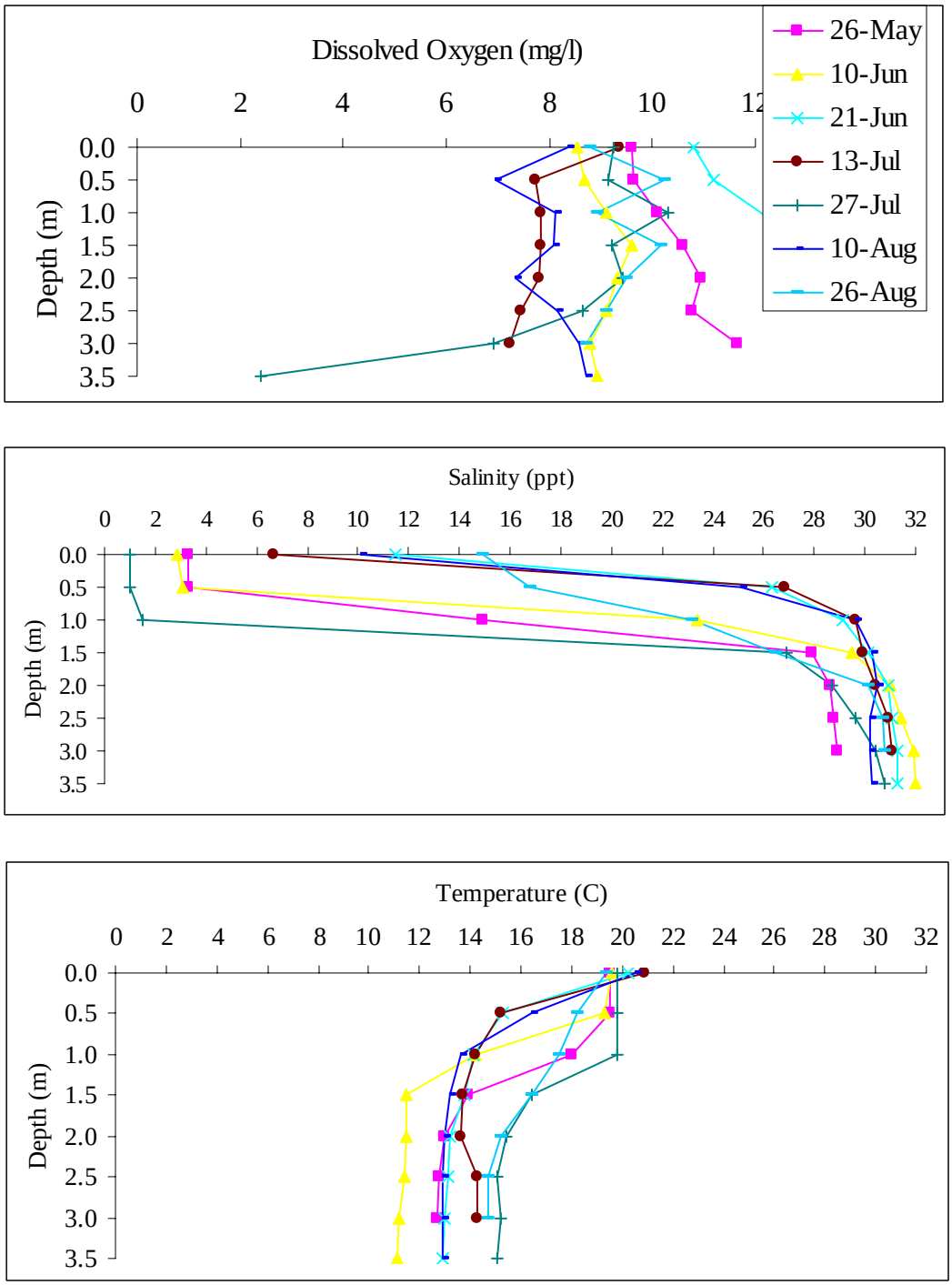


Figure 13: Water quality conditions at the Jenner Gulch station, 2004

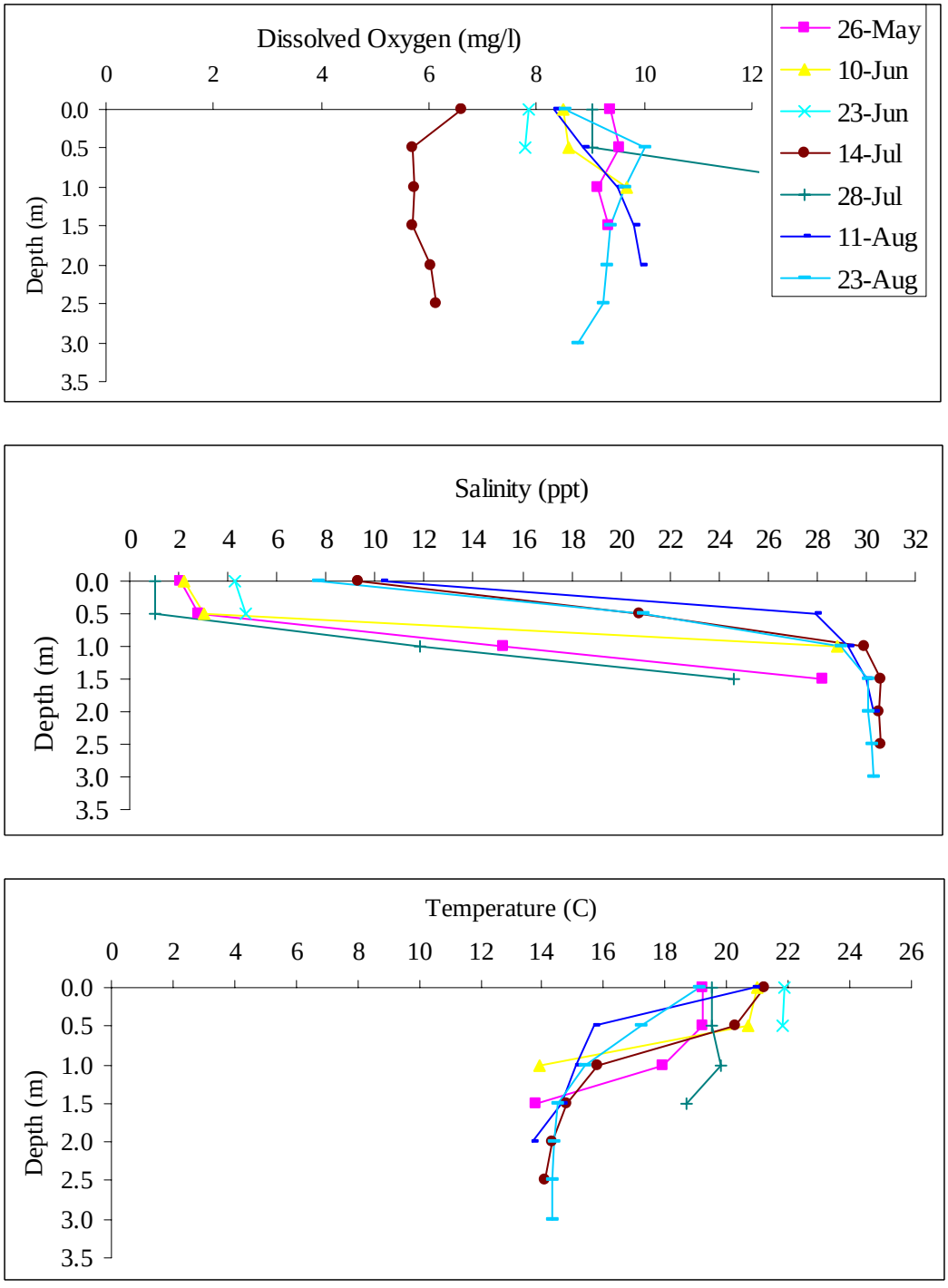


Figure 14: Water quality conditions at the Rocky Bar station, 2004

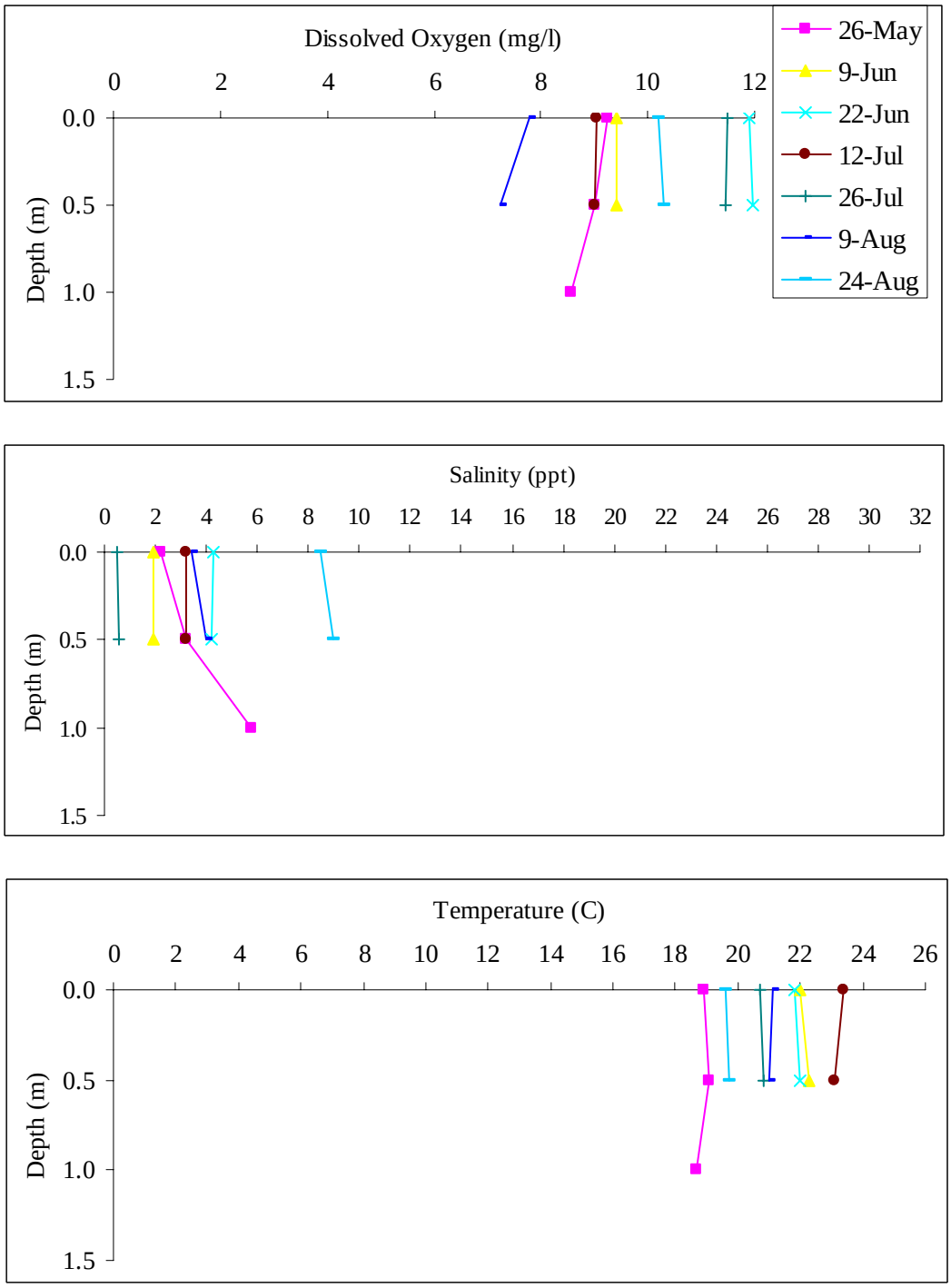


Figure 15: Water quality conditions at the Willow Creek station, 2004

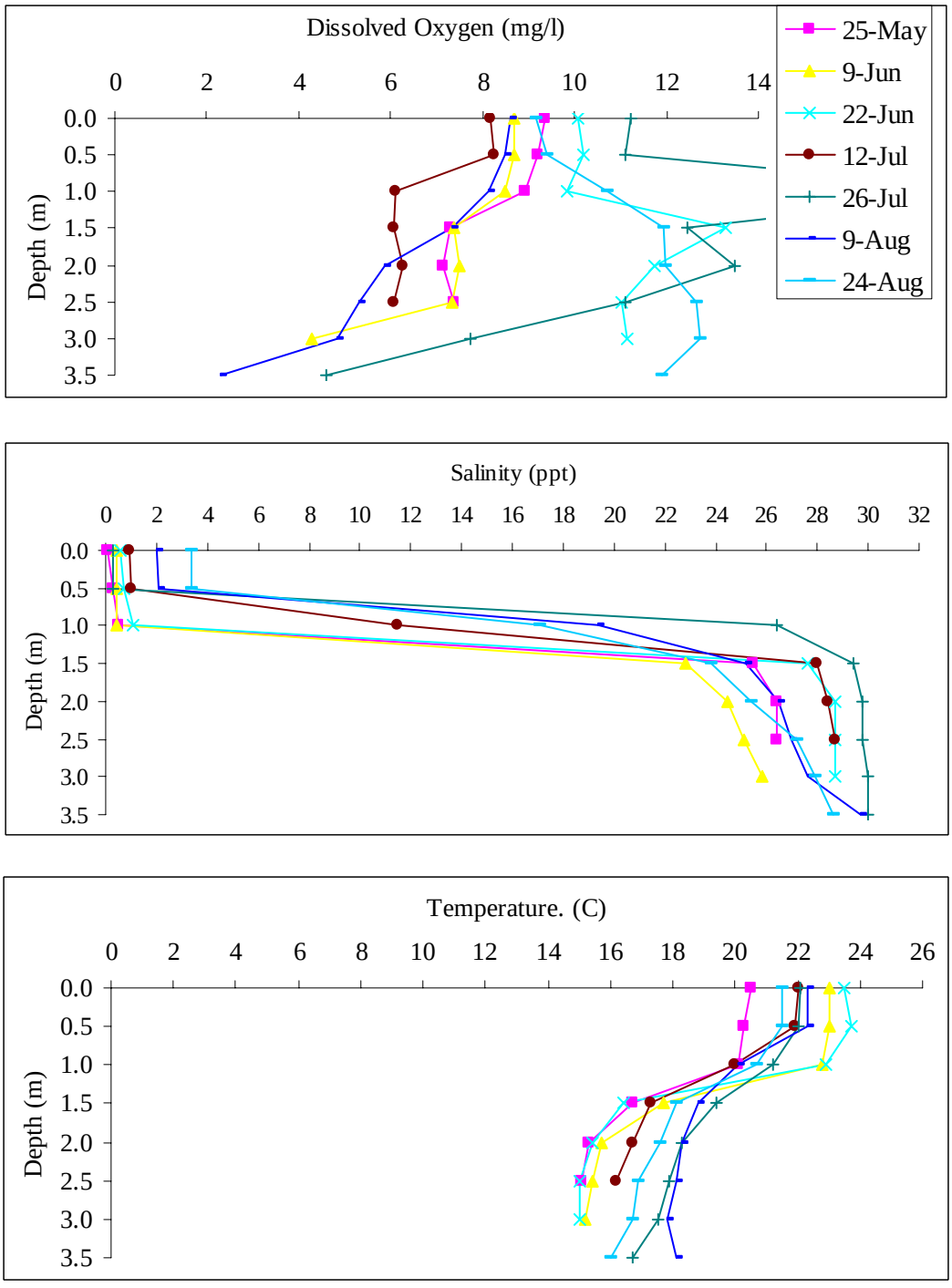


Figure 16: Water quality conditions at the Sheephouse Creek station, 2004

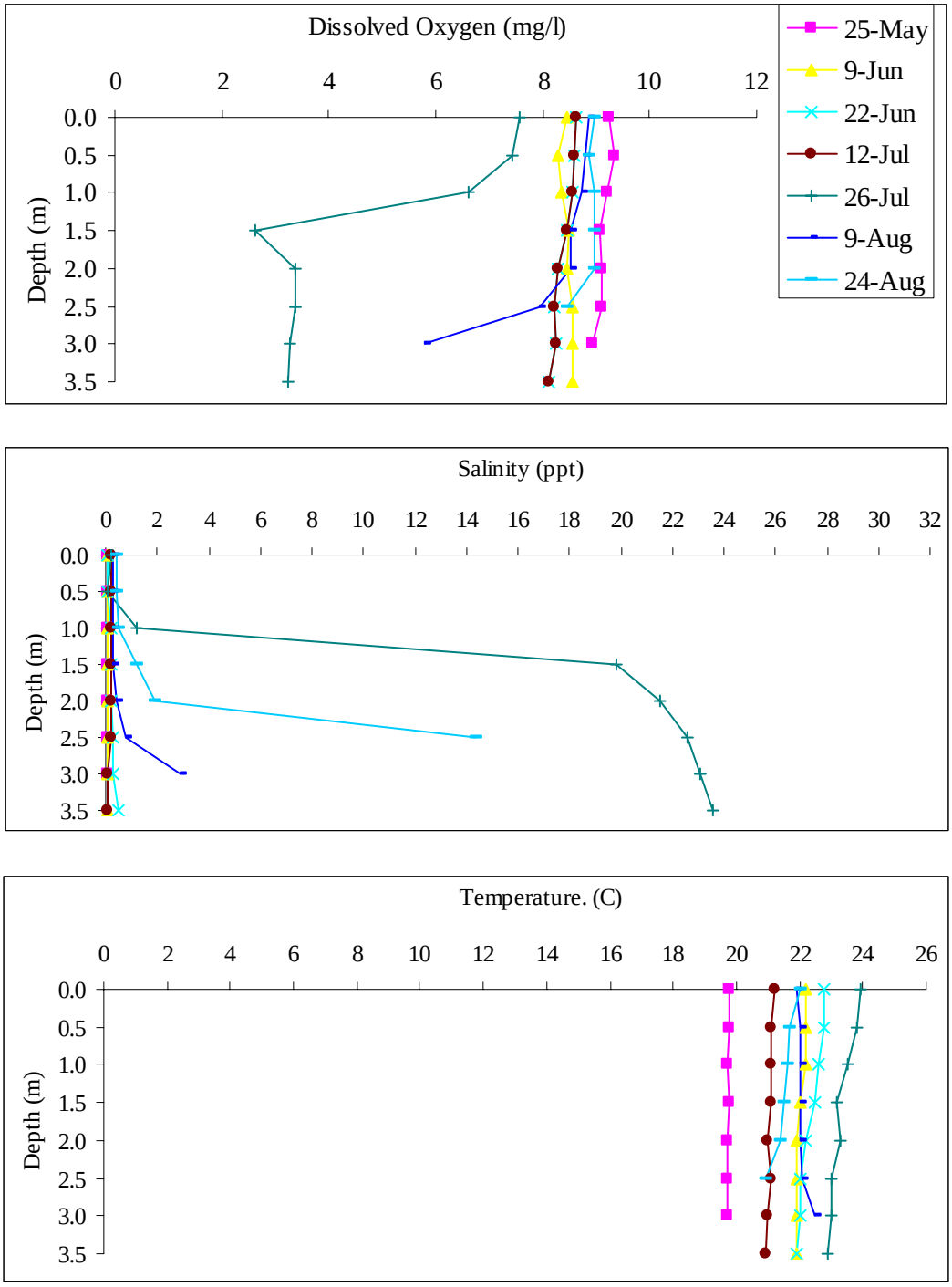


Figure 17: Water quality conditions at the Heron Rookery station, 2004

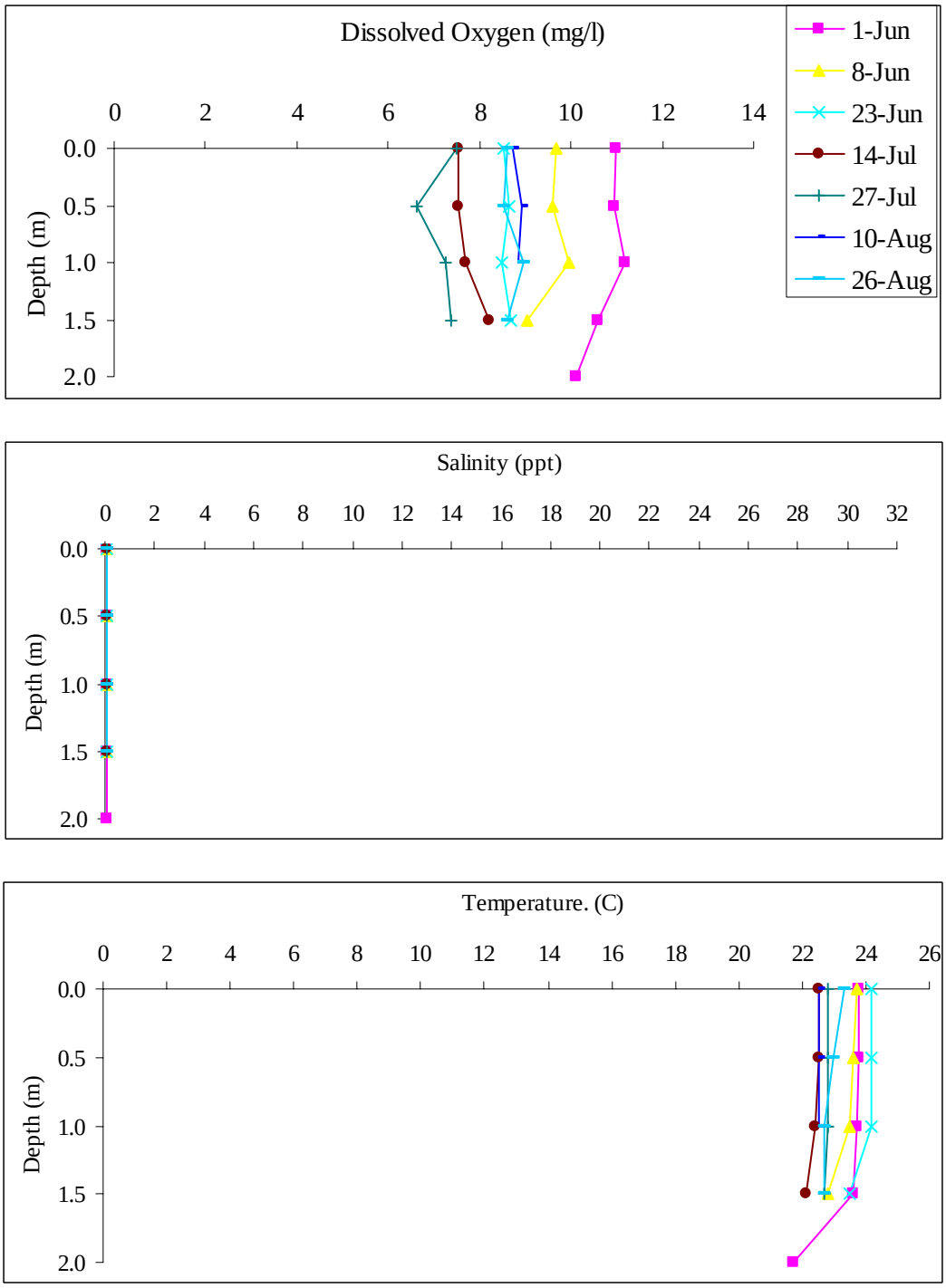


Figure 18: Water quality conditions at the Austin Creek station, 2004

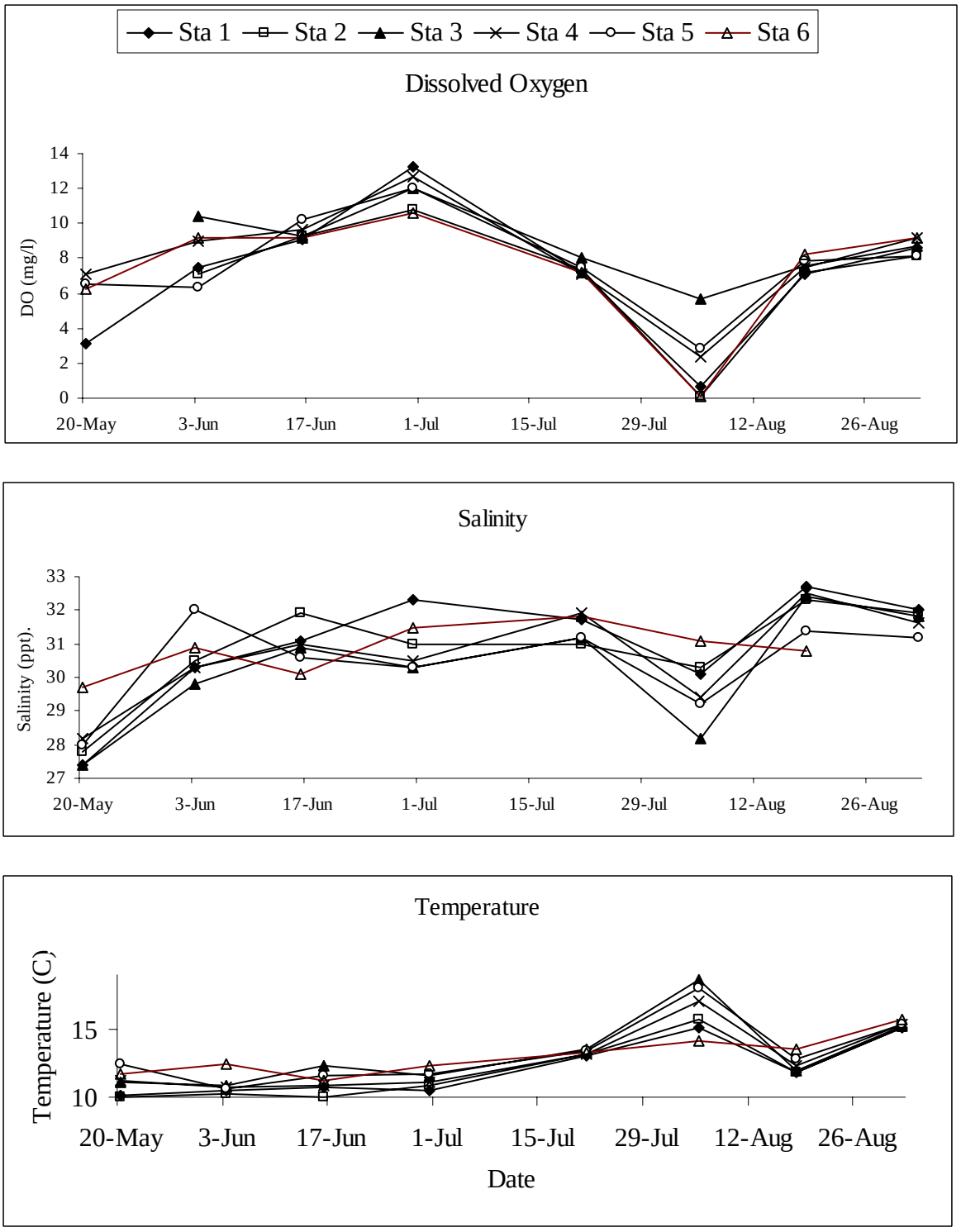


Figure 19: Bottom water quality conditions collected at macro-invertebrate trap stations in the lower Estuary, 2004. The locations of trap stations are shown on Figure 1.

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 average depth at trap stations was 4.2 m (13.8 ft). DO, salinity, and temperature gradually increased from 20 May to 1 July. This pattern is probably related to the decrease in spring river flows into the Estuary and seasonal increases in temperature. This trend changed during the closed-mouth conditions from 25 July to 6 August when water temperatures increased by as much as 5.6 °C, DO was nearly 0 mg/l at 3 stations, and salinities were less effected but decreased to as low as 28.2 ppt at station 3 in the lower Estuary from a high of 31.2 ppt on 21 July. These anoxic conditions were probably short-lived. During the 18 August survey, 12 days after the river mouth had reopened, water quality had resumed conditions similar to pre-closure conditions.

DISCUSSION

The results of the 2004 study found 31 fish species from marine, estuarine, and riverine origins. The detection of four new fish species previously undetected during past field studies (see Cook 2004; Martini-Lamb 2001) indicates that the fish fauna of the Estuary remains understudied. Monitoring studies conducted in the 1990s focused on fish sampling during river mouth breaching events that usually occurred during the spring and fall (Martini-Lamb 2001), which may be the reason why some species were not detected. The distribution of species was influenced by the salinity gradient in the Estuary that is seawater near the mouth of the Russian River and freshwater at the upstream end. An exception to this distribution pattern were anadromous fish that occurred throughout the Estuary regardless of salinity levels.

The distribution and abundance of salmonids rearing in the Estuary differed spatially, temporally, and by species. Chinook salmon smolts were habitat generalists occurring at most sample stations located throughout the Estuary and 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. An explanation for this distribution is that creek mouths are sources of cool, freshwater that steelhead use as refuges. These observations of Chinook salmon briefly rearing in the Estuary and steelhead concentrated at freshwater sources supports the findings of Cannata (2003) and Smith (1990) who found that freshwater lagoons are more productive rearing habitat for salmonids. However, additional studies should be conducted to further assess this trend.

The brief mouth closure during late-summer was not adequate to transform the Estuary into a freshwater lagoon and improve rearing habitat for salmonids. On the contrary, this closure episode negatively affected water quality conditions by forming an anoxic layer at the bottom during the closure period. What is needed to form a stable lagoon system is a prolonged mouth closure starting probably in spring. This would allow heightened spring inflows to convert the system to a freshwater lagoon and thereby stabilize salinity and DO conditions, which would also increase and stabilize the invertebrate food base for salmonids.

The 2004 data indicated that the Estuary is a nursery for juvenile Dungeness crabs. Juveniles were found throughout the lower Estuary. Future studies should focus on the distribution of

juveniles in the middle and upper Estuary and evaluate the regional importance of the Estuary as a nursery.

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