

# Redwood

*National and State Parks*

National Park Service  
US Department of the Interior

Department of Parks and Recreation  
State of California

## Redwood Creek Estuary Monitoring 2005 Annual Progress Report



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### **Cover Photographs**

**Top Left: Coastal cutthroat trout from Redwood Creek Estuary (August 23, 2005 RNSP)**

**Top Right: Estuary crew (August 25, 2005 RNSP)**

**Bottom Left: Redwood Creek estuary from Old State Highway (October 31, 2005 RNSP)**

**Bottom Right: Juvenile chinook salmon from Redwood Creek Estuary (August 23, 2005 RNSP)**

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## Introduction

This annual report summarizes Redwood National and State Parks Fish and Wildlife Branch biological and physical monitoring activities in the Redwood Creek estuary for calendar year 2005. Monitoring has occurred in the Redwood Creek estuary since 1980. The purpose of the estuary monitoring is to estimate fish population numbers and growth; record estuary water quality and water elevations; determine cross section changes; and document breaching incidents. This report serves as the annual report for the Division of Resource Management and Science.

## Location

Redwood Creek estuary is located 2.5 miles west of Orick, California at the confluence of Redwood Creek with the Pacific Ocean (Figure 1). Redwood Creek is 108 km long and the basin is 720 km<sup>2</sup> in area. The U.S. Army Corps of Engineers completed construction of 3.4 miles of flood control levees in 1968 on lower Redwood Creek. The levees bisect and terminate in the estuary. The estuary consists of the north and south sloughs, and the embayment. The south slough was the last meander of the river bypassed by the south levee.

## Methods

### Fish Monitoring

Population Estimates - The Peterson mark and recapture method (Youngs and Robson 1978) was used to estimate numbers of juvenile salmonid fish in the Redwood Creek embayment. Fish were seined with a 150-long, 15-foot wide, ¼ inch mesh beach seine net deployed off the bow of a 16-foot boat with 15 or 25hp outboard motor. Seining occurred downstream of the south levee culverts with most net hauls downstream of the NPS boundary line in the embayment along the sand shore and north and south levee rip rap. A blue mark was applied to the upper, middle, or lower caudal fin or anal fin of MS-222 anesthetized fish using a Panjet needleless injector and Alcian Blue dye. Captured fish were marked the first two days, allowed to mix the third day, and seined on the fourth day to determine the ratio of marked to unmarked fish. Population and 95 percent confidence interval (95% CI) estimates are rounded off to the nearest 10. Four population estimates were done during summer 2005.

Growth Estimates – Fish fork lengths (mm) were measured to the nearest 1-mm. Though not always possible, a target number of 200 fork lengths each of chinook salmon (*Oncorhynchus tshawytscha*) and steelhead trout (*O. mykiss*), and wet weight (g) measurements from 30 juveniles of each species were taken. Two electronic balances were used, a 200 g ± 0.01g capacity balance for smaller fish, and a 5,000 g ± 2g capacity balance for larger fish. Other salmonid species, coastal cutthroat trout (*O. clarki*) and coho salmon (*O. kisutch*), though not as numerous, were measured and weighed. Non-salmonids were also measured (total length). Seven growth estimates were conducted, four in conjunction with the population estimates, and three one day estimates between and after population estimates.

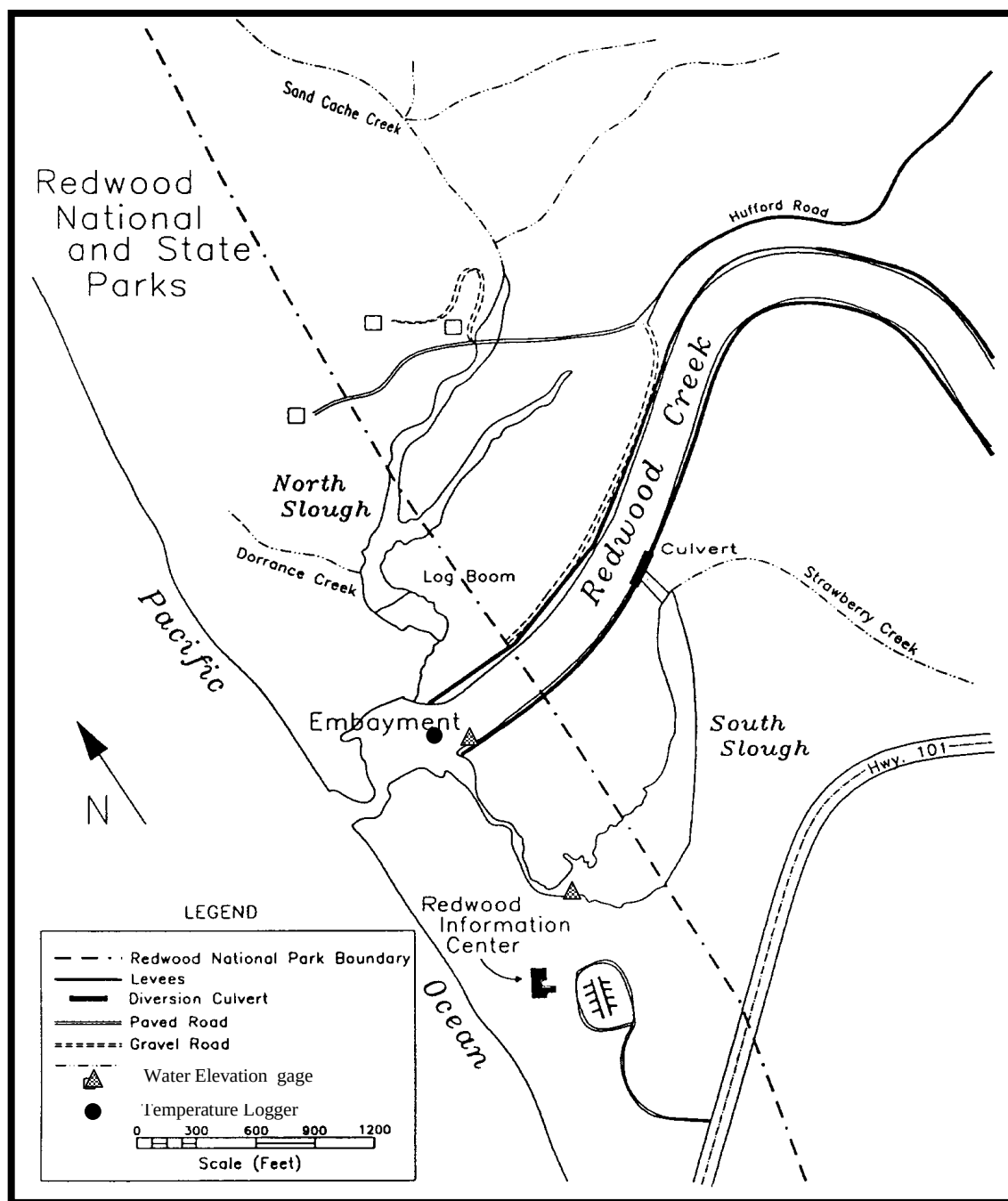


Figure 1. Map of the Redwood Creek Estuary, Humboldt County, California, including location of the embayment, north and south sloughs, and two water elevation gages and water temperature logger.

Condition Factor- Condition factor, a measure of fish ‘fatness’ was calculated for salmonid species measured and weighed. Because of the wide range of fish lengths, condition factor ( $K'$ ) was calculated as:  $K' = (100 \times \text{Weight}_{(g)}) / \text{Fork Length}_{(cm)}^b$  (Bagenal and Tesch 1978). Slope (b) was calculated as:  $\log_{10} \text{Weight}_{(g)} = \log_{10} a + b \log_{10} \text{Fork Length}_{(cm)}$ .

### **Water Quality Monitoring**

Water Temperature - Water temperature (°C) was measured hourly in the Redwood Creek embayment. An Onset TIDBIT™ temperature logger was located in the Redwood Creek channel between the ends of the north and south flood control levees (Figure 1). The probe, anchored to a large cinder block, was suspended in the water column about one foot off the bottom substrate.

### **Tide and Stream Flow Data**

Tide Data: Calendar year 2005 tide data for the mouth of Redwood Creek was compiled using Crescent City Harbor, California verified tides downloaded from NOAA-National Ocean Services, Center for Operational Oceanographic Products and Services ([http://co-ops.nos.noaa.gov/cgi-bin/station\\_info.cgi?stn=9419750+Crescent+City+,+CA](http://co-ops.nos.noaa.gov/cgi-bin/station_info.cgi?stn=9419750+Crescent+City+,+CA)). Data was downloaded as feet above Mean Sea Level (MSL) at local standard time. It was corrected for the locality of the mouth of Redwood Creek [CC tide x 0.98] (Hubbard 1986).

Stream Flow Data: Hourly Redwood Creek flow data, cubic feet per second (cfs), at Orick for calendar year 2005 was downloaded from the California Department of Water Resources, Division of Flood Management website (<http://cdec.water.ca.gov>). Water Resources has not yet reviewed the preliminary flow data for accuracy and it is subject to revision. The Orick gaging station (ORK) is located on Redwood Creek downstream of the confluence of Prairie Creek just north of the town of Orick.

### **Estuary Water Levels**

South slough water elevations (feet MSL) were recorded at 30-minute intervals by a continuous recording gage using a pressure transducer and ENMOS logger. The gage site is located at the end of the Kuechel Visitor Center boardwalk platform in the south slough (Figure 1). A seasonal gage was installed at the end of the south levee to measure the water elevation in the estuary embayment. The south levee gage, a Global Water WL-14 Water Level Logger, measured embayment water levels every 15-minutes.

### **Estuary Cross Sections**

The five estuary cross sections were surveyed in 2005 after a one year lapse in 2004. Established and first surveyed in 1998 in the embayment, the northside cross section endpoints located along the base of the hill are 8 ft t-bar fence posts buried the sand, or partially buried monumented sea stacks. The permanent endpoints are surveyed and referenced to a BLM benchmark located at the park boundary fence separating the pasture from the parking area adjacent to the north levee. Each cross section is shot at a bearing of 170° using a Nikon Total Station. A wetsuited person with a rod and prism located points in the embayment at breaks in slope. Another person continued the transect in the adjacent dunes. Transects are measured to at least 11ft MSL in elevation.

### **Sand Berm Elevation Monitoring**

No sand berm elevations parallel to the shore were surveyed in 2005. The last surveys were conducted in 2002. Special condition #4 of an expired Corps permit specified a survey of sand berm elevations parallel to the shore, along the highest ridge of the sand dunes, once per month from May to September. The survey reach extends a minimum of 100 feet north of the estuary to 100 feet south of the Kuechel Visitor Center (KVC), approximately 3,000 ft in length. Surveys are conducted with a Nikon Total Station and rod with prism. Measurements are taken at breaks in slope along the sand berm. Survey elevations are referenced in the south to Melch 3, a permanent NOAA benchmark located west of KVC, to the end of the KVC west boardwalk, and in the north to the BLM benchmark, and the western most estuary cross-section (E-5) endpoint, RM2, a double monumented sea stack.

### **Other Activities**

CDFG Redwood Creek Downstream Migrant Trapping - The California Department of Fish and Game (CDFG) ran two downstream migrant rotary screw traps in Redwood Creek in 2005. Steelhead smolts PIT (passive integrated transponders) tagged at the upper migrant trap were recaptured in the estuary.

RNSP/OMSI Seining in Lower Redwood - On July 19, with the help of Oregon Museum of Science and Industry (OMSI) salmon camp students, lower Redwood Creek below the 101 bridge was seined using a small beach seine in three locations.

Levee Maintenance/Coastal Commission Permit - A permit was granted to Humboldt County for levee maintenance, gravel extraction and vegetation removal downstream of the Highway 101 bridge.

U.S. Army Corps of Engineers Visits - There were two visits to the flood control project by district and regional Corps senior personnel in 2005.

HSU Oceanography Senior Field Cruise Project - The class conducted water quality monitoring of the estuary and offshore waters.

HSU River Restoration Class - Dr. Walt Duffy's River Restoration class visited the park on September 24 for an estuary field trip.

### **2005 Results**

#### **Fish Monitoring**

Presence – During the summer and fall of 2005, four salmonid species were seined in the Redwood Creek embayment; chinook and coho salmon, and steelhead and coastal cutthroat trout. Juvenile chinook and steelhead were present on all sample dates between June 6 and October 18. Half-pounder steelhead (smaller immature sea-run steelhead returning after less than one year in the ocean) were present August 25. Cutthroat were captured on all sample dates, except for October 18. However, if they were in the closed estuary the week of September 19, they should have been in the estuary on October 18. Coho salmon were captured in June and the week of September 19.

In addition to the juvenile salmon and steelhead trout, half-pounder steelhead and adult cutthroat captured, 13 additional fish species were captured. Four of those, American Shad, Bay Pipefish, Penpoint Gunnel, and Walleye Surfperch were new species observations for the Redwood Creek estuary. The Pacific Herring capture was a second occurrence in the estuary. Marine species presence was due to the mouth of the creek being open to the ocean and tidal action into the estuary. Walleye Surfperch had been seined at low tide at Crescent Beach on August 18 and at Gold Bluffs Beach on August 19 (Cox, et al 2005)

*Other Species* - One amphibian, two reptiles, 81 birds (72 identified and 9 unidentified species), three mammals, seven invertebrates, and four algal species were observed. The 2005 estuary bird list is more robust because of the birding expertise of Heather Brown, a member of the crew. The bull elk observations along the levee next to the middle island were first time mammal observations. A complete list of all fish and other species captured or observed in and around the Redwood Creek estuary is presented in Table 1.

Of the fish captured, chinook, coho, and steelhead are federally listed as threatened. Of the birds observed or heard, the Brown Pelican is federally listed as endangered, and the Bald Eagle and Marbled Murrelet are federally listed as threatened. No endangered tidewater gobies (*Eucyclogobius newberryi*) were captured during estuary seining in 2005.

Population Estimates - Low numbers of salmonids were estimated in the estuary for 2005. Four population estimates were conducted on Monday, Tuesday, and Thursday during the weeks of June 6, July 11, August 22, and September 19 (Table 2). The mouth was open during the first three population estimates and closed during the September 19 estimate. The number of fish marked, marked recaptures, total individuals captured in the 'second sample', total number of seines, and fins marked are presented in Appendix I.

*Chinook Salmon* - The first juvenile chinook salmon estimate, the week of June 6 was 4,660 (95% Confidence Interval [CI] 3,190 to 6,130). During the weeks of July 11 and August 22, no marked fish were recaptured. The actual number of chinook captured in 36 seine net hauls the week of July 11 was 34, and 2 chinook in 34 seine hauls the week of August 22. The estimated number decreased to 50 chinook (95% CI 26 [actually caught] to 84) the week of September 19.

*Steelhead Trout* - For juvenile steelhead trout, no marked fish were recaptured during the estimate the week of June 6. The actual number of steelhead captured in 32 seine hauls was 42. The estimate the week of July 11 was 960 (95% CI 89 [actually caught] to 2,220). The population estimate was 300 (95% CI 109 [actually caught] to 540) on August 22. The last steelhead estimate on September 19 was 540 (95% CI 155 [actually caught] to 930).

*Coho Salmon* - A total of seven juvenile coho salmon were caught in the estuary during summer 2005, four the week of June 6. One was caught the week of September 19, and 2 additional coho were caught during a one-day growth estimate on June 23. No estimate was possible as no marked fish were recaptured.

Table 1. List of salmonid and non-salmonid fish seined, birds, amphibians, reptiles, mammals, invertebrates, and others observed at and adjacent to the Redwood Creek estuary, Redwood National and State Parks, Humboldt County, California during the summer/fall 2005 fish sampling (X denotes presence).

| Species                            |                                   | 2005 Date           |         |                      |       |                     |                      |        |
|------------------------------------|-----------------------------------|---------------------|---------|----------------------|-------|---------------------|----------------------|--------|
| Common Name                        | Scientific Name                   | June 6 <sup>a</sup> | June 23 | July 11 <sup>a</sup> | Aug 9 | Aug 22 <sup>a</sup> | Sept 19 <sup>a</sup> | Oct 18 |
| <b>Salmonid Fish</b>               |                                   |                     |         |                      |       |                     |                      |        |
| Chinook Salmon *                   | <i>Oncorhynchus tshawytscha</i>   | X                   | X       | X                    | X     | X                   | X                    | X      |
| Coastal Cutthroat Trout            | <i>Oncorhynchus clarki</i>        | X                   | X       | X                    | X     | X                   | X                    |        |
| Coho Salmon *                      | <i>Oncorhynchus kisutch</i>       | X                   | X       |                      |       |                     | X                    |        |
| Steelhead Trout *                  | <i>Oncorhynchus mykiss</i>        | X                   | X       | X                    | X     | X                   | X                    | X      |
| <b>Other Fish</b>                  |                                   |                     |         |                      |       |                     |                      |        |
| American Shad                      | <i>Alosa sapidissima</i>          |                     | X       |                      |       |                     |                      |        |
| Bay Pipefish                       | <i>Syngnathus leptorhynchus</i>   |                     |         |                      |       | X                   |                      |        |
| Night Smelt                        | <i>Spirinchus starksi</i>         |                     |         |                      |       |                     | X                    |        |
| Pacific Herring                    | <i>Clupea pallasii</i>            |                     |         |                      |       | X                   |                      |        |
| Penpoint Gunnel                    | <i>Apodichthys flavidus</i>       |                     |         |                      |       |                     | X                    |        |
| Prickly Sculpin                    | <i>Cottus asper</i>               | X                   |         | X                    |       | X                   | X                    | X      |
| Sacramento Sucker                  | <i>Catostomus occidentalis</i>    |                     |         |                      |       |                     | X                    |        |
| Shiner Surf Perch                  | <i>Cymatogaster aggregata</i>     |                     |         |                      | X     | X                   | X                    |        |
| Staghorn Sculpin                   | <i>Leptocottus armatus</i>        | X                   | X       | X                    | X     | X                   | X                    | X      |
| Starry Flounder                    | <i>Platichthys stellatus</i>      | X                   | X       | X                    | X     | X                   | X                    | X      |
| Surf Smelt                         | <i>Hypomesus pretiosus</i>        |                     | X       |                      |       | X                   |                      |        |
| Three Spine Stickleback            | <i>Gasterosteus aculeatus</i>     | X                   | X       | X                    | X     | X                   | X                    | X      |
| Walleye Surf Perch                 | <i>Hyperprosopon argenteum</i>    |                     |         |                      |       | X                   |                      |        |
| <b>Amphibians</b>                  |                                   |                     |         |                      |       |                     |                      |        |
| Western Toad (Adults and tadpoles) | <i>Bufo boreas</i>                |                     |         | X                    |       | X                   | X                    |        |
| <b>Reptiles</b>                    |                                   |                     |         |                      |       |                     |                      |        |
| Western Fence Lizard               | <i>Sceloporus occidentalis</i>    |                     |         |                      |       |                     | X                    |        |
| Garter Snake                       | <i>Thamnophis sp.</i>             |                     |         |                      |       | X                   |                      |        |
| <b>Birds</b>                       |                                   |                     |         |                      |       |                     |                      |        |
| American Coot                      | <i>Fulica americana</i>           |                     |         |                      |       |                     |                      | X      |
| American Crow                      | <i>Corvus brachyrhynchos</i>      | X                   | X       | X                    | X     | X                   | X                    |        |
| American Goldfinch                 | <i>Carduelis tristis</i>          | X                   | X       | X                    | X     | X                   | X                    |        |
| American Robin                     | <i>Turdus migratorius</i>         | X                   | X       | X                    |       |                     | X                    |        |
| Bald Eagle *                       | <i>Haliaeetus leucocephalus</i>   |                     | X       | X                    |       |                     |                      |        |
| Band-tailed Pigeon                 | <i>Patagioenas fasciata</i>       | X                   | X       |                      |       |                     | X                    |        |
| Barn Swallow                       | <i>Hirundo rustica</i>            | X                   | X       | X                    | X     | X                   |                      |        |
| Belted Kingfisher                  | <i>Ceryle alcyon</i>              |                     |         |                      | X     | X                   |                      |        |
| Black Oystercatcher                | <i>Haematopus bachmani</i>        | X                   |         | X                    |       |                     |                      |        |
| Black Phoebe                       | <i>Sayornis nigricans</i>         |                     |         | X                    | X     | X                   | X                    |        |
| Black-capped Chickadee             | <i>Poecile atricapillus</i>       |                     |         |                      |       | X                   | X                    |        |
| Brandt's Cormorant                 | <i>Phalacrocorax penicillatus</i> |                     |         |                      |       |                     | X                    |        |
| Brewer's Blackbird                 | <i>Euphagus cyanocephalus</i>     | X                   | X       | X                    |       |                     |                      |        |

| Species                       |                                   | 2005 Date           |         |                      |       |                     |                      |        |
|-------------------------------|-----------------------------------|---------------------|---------|----------------------|-------|---------------------|----------------------|--------|
| Common Name                   | Scientific Name                   | June 6 <sup>a</sup> | June 23 | July 11 <sup>a</sup> | Aug 9 | Aug 22 <sup>a</sup> | Sept 19 <sup>a</sup> | Oct 18 |
| Brown Pelican **              | <i>Pelecanus occidentalis</i>     | X                   | X       | X                    | X     | X                   | X                    | X      |
| Brown-headed Cowbird          | <i>Molothrus ater</i>             | X                   |         | X                    |       |                     |                      |        |
| Bufflehead                    | <i>Bucephala albeola</i>          |                     |         |                      |       |                     |                      | X      |
| California Gull               | <i>Larus californicus</i>         |                     |         |                      | X     | X                   | X                    |        |
| California Quail              | <i>Callipepla californica</i>     | X                   | X       | X                    | X     | X                   | X                    |        |
| Canada Goose                  | <i>Branta canadensis</i>          | X                   |         |                      | X     | X                   |                      | X      |
| Caspian Tern                  | <i>Sterna caspia</i>              | X                   | X       | X                    | X     | X                   | X                    |        |
| Cedar Waxwing                 | <i>Bombycilla cedrorum</i>        | X                   |         | X                    | X     | X                   | X                    |        |
| Chestnut-backed Chickadee     | <i>Poecile rufescens</i>          |                     |         | X                    | X     | X                   | X                    |        |
| Cliff Swallow                 | <i>Petrochelidon pyrrhonota</i>   | X                   |         | X                    |       |                     |                      |        |
| Common Merganser              | <i>Mergus merganser</i>           | X                   | X       | X                    |       |                     |                      |        |
| Common Raven                  | <i>Corvus corax</i>               | X                   | X       | X                    | X     | X                   | X                    | X      |
| Double-crested Cormorant      | <i>Phalacrocorax auritus</i>      | X                   | X       | X                    | X     | X                   | X                    | X      |
| Elegant Tern                  | <i>Sterna elegans</i>             |                     |         | X                    |       |                     |                      |        |
| European Starling             | <i>Sturnus vulgaris</i>           | X                   |         |                      |       |                     |                      |        |
| Great Blue Heron              | <i>Ardea herodias</i>             |                     | X       | X                    |       |                     | X                    |        |
| Great Egret                   | <i>Ardea alba</i>                 | X                   |         | X                    | X     | X                   |                      | X      |
| Green Heron                   | <i>Butorides virescens</i>        | X                   |         |                      |       |                     |                      |        |
| Heermann's Gull               | <i>Larus heermanni</i>            |                     | X       | X                    | X     | X                   | X                    |        |
| Killdeer                      | <i>Charadrius vociferus</i>       | X                   |         |                      |       | X                   | X                    | X      |
| Mallard                       | <i>Anas platyrhynchos</i>         |                     | X       | X                    | X     | X                   |                      |        |
| Marbled Murrelet *            | <i>Brachyramphus marmoratus</i>   |                     | X       |                      |       |                     |                      |        |
| Marsh Wren                    | <i>Cistothorus palustris</i>      |                     | X       |                      |       |                     |                      |        |
| Northern Flicker              | <i>Colaptes auratus</i>           | X                   |         | X                    |       | X                   | X                    | X      |
| Northern Harrier              | <i>Circus cyaneus</i>             |                     |         | X                    |       |                     | X                    | X      |
| Northern Rough-winged Swallow | <i>Stelgidopteryx serripennis</i> | X                   | X       | X                    | X     | X                   |                      |        |
| Orange-crowned Warbler        | <i>Vermivora celata</i>           | X                   | X       |                      |       |                     |                      |        |
| Osprey                        | <i>Pandion haliaetus</i>          | X                   | X       | X                    | X     | X                   | X                    |        |
| Pacific-slope Flycatcher      | <i>Empidonax difficilis</i>       |                     |         | X                    |       |                     |                      |        |
| Pelagic Cormorant             | <i>Phalacrocorax pelagicus</i>    | X                   |         | X                    |       | X                   | X                    |        |
| Peregrine Falcon              | <i>Falco peregrinus</i>           |                     |         |                      |       | X                   |                      |        |
| Purple Finch                  | <i>Carpodacus purpureus</i>       | X                   | X       | X                    |       |                     |                      |        |
| Red Crossbill                 | <i>Loxia curvirostra</i>          |                     |         |                      |       |                     | X                    |        |
| Red-necked Phalarope          | <i>Phalaropus lobatus</i>         |                     |         |                      |       | X                   |                      |        |
| Red-shouldered Hawk           | <i>Buteo lineatus</i>             |                     |         | X                    |       | X                   | X                    | X      |
| Red-tailed Hawk               | <i>Buteo jamaicensis</i>          | X                   |         |                      | X     | X                   |                      |        |
| Red-winged Blackbird          | <i>Agelaius phoeniceus</i>        | X                   |         | X                    |       |                     |                      |        |
| Ring-billed Gull              | <i>Larus delawarensis</i>         |                     |         |                      |       | X                   |                      |        |
| Sanderling                    | <i>Calidris alba</i>              |                     | X       |                      |       |                     |                      |        |
| Song Sparrow                  | <i>Melospiza melodia</i>          | X                   | X       | X                    |       |                     | X                    |        |
| Spotted Sandpiper             | <i>Actitis macularius</i>         |                     |         |                      |       |                     | X                    |        |
| Steller's Jay                 | <i>Cyanocitta stelleri</i>        |                     |         | X                    |       |                     | X                    |        |
| Surf Scoter                   | <i>Melanitta perspicillata</i>    | X                   |         | X                    |       |                     |                      | X      |

| Species                                                                |                                  | 2005 Date           |         |                      |       |                     |                      |        |
|------------------------------------------------------------------------|----------------------------------|---------------------|---------|----------------------|-------|---------------------|----------------------|--------|
| Common Name                                                            | Scientific Name                  | June 6 <sup>a</sup> | June 23 | July 11 <sup>a</sup> | Aug 9 | Aug 22 <sup>a</sup> | Sept 19 <sup>a</sup> | Oct 18 |
| Swainson's Thrush                                                      | <i>Catharus ustulatus</i>        | X                   | X       | X                    |       |                     |                      |        |
| Tree Swallow                                                           | <i>Tachycineta bicolor</i>       |                     |         | X                    |       |                     |                      |        |
| Turkey Vulture                                                         | <i>Cathartes aura</i>            | X                   | X       | X                    | X     | X                   | X                    |        |
| Unidentified Cormorant                                                 | <i>Phalacrocorax sp.</i>         | X                   |         |                      |       |                     | X                    |        |
| Unidentified Grebe                                                     | Podicipedidae                    |                     |         |                      |       |                     | X                    |        |
| Unidentified Gull                                                      | <i>Larus sp</i>                  | X                   | X       | X                    |       | X                   | X                    | X      |
| Unidentified Hummingbird                                               | <i>Trochilidae sp</i>            | X                   |         |                      |       |                     |                      |        |
| Unidentified Sandpiper                                                 | Scolopacidae                     |                     |         | X                    |       | X                   |                      |        |
| Unidentified Scoter                                                    | <i>Melanitta sp.</i>             |                     |         |                      |       | X                   |                      |        |
| Unidentified Swallow                                                   | <i>Hirundidae sp</i>             |                     |         |                      | X     |                     |                      |        |
| Unidentified Teal                                                      | <i>Anas sp</i>                   |                     |         |                      |       |                     |                      | X      |
| Unidentified Yellowleg or grayleg                                      | Scolopacidae                     |                     | X       |                      |       | X                   |                      |        |
| Vaux's Swift                                                           | <i>Chaetura vauxi</i>            | X                   |         |                      |       |                     |                      |        |
| Violet-green Swallow                                                   | <i>Tachycineta thalassina</i>    | X                   | X       | X                    |       |                     |                      |        |
| Western Grebe                                                          | <i>Aechmophorus occidentalis</i> | X                   |         |                      |       | X                   |                      |        |
| Western Gull                                                           | <i>Larus occidentalis</i>        | X                   | X       | X                    | X     | X                   | X                    |        |
| Western Sandpiper                                                      | <i>Calidris mauri</i>            |                     |         |                      | X     | X                   |                      |        |
| Western Wood-Pewee                                                     | <i>Contopus sordidulus</i>       | X                   |         |                      |       |                     |                      |        |
| Whimbrel                                                               | <i>Numenius phaeopus</i>         |                     |         |                      |       | X                   | X                    |        |
| White-crowned Sparrow                                                  | <i>Zonotrichia leucophrys</i>    | X                   | X       | X                    |       | X                   | X                    |        |
| Wilson's Warbler                                                       | <i>Wilsonia pusilla</i>          | X                   | X       |                      |       |                     |                      |        |
| Winter Wren                                                            | <i>Troglodytes troglodytes</i>   | X                   |         |                      | X     | X                   |                      |        |
| Wrentit                                                                | <i>Chamaea fasciata</i>          | X                   | X       | X                    | X     | X                   | X                    |        |
| Yellow-breasted Chat                                                   | <i>Icteria virens</i>            | X                   | X       |                      |       |                     |                      |        |
| Yellow-throated Warbler                                                | <i>Dendroica dominica</i>        |                     |         | X                    |       |                     |                      |        |
| <b>Mammals</b>                                                         |                                  |                     |         |                      |       |                     |                      |        |
| Brush Rabbit                                                           | <i>Sylvilagus bachmani</i>       |                     |         | X                    |       |                     |                      |        |
| Harbor Seal                                                            | <i>Phoca vitulina</i>            | X                   | X       |                      |       |                     |                      |        |
| Roosevelt Elk                                                          | <i>Cervus elaphus</i>            |                     | X       |                      |       |                     |                      |        |
| <b>Invertebrates</b>                                                   |                                  |                     |         |                      |       |                     |                      |        |
| Amphipod                                                               | <i>Corophium sp.</i>             |                     |         |                      |       | X                   | X                    |        |
| Bay Shrimp                                                             | <i>Crangon franciscorum</i>      |                     |         | X                    |       | X                   | X                    |        |
| Caddisfly (larvae)                                                     | Limniphilidae                    | X                   | X       |                      |       |                     |                      |        |
| Comb Jelly Fish                                                        | Ctenophora                       |                     |         |                      |       | X                   |                      |        |
| Isopod                                                                 | <i>Gnorimosphaeroma sp.</i>      | X                   |         |                      |       | X                   |                      |        |
| Mysid Shrimp                                                           | <i>Neomysis mercedes</i>         |                     |         |                      |       | X                   | X                    |        |
| Stonefly (larvae)                                                      | <i>Pteronarcys sp.</i>           |                     |         | X                    |       |                     |                      |        |
| <b>Algae/Vascular Plants</b>                                           |                                  |                     |         |                      |       |                     |                      |        |
| Eel Grass (detritus)                                                   | <i>Vallisneria americana</i>     |                     |         |                      |       | X                   |                      |        |
| Green Algae                                                            | <i>Enteromorpha sp.</i>          |                     |         |                      |       | X                   |                      |        |
| Sea Lettuce                                                            | <i>Ulva sp.</i>                  |                     |         |                      |       |                     |                      |        |
| Surf Grass (detritus)                                                  | <i>Phyllospadix scouleri</i>     |                     |         |                      |       | X                   |                      |        |
| <sup>a</sup> = the week of                                             |                                  |                     |         |                      |       |                     |                      |        |
| * = Federally listed as Threatened ** = Federally listed as Endangered |                                  |                     |         |                      |       |                     |                      |        |

Table 2. Population estimates and 95 percent confidence intervals for juvenile chinook and coho salmon, juvenile steelhead trout, coastal cutthroat trout, and half-pounder steelhead seined in the Redwood Creek estuary embayment, Humboldt County, California, summer/fall 2005. Mouth of creek denotes if Redwood Creek mouth was open or closed to the Pacific Ocean during the estimate.

| 2005<br>DATE                                                                                                                                                                                  | Mouth of Creek<br>(Open or Closed) | Chinook Salmon         |                            | Coho Salmon            |                            |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|------------------------|----------------------------|------------------------|----------------------------|
|                                                                                                                                                                                               |                                    | Population<br>Estimate | 95% Confidence<br>Interval | Population<br>Estimate | 95% Confidence<br>Interval |
| 06/6, 7, 9                                                                                                                                                                                    | OPEN                               | 4,660                  | 3,190 - 6,130              | 4 <sup>b</sup>         | ---                        |
| 07/11, 12, 14                                                                                                                                                                                 | OPEN                               | 34 <sup>b</sup>        | ---                        | None caught            | ---                        |
| 08/22, 23, 25                                                                                                                                                                                 | OPEN                               | 2 <sup>b</sup>         | ---                        | None caught            | ---                        |
| 09/19, 20, 22                                                                                                                                                                                 | CLOSED                             | 50                     | 26 <sup>a</sup> - 84       | 1 <sup>b</sup>         | ---                        |
|                                                                                                                                                                                               |                                    | Steelhead Trout        |                            | Cutthroat Trout        |                            |
| 06/6, 7, 9                                                                                                                                                                                    | OPEN                               | 42 <sup>b</sup>        | ---                        | 3 <sup>b</sup>         | ---                        |
| 07/11, 12, 14                                                                                                                                                                                 | OPEN                               | 960                    | 89 <sup>a</sup> - 2,220    | 24                     | 11 <sup>a</sup> - 57       |
| 08/22, 23, 25                                                                                                                                                                                 | OPEN                               | 300                    | 109 <sup>a</sup> - 540     | 47                     | 30 <sup>a</sup> - 70       |
| 09/19, 20, 22                                                                                                                                                                                 | CLOSED                             | 540                    | 155 <sup>a</sup> - 930     | 5 <sup>b</sup>         | ---                        |
|                                                                                                                                                                                               |                                    | Half Pounder Steelhead |                            |                        |                            |
| 08/22, 23, 25                                                                                                                                                                                 | OPEN                               | 3 <sup>b</sup>         | ---                        |                        |                            |
| a. Actual minimum count, calculated 95% lower confidence interval was below what was actually caught<br>b. Actual number of fish captured in seine net hauls. No marked fish were recaptured. |                                    |                        |                            |                        |                            |

*Cutthroat Trout* - For cutthroat trout, no marked fish were recaptured during the week of the June 6 estimate. The actual number of cutthroat captured in 32 seine hauls was three. The estimate the week of July 11 was 24 (95% CI 11 [actually caught] to 57). The estimate the week of August 22 was 47 (95% CI 30 [actually caught] to 70). No marked fish were recaptured during the September 19 estimate, only five cutthroat were captured in 34 seine hauls. On the one-day growth estimates of June 23 and August 9, 10 and 37 cutthroat were captured, respectively. None were captured on October 18. A total of 99 cutthroat were caught during the 2005 season.

*Starry Flounder* - As we were seining relatively large numbers of starry flounder, population estimates were attempted in 2005 (Table 3). Only one estimate the week of June 6 was successful. No marked fish were recaptured in the later three estimates. The population estimate the week of June 6 was 136 (95% CI 24 [actually caught] to 380). The actual number of starry flounder caught during the week of July 11, August 22, and September 19 were 17, 8, and 5, respectively.

Table 3. Population estimates for starry flounder seined in the Redwood Creek estuary embayment, Humboldt County, California, summer/fall 2005. Mouth of creek denotes if Redwood Creek mouth was open or closed to the ocean during the estimate.

| 2005<br>DATE                                                                                         | Mouth of Creek<br>(Open or Closed) | Starry Flounder        |                            |
|------------------------------------------------------------------------------------------------------|------------------------------------|------------------------|----------------------------|
|                                                                                                      |                                    | Population<br>Estimate | 95% Confidence<br>Interval |
| 06/6, 7, 9                                                                                           | OPEN                               | 136                    | 24 <sup>a</sup> - 380      |
| 07/11, 12, 14                                                                                        | OPEN                               | 17 <sup>b</sup>        | ---                        |
| 08/22, 23, 25                                                                                        | OPEN                               | 8 <sup>b</sup>         | ---                        |
| 09/19, 20, 22                                                                                        | CLOSED                             | 5 <sup>b</sup>         | ---                        |
| a. Actual minimum count, calculated 95% lower confidence interval was below what was actually caught |                                    |                        |                            |
| b. Actual number of fish captured in seine net hauls. No marked fish were recaptured.                |                                    |                        |                            |

Growth Estimates – Seven growth estimates were conducted, four in conjunction with population estimates during the weeks of June 6, July 11, August 22 and September 19, and three growth estimates on June 23, August 9, and October 18 (Table 4). The absence of fish made it difficult to attain the 200 length measurements for chinook and steelhead. We were only able to measure 200 fish once, during the week of June 6 for chinook .

*Chinook Salmon* – A total of 333 juvenile chinook salmon were measured. Mean fork length increased from 61 to 114 mm, an increase of 53 mm between the weeks of June 6 and September 19 (Table 4 and Figure 2). The smallest fish were measured in June at 46 mm. The largest fish measured was 136 mm (most likely a 2+ juvenile) in September. The minimum and maximum fork lengths measured the week of June 6 were 46 and 97 mm, respectively. The minimum and maximum fork lengths measured the week of September 19 were 90 and 136 mm, respectively. The one chinook seined on October was 118 mm.

Table 4. Mean fork length (mm), mean weight (g), standard deviation, range, dates, and numbers sampled of juvenile chinook and coho salmon; and steelhead, coastal cutthroat, and half-pounder trout seined in the Redwood Creek estuary embayment, Humboldt County, California, during summer/fall of 2005 from June 06 to October 18. Mouth denotes if Redwood Creek mouth was open or closed to the ocean.

| Growth - Redwood Creek Estuary – Summer/Fall 2005 |        |                  |      |          |           |                |      |           |             |
|---------------------------------------------------|--------|------------------|------|----------|-----------|----------------|------|-----------|-------------|
| 2005<br>DATE                                      | MOUTH  | FORK LENGTH (mm) |      |          |           | WEIGHT (g)     |      |           |             |
|                                                   |        | No.<br>Measured  | Mean | Std. Dev | Range     | No.<br>Weighed | Mean | Std. Dev. | Range       |
| JUVENILE CHINOOK SALMON                           |        |                  |      |          |           |                |      |           |             |
| 06/ 06, 07                                        | OPEN   | 214              | 61   | 9.7      | 46 - 97   | 39             | 3.2  | 2.2       | 1.1 - 9.9   |
| 06/ 23                                            | OPEN   | 41               | 78   | 12.5     | 46 - 100  | 30             | 4.9  | 2.2       | 1.0 - 10.9  |
| 07/ 12                                            | OPEN   | 34               | 82   | 5.9      | 73 - 95   | 30             | 6.3  | 1.6       | 3.3 - 9.5   |
| 08/ 09                                            | OPEN   | 15               | 91   | 7.0      | 70 - 100  | 15             | 8.3  | 1.7       | 3.8 - 10.9  |
| 08/ 23, 25                                        | OPEN   | 2                | 100  | 4.2      | 97 - 103  | 2              | 10.8 | 1.3       | 9.9 - 11.7  |
| 09/ 19, 20, 22                                    | CLOSED | 26               | 114  | 11.9     | 90 - 136  | 26             | 17.5 | 5.8       | 7.9 - 32.3  |
| 10/ 18                                            | CLOSED | 1                | 118  | -        | -         | 1              | 17.7 | -         | -           |
| JUVENILE COHO SALMON                              |        |                  |      |          |           |                |      |           |             |
| 06/ 07                                            | OPEN   | 4                | 86   | 35.3     | 58 - 134  | 4              | 10.2 | 12.3      | 1.7 - 28.0  |
| 06/ 23                                            | OPEN   | 2                | 115  | 0        | 115 - 115 | 2              | 20.7 | 0.21      | 20.5 - 20.8 |
| 07/ 11, 12, 14                                    | OPEN   | -                | -    | -        | -         | -              | -    | -         | -           |
| 08/ 09                                            | OPEN   | -                | -    | -        | -         | -              | -    | -         | -           |
| 08/ 22, 23, 25                                    | OPEN   | -                | -    | -        | -         | -              | -    | -         | -           |
| 09/ 22                                            | CLOSED | 1                | 115  | -        | -         | 1              | 14.9 | -         | -           |
| 10/ 18                                            | CLOSED | -                | -    | -        | -         | -              | -    | -         | -           |

| Growth – Redwood Creek Estuary – Summer/Fall 2005 (con't.) |        |                  |      |          |           |                |       |          |              |
|------------------------------------------------------------|--------|------------------|------|----------|-----------|----------------|-------|----------|--------------|
| 2005<br>DATE                                               | MOUTH  | FORK LENGTH (mm) |      |          |           | WEIGHT (g)     |       |          |              |
|                                                            |        | No.<br>Measured  | Mean | Std. Dev | Range     | No.<br>Weighed | Mean  | Std. Dev | Range        |
| JUVENILE STEELHEAD TROUT                                   |        |                  |      |          |           |                |       |          |              |
| 06/ 06, 07, 09                                             | OPEN   | 42               | 120  | 21.1     | 52 - 161  | 30             | 18.2  | 9.7      | 6.2 - 39.9   |
| 06/ 23                                                     | OPEN   | 122              | 140  | 18.3     | 100 - 200 | 30             | 30.6  | 11.7     | 12.1 - 64.6  |
| 07/ 11, 12, 14                                             | OPEN   | 90               | 151  | 17.2     | 110 - 185 | 54             | 36.8  | 12.5     | 14.0 - 63.6  |
| 08/ 09                                                     | OPEN   | 95               | 145  | 21.4     | 85 - 235  | 30             | 36.8  | 15.5     | 6.6 - 61.9   |
| 08/ 22, 23, 25                                             | OPEN   | 109              | 153  | 23.0     | 93 - 210  | 30             | 44.9  | 22.0     | 9.6 - 104.3  |
| 09/ 19, 20, 22                                             | CLOSED | 148              | 159  | 27.7     | 65 - 223  | 31             | 49.9  | 28.0     | 6.0 - 121.6  |
| 10/ 18                                                     | CLOSED | 1                | 190  | -        | -         | 1              | 83.3  | -        | -            |
| CUTTHROAT TROUT                                            |        |                  |      |          |           |                |       |          |              |
| 06/ 07, 09                                                 | OPEN   | 3                | 240  | 51.7     | 196 - 297 | 3              | 148.4 | 102.3    | 69.5 - 264   |
| 06/ 23                                                     | OPEN   | 10               | 211  | 17.4     | 185 - 235 | 10             | 96.2  | 33.3     | 31.1 - 130.8 |
| 07/ 11,12, 14                                              | OPEN   | 14               | 272  | 87.1     | 185 - 440 | 13             | 278   | 300.3    | 41.4 - 844   |
| 08/ 09                                                     | OPEN   | 37               | 331  | 45.4     | 271 - 465 | 25             | 440   | 241.4    | 200 - 1194   |
| 08/ 22, 23, 25                                             | OPEN   | 30               | 330  | 56.5     | 202 - 431 | 30             | 437   | 214.7    | 68.0 - 884   |
| 09/ 19, 20, 22                                             | CLOSED | 5                | 326  | 68.1     | 223 - 412 | 5              | 448   | 231.9    | 117.0 - 754  |
| 10/ 18                                                     | CLOSED | -                | -    | -        | -         | -              | -     | -        | -            |
| HALF POUNDER STEELHEAD                                     |        |                  |      |          |           |                |       |          |              |
| 08/ 25                                                     | OPEN   | 3                | 318  | 19.0     | 299-337   | 3              | 379   | 77.6     | 296 - 450    |

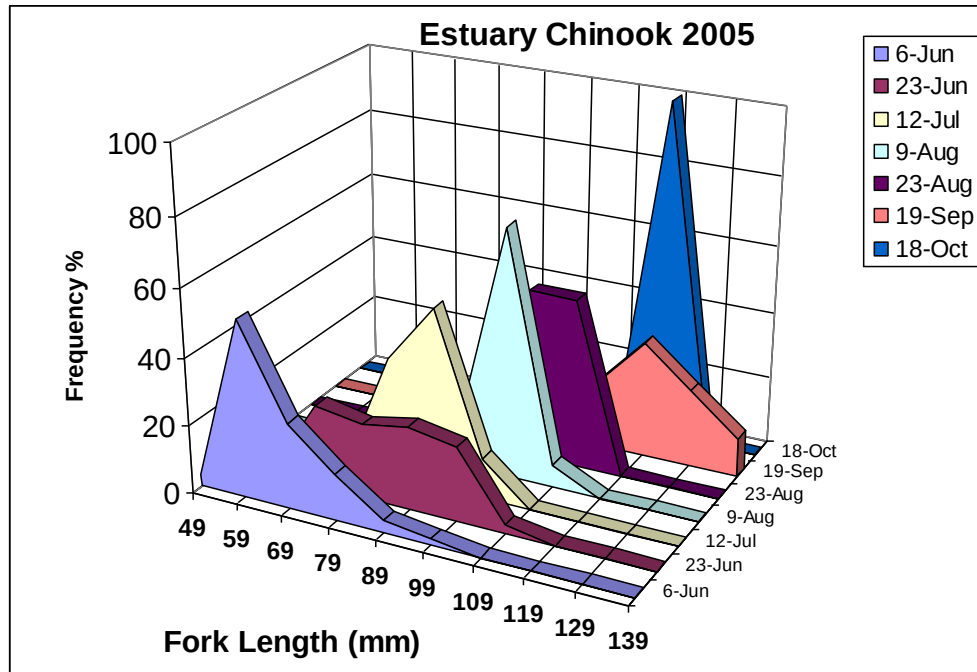


Figure 2. Fork length (mm) versus frequency (%) histogram of Redwood Creek estuary juvenile chinook sampled June 6 through October 18, 2005. The fork length intervals were 10-mm increments.

One juvenile chinook salmon was caught beach seining at low tide at Gold Bluffs Beach (opposite Espau Lagoon), north of Redwood Creek on August 19. Its total length was 93 mm (Karah Cox, personal communication). The sampling was part of a marine resources study conducted by HSU graduate students.

Of a total of 143 chinook weighed, mean weight increased from 3.2 g to 17.5 g between the weeks of June 6 and September 19, and increase of 14.3 grams. The one chinook weighed on October 18 weighed 17.7 g. During the sample period the minimum and maximum chinook weights were 1.0 g and 32.3 g, respectively.

*Coho Salmon* - Of the seven coho measured, fork lengths ranged from 58 mm to 134 mm. Weight ranged from 1.7 g to 28.0 g.

*Steelhead Trout* - A total of 607 juvenile steelhead were measured. Mean fork length increased from 120 mm to 159 mm, an increase of 39 mm between the weeks of June 7 and September 19 (Table 4). A lone steelhead caught on October 18 was 190 mm. For the season, the smallest fish measured was 52 mm, the largest 235 mm. Several age classes were present but few young-of-the-year fish were captured (Figure 3). Mean juvenile weight ranged from 18.2 g to 49.9 g, and increase of 31.7 grams between the weeks of June 7 and September 19. The lone steelhead caught on October 18 weighed 83.3 g. The minimum and maximum weight measured during the sample season was 6.2 g and 121.6 g, respectively.

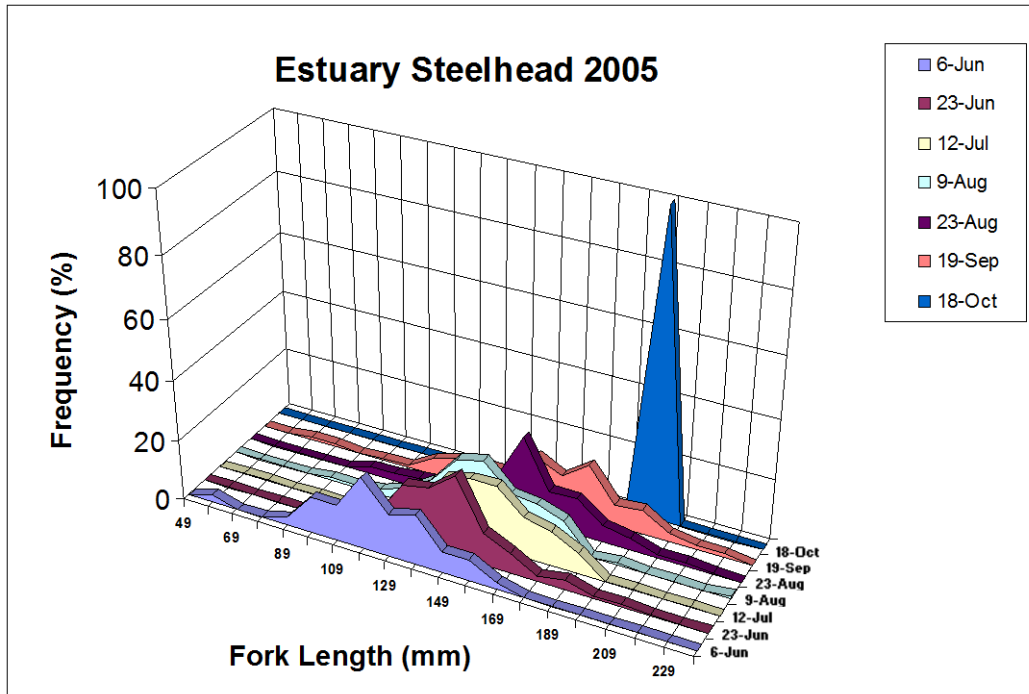


Figure 3. Fork length (mm) versus frequency (%) histogram of Redwood Creek estuary juvenile steelhead trout sampled June 6 through October 18, 2005. The fork length intervals were 10-mm increments. Several age classes are present.

*Half-Pounder Steelhead* - The three half-pounder steelhead seined on August 25 are reported separately from the juvenile steelhead data. The fish mean fork length was 318 mm (range 299mm to 337mm) and mean weight was 379 g (range 296g to 450 g) (Table 4).

*Cutthroat Trout* - A total of 99 coastal cutthroat trout were captured. Mean fork length generally increased from June to September, 211 mm to 326 mm, a 86 mm increase (Table 4). The smallest cutthroat measured was 185 mm, the largest 465 mm. Mean weight increased from 96.2 g to 448 g, an increase of 352 g. Weights ranged between 31.1 g and 1194 g (2.6 lbs).

*Non-Salmonid Fish* - Total length (mm) data for starry flounder, Sacramento sucker, American shad, shiner and walleye surfperch, bay pipefish, staghorn and prickly sculpin, and night smelt seined in the Redwood Creek embayment are presented in Table 5.

Condition Factor (K') – Fish condition factors are presented in Table 6. Species mean conditions factors of each date remained approximately the same throughout the season. Mean chinook K' for seven sample dates ranged from 0.657 to 0.735, but individual K' ranged between 0.410 and 0.905. The seasonal mean for all chinook was 0.703. The seasonal mean for all seven coho was 0.551. Mean steelhead K' for sample dates ranged from 0.902 to 1.081, but individual K' ranged between 0.667 and 1.368. The seasonal mean for all steelhead was 0.984. Mean cutthroat K' for the sample dates ranged from 0.325 to 0.366, but individual K' ranged between 0.140 and 0.421. The seasonal mean for all cutthroat was 0.348.

Table 5. Mean total length (mm), standard deviation, range, dates, and numbers sampled of non-salmonid fish captured in the Redwood Creek estuary embayment, Humboldt County, California, during summer and fall 2005. Mouth denotes if Redwood Creek mouth was open or closed to the ocean.

| 2005<br>DATE      | MOUTH  | TOTAL LENGTH (mm) |      |          |           |
|-------------------|--------|-------------------|------|----------|-----------|
|                   |        | No.<br>Measured   | Mean | Std. Dev | Range     |
| STARRY FLOUNDER   |        |                   |      |          |           |
| 06/ 06, 07, 09    | OPEN   | 24                | 135  | 29.7     | 90 - 192  |
| 06/ 23            | OPEN   | 16                | 128  | 24.2     | 97 - 173  |
| 07/ 11, 12, 14    | OPEN   | 17                | 200  | 109.8    | 111 - 545 |
| 08/ 09            | OPEN   | 3                 | 224  | 46.4     | 174 - 266 |
| 08/ 22, 23, 25    | OPEN   | 8                 | 148  | 128.6    | 26 - 360  |
| 09/ 19, 20        | CLOSED | 5                 | 65   | 6.6      | 57 - 72   |
| 10/ 18            | CLOSED | 1                 | 86   |          |           |
| AMERICAN SHAD     |        |                   |      |          |           |
| 06/ 23            | OPEN   | 1                 | 205  | -        | -         |
| SACRAMENTO SUCKER |        |                   |      |          |           |
| 09/ 19            | CLOSED | 1                 | 49   | -        | -         |
| WALLEYE SURFPERCH |        |                   |      |          |           |
| 08/ 23            | OPEN   | 3                 | 75   | 5.0      | 70 - 80   |
| SHINER SURFPERCH  |        |                   |      |          |           |
| 08/ 22, 23, 25    | OPEN   | 82                | 52   | 11.3     | 37 - 90   |
| 09/ 19            | CLOSED | 82                | 68   | 14.1     | 53 - 122  |
| BAY PIPEFISH      |        |                   |      |          |           |
| 08/25             | OPEN   | 1                 | 200  | -        | -         |
| STAGHORN SCULPIN  |        |                   |      |          |           |
| 09/ 19            | CLOSED | 2                 | 50   | 29.7     | 29 - 71   |
| PRICKLY SCULPIN   |        |                   |      |          |           |
| 09/ 19            | CLOSED | 1                 | 90   | -        | -         |
| NIGHT SMELT       |        |                   |      |          |           |
| 09/ 20            | CLOSED | 2                 | 107  | 2.8      | 105 - 109 |

Table 6. Mean condition factor (K'), sample size, standard deviation, minimum and maximum values of captured salmonids measured (fork length cm) and weighed (g) from the Redwood Creek embayment, Humboldt County, California, during the summer and fall of 2005. Condition factor is calculated as:  $K' = 100W_{(g)} / FKL_{(cm)}^b$ . Slope (b) was calculated as:  $\log_{10} \text{Weight}_{(g)} = \log_{10} a + b \log_{10} \text{Fork Length}_{(cm)}$ .

| Condition Factor (K') - Redwood Creek Estuary 2005 |          |           |           |          |           |           |            |                      |
|----------------------------------------------------|----------|-----------|-----------|----------|-----------|-----------|------------|----------------------|
| Date (week of)                                     | 6/6/2005 | 6/23/2005 | 7/12/2005 | 8/9/2005 | 8/23/2005 | 9/19/2005 | 10/18/2005 | Summer/<br>Fall 2005 |
| <b>Chinook Salmon (b = 3.201)</b>                  |          |           |           |          |           |           |            |                      |
| Mean                                               | 0.669    | 0.735     | 0.715     | 0.712    | 0.679     | 0.702     | 0.657      | 0.703                |
| Count                                              | 39       | 30        | 30        | 15       | 2         | 26        | 1          | 143                  |
| Standard Deviation                                 | 0.075    | 0.068     | 0.073     | 0.040    | 0.012     | 0.060     | ---        | 0.070                |
| Minimum                                            | 0.410    | 0.463     | 0.522     | 0.654    | 0.671     | 0.519     | ---        | 0.410                |
| Maximum                                            | 0.770    | 0.862     | 0.905     | 0.795    | 0.688     | 0.826     | ---        | 0.905                |
| <b>Coho Salmon (b = 3.316)</b>                     |          |           |           |          |           |           |            |                      |
| Mean                                               | 0.538    | 0.628     |           |          |           | 0.453     |            | 0.551                |
| Count                                              | 4        | 2         | 0         | 0        | 0         | 1         | 0          | 7                    |
| Standard Deviation                                 | 0.043    | 0.006     |           |          |           | ---       |            | 0.068                |
| Minimum                                            | 0.500    | 0.623     |           |          |           | ---       |            | 0.453                |
| Maximum                                            | 0.597    | 0.632     |           |          |           | ---       |            | 0.632                |
| <b>Steelhead Trout (b = 3.040)</b>                 |          |           |           |          |           |           |            |                      |
| Mean                                               | 0.902    | 1.064     | 0.945     | 1.029    | 0.990     | 1.005     | 1.081      | 0.984                |
| Count                                              | 30       | 30        | 54        | 30       | 30        | 31        | 1          | 206                  |
| Standard Deviation                                 | 0.118    | 0.058     | 0.050     | 0.067    | 0.071     | 0.086     | ---        | 0.091                |
| Minimum                                            | 0.667    | 0.964     | 0.750     | 0.892    | 0.697     | 0.878     | ---        | 0.667                |
| Maximum                                            | 1.291    | 1.197     | 1.060     | 1.164    | 1.097     | 1.368     | ---        | 1.368                |
| <b>Cutthroat Trout (b = 3.335)</b>                 |          |           |           |          |           |           |            |                      |
| Mean                                               | 0.333    | 0.358     | 0.325     | 0.354    | 0.347     | 0.366     |            | 0.348                |
| Count                                              | 3        | 10        | 13        | 25       | 30        | 5         | 0          | 86                   |
| Standard Deviation                                 | 0.009    | 0.075     | 0.063     | 0.025    | 0.032     | 0.033     |            | 0.043                |
| Minimum                                            | 0.324    | 0.155     | 0.140     | 0.302    | 0.302     | 0.310     |            | 0.140                |
| Maximum                                            | 0.341    | 0.417     | 0.374     | 0.412    | 0.421     | 0.394     |            | 0.421                |

## Water Quality Monitoring

Water Temperature - In summer/fall 2005, water temperature (°C) was the only water quality parameter monitored in the Redwood Creek estuary. A TidBit temperature logger recorded water temperature every 1-hour from June 9 through October 20, 2005 (Figure 4). Similar to other years, placement of the probe was delayed from the recommended June 1<sup>st</sup> date because the mouth was open. It was feared the probe would be stolen when exposed at low water levels. The maximum and minimum temperatures measured between June 9 and October 20 were 22.3°C (July 18, 5 and 6 pm) and 12.0°C (June 18, 7 and 8 am, and June 19, 4 am to 9 am), respectively. The average water temperature for this period was 15.9°C. The maximum and minimum water temperatures from July 1 to August 31, the warmest period of the summer, were 22.3 °C and 12.8°C, respectively. The average water temperature for that period was 16.6°C.

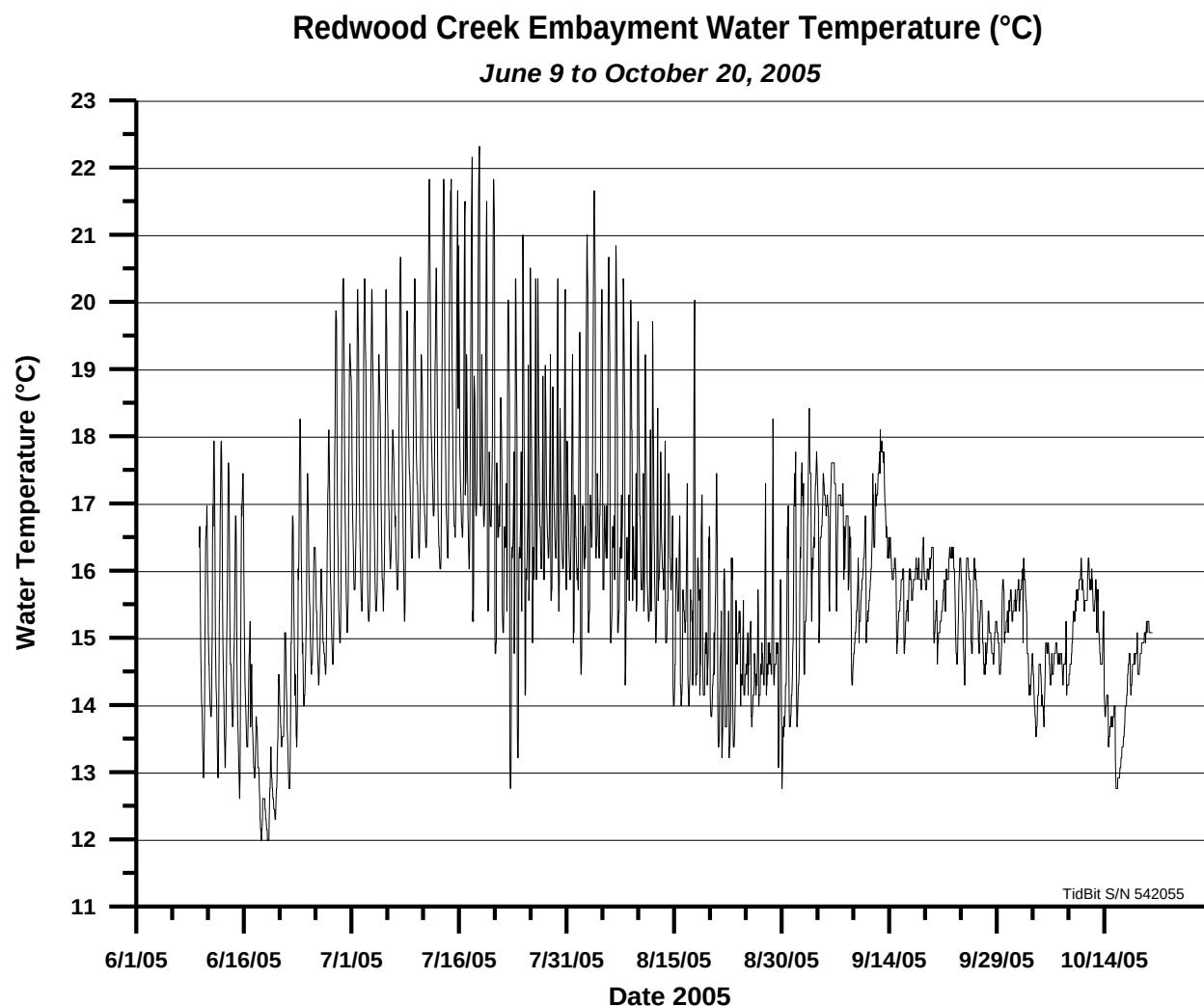


Figure 4. Redwood Creek estuary water temperatures (°C) measured by an Onset Tidbit temperature logger located in the embayment between the ends of the north and south flood control levees. The temperature logger, located one foot from the bottom, recorded water temperature every 1-hour from June 9 to October 20, 2005.

The large daily temperature ranges in the embayment when the mouth was open are the result of tidal action; the minimums influenced by the cooler ocean water entering the estuary at high tide, and the maximums influenced by the warmer water from upstream at low tide (Figure 5). After the closure of the mouth in early September, the diurnal ranges and maximum temperatures were less.

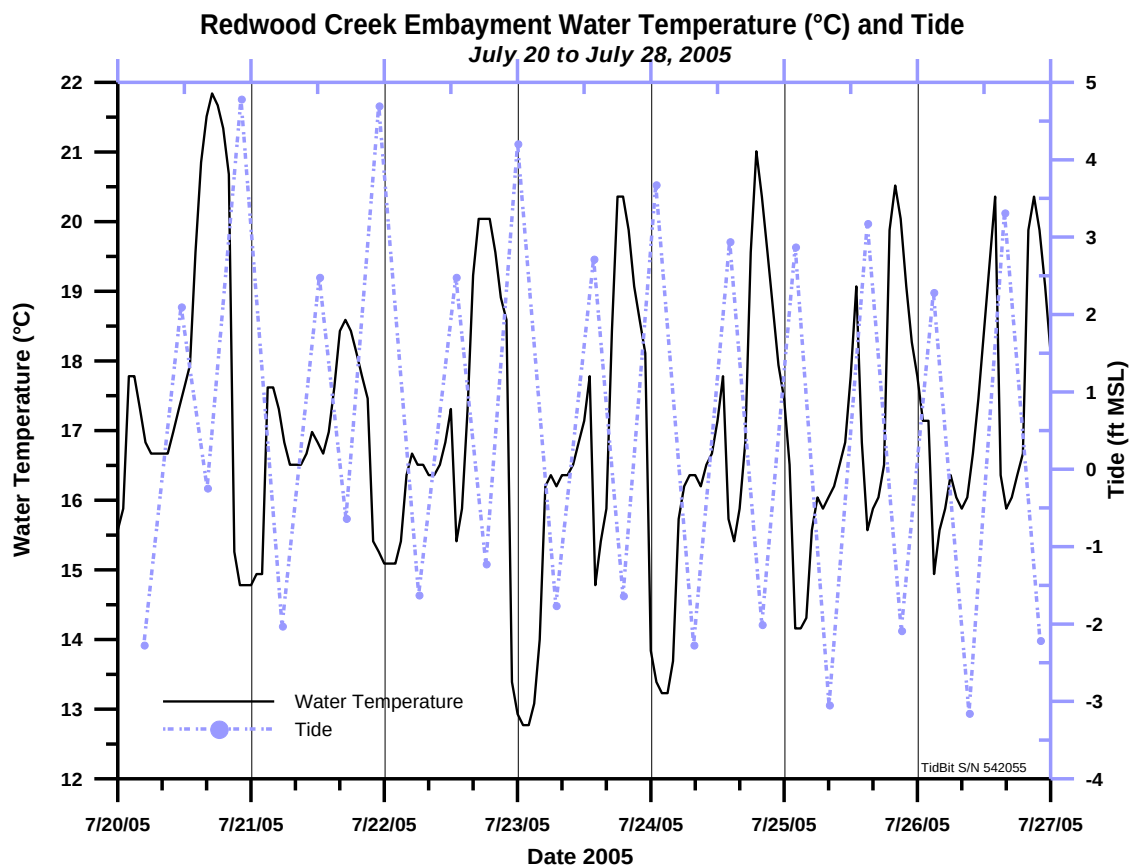


Figure 5. Embayment water temperature (°C) and estimated tides at the mouth of Redwood Creek for the period July 20 to July 28, 2005, a period of extreme high high and low low tides.

### **Tide and Stream Flow**

Tides at the Mouth of Redwood Creek - The maximum and minimum tide at the mouth of Redwood Creek (based on verified tides at Crescent City, California) was 6.03 ft MSL and -3.64 ft MSL, respectively, a range of 9.67 feet. Tidal data is included in Figure 6.

Stream Flow - Calendar year 2005 stream flow data, January 1 through December 31, is presented in Appendix II. The maximum flow was 30,100 cfs on December 30. The gage measured a minimum flow of 15 cfs between September 29 and October 1. The first appreciable stream flow of the fall occurred on October 15, when after 1.36 inches of rain, the flow went from 18 cfs to a peak of 123 cfs. The flow data is provisional and subject to revision by the California Department of Water Resources.

## **Estuary Water Level**

### **South Slough and South Levee/Embayment Water Level Gaging**

South slough water elevations (feet MSL) were recorded every 30 minutes for the period January 1 to October 24 when the recorder failed due to floating wood that destroyed the transducer cable (Tom Marquette, personal communication) (Figure 6). Elevation data recorded between January 3 and 31 was suspected as bad and not graphed.

The temporary south levee/embayment gage was installed on June 2 and removed on December 5. It measured the embayment water level every 15 minutes (Figure 7). Only the data recorded to November 16, a previous download date, was used because sometime after that date large incoming waves and/or debris pushed the standing well pipe askew and pulled the cable causing the transducer to rise in the pipe.

The embayment gage site at the end of the south levee measured lower embayment water elevations than the gage in the south slough. The lowest water levels in the south slough are limited by the invert of the south slough culvert gates and sand deposited in the south slough outlet channel. Based on the 2005 south slough water elevation gaging data, before the south slough culverts were opened, the lowest south slough water elevation was limited to 3.6 ft MSL. With the culverts open, the lowest south slough elevation was limited to 2.3 ft MSL. The bottom of the culvert (invert) is lower than the natural south slough channel thalweg. The lowest embayment water elevation measured by the south levee/embayment gage was -0.11 ft MSL (Figure 7). The south levee/embayment gage had the potential to measure to -1.9 ft MSL.

## **Closure, Breaching and Estuary Response**

Based on observations and the recording water level gages in the south slough and embayment, the Redwood Creek estuary closed once and was illegally breached on the third attempt. The estuary mouth closed on September 7 and remained closed for 57 days until breached on November 3.

### **September 7<sup>th</sup> Closure.**

The mouth of the estuary closed on September 7, 2005 at an embayment elevation of 4.3 ft MSL (Figure 6 and 7). Redwood Creek flow at the time was 28 cfs. The 2005 mouth closure was much later in the season than in past years. For 1997 through 2004, the mouth initially closed in late June to mid-July. Late seasonal rains in spring that increased river flow likely influenced the timing of the mouth closure.

### **October 24 Illegal Breach Attempt.**

On October 25, a RNSP employee walking on the beach saw the remnants of an illegal breaching attempt from the day before. The hand dug channel was not successful. It had filled in with sand from wave overwash (Figure 8).

On October 25, after 0.44 inches of rain (measured at the Orick stream flow gage), flow increased from 25 cfs to a peak of 53 cfs. The mouth remained closed.

## South Slough Water Levels and Tides at Mouth of Redwood Creek 1/01/05 to 12/31/05

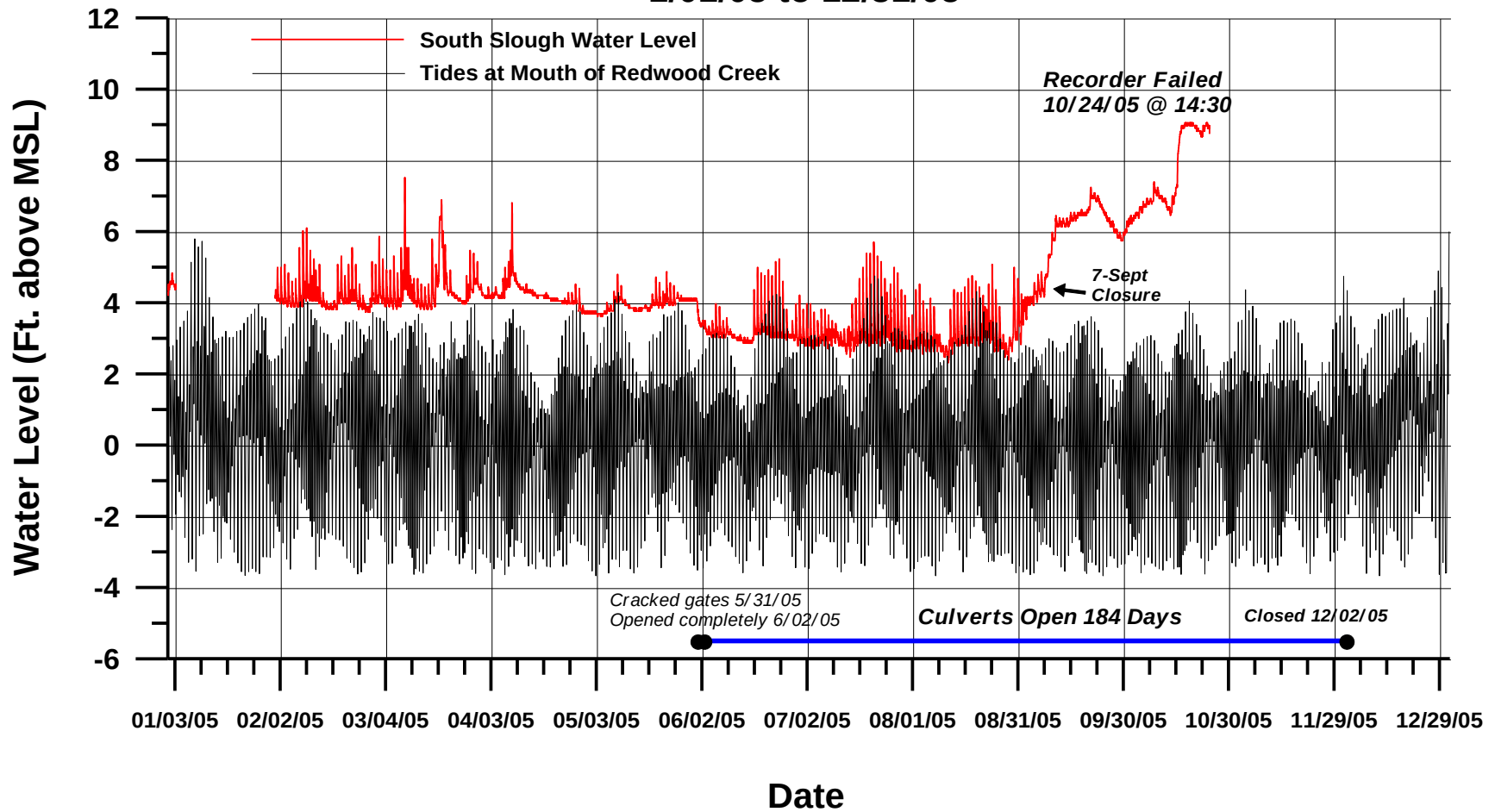


Figure 6. South slough water elevations (feet Mean Sea Level [MSL]) of the Redwood Creek estuary, Humboldt County and tides at the mouth of Redwood Creek for the period January 1 to December 31, 2005. Crescent City verified tidal elevations (ft. MSL) were corrected for the coastal locality at the mouth of Redwood Creek.

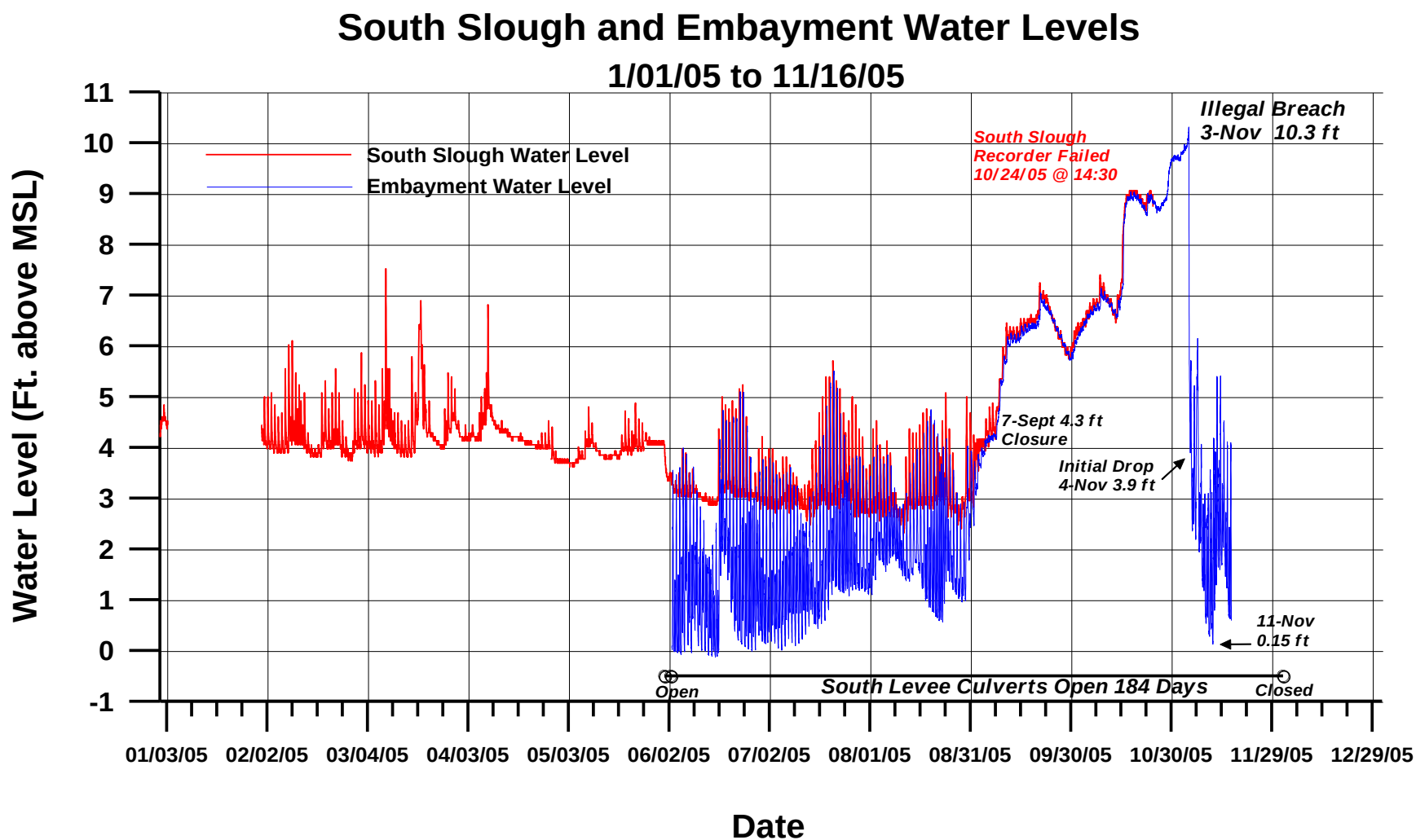


Figure 7. Water level elevations (ft. Mean Sea Level [MSL]) recorded in the south slough and at the end of the south levee of the embayment, Redwood Creek estuary, Humboldt County, California for calendar year 2005.



Figures 8. Left: Failed October 24 illegal breaching attempt (October 26, 2005 RNSP). The channel had filled in with sand from wave overwash.  
 Right: Relation of excavated channel and sand berm with 8.76 ft (MSL) estuary water elevation (October 26, 2005 RNSP).

#### October 27 Illegal Breach Attempt

On the afternoon of October 27, in response to reports of activity on the berm, RNSP resource and law enforcement personnel walked out to the berm where two people with shovels had been seen. An illegally dug channel was present and water was flowing in the channel (Figure 9). The two people came back and contact was made. They were asked if they had a permit, but no answer was given. One of the people, a landowner, discussed their frustration with the continuing problem of water in the fields and no action after years of talking. Not wanting to escalate the situation, water flow in the channel was stopped and the channel partially filled with sand after they left (Figure 10). No NPS citation was written for the breaching. The landowner was told it would be referred to NOAA Fisheries. The water elevation of the estuary was 8.9 ft MSL at the time of the incident.

On October 28, after 0.6 inches of rain, Redwood Creek flow peaked at 141 cfs, up from around 25 cfs. The mouth remained closed.

#### November 3rd Illegal Breach

At noon on November 3<sup>rd</sup>, a rainy day, RNSP fishery biologists went out to the berm to check on the height of the water in relation to the sand berm. All traces of the previous hand dug channels were gone. At one low point of the berm the sand was saturated. The water table was exposed when the sand was scraped with a boot heel. It appeared the estuary water level was only inches from



Figure 9. Water flowing in a channel that was illegally dug to breach the sand berm and lower the water elevation of the Redwood Creek estuary on October 27, 2005 (RNSP).



Figure 10. Filling in the illegally dug channel to stop the water flow (October 27, 2005 RNSP).

over-topping the berm. Later that afternoon, the same person from the October 27<sup>th</sup> breaching attempt and others were contacted by law enforcement personnel on the berm where an illegal channel was being dug. Water was flowing through the excavated channel. No citations were written.

As it takes several hours for an excavated channel to widen and deepen and begin to drain the estuary, the water elevation continued to increase 0.3 feet. The estuary water elevation peaked at 10.3 ft MSL at 9:30 pm before a precipitous drop to an initial low of 3.9 ft MSL at 8:45 am the next morning on November 4, a decrease of 6.4 feet and 1,609,800 cubic feet in estuary volume in 11 hours and 15 minutes (Figure 7). The estuary water level eventually bottomed out at 0.15 ft MSL on November 11, a total drop of 10.2 feet.

The November 3<sup>rd</sup> storm deposited 1.08 inches of rain, and flow increased from 56 cfs on November 3 to a peak of 1,370 cfs on November 4 at 4am and down to 295 cfs on November 5 at 10pm. At the time of the uncontrolled breach, discharge at 9pm and 10pm was 467 cfs and 572 cfs, respectively. The tides on November 3 were a high high tide of 4.4 ft MSL (8.2 ft MLLW) at 11:12 am, a low low tide of -2.9 ft MSL (0.7 ft MLLW) at 6:42 pm, and a high tide of 2.1 ft MSL (5.9 ft MLLW) at 1:12 am on November 4.

In all probability, the mouth would have naturally breached the evening of November 3<sup>rd</sup> without manipulation from anyone. In addition, between November 5 at 10pm and November 7 at 10 am, 4.44 inches of rain fell. Redwood Creek peaked at 7,670 cfs at 10 am on November 6<sup>th</sup>. In this case, the timing of the illegal breaching would not have caused any stranding of returning adult fish migrating up Redwood Creek.

### **South Slough Culvert Gates**

The culvert gates are opened to increase circulation between the south slough and the embayment after the last storms of spring. The three south slough culvert gates were cracked opened about 3 - 4 inches on May 31. Brown in color, water flowed out through the culverts into Redwood Creek when the gates were opened. The mouth was open at the time, the flow ~ 570 cfs and the incoming tide mixed with the plume before it reached the ends of the levees. The partial opening was done to lower the water level in the slough gradually and dilute the effluent plume. The culvert gates were completely opened on June 2<sup>nd</sup>. This stopped water flowing through the south slough channel outlet. The gates were closed on December 2. Water was flowing into the slough through the gates when they were closed. The gates were open for 184 days (Figure 6).

### **Estuary Cross Sections**

The five permanent parallel cross-sections in the embayment (E-1 through E-5) were surveyed on July 5<sup>th</sup>. Starting at the end of the levees with E-1 and ending at E-5, the sea stack adjacent to the berm, the surveys extended south from the base of the hill, through the embayment, and into the sand dunes north of KVC. Estuary cross sections, 1998 to 2005, are presented in Appendix III. The deepest surveyed point at cross-section E-1 was -2.49 ft MSL, at E-2 it was -2.75 ft MSL, at E-3 it was -3.42 ft MSL, at E-4 it was -4.03 ft MSL, and at E-5 it was -4.67 ft MSL.

The total cross section net change (scour [-] or fill [+]) and total scour and fill compared to the last survey in 2003 were as follows: E-1 net change -107.6 ft<sup>2</sup> (total scour -193.8 ft<sup>2</sup>, total fill +86.2 ft<sup>2</sup>); E-2 net change +7.9 ft<sup>2</sup> (total scour -496.1 ft<sup>2</sup>, total fill +504.0 ft<sup>2</sup>); E-3 net change +469.1 ft<sup>2</sup> (total scour -458.4 ft<sup>2</sup>, total fill +927.6 ft<sup>2</sup>); E-4 net change +1,504.1 ft<sup>2</sup> (total scour -393.6 ft<sup>2</sup>, total fill +1,897.7 ft<sup>2</sup>); and E-5 net change -1,463.5 ft<sup>2</sup> (total scour -1,694.4 ft<sup>2</sup>, total fill +230.9 ft<sup>2</sup>).

Also calculated for the embayment (excluding the north and south sloughs and the area of the embayment/channel upstream of the ends of the levees) was embayment volume (ft<sup>3</sup>) and wetted width for the cross sections for varying water elevations (Appendix III and Table 7). Calculated embayment volume ranged from 1,543 ft<sup>3</sup> at -4 ft MSL to 4,111,693 ft<sup>3</sup> at 11 ft MSL. At 0 ft MSL the volume was 314,511 ft<sup>3</sup>.

Table 7. Calculated 1998, 1999, 2000, 2001, 2002, and 2005 water volume (ft<sup>3</sup>) of the Redwood Creek embayment at water elevations of 11 to -4 ft MSL. The embayment is the area west of the ends of the north and south levee to the berm and not including the north or south sloughs. (Compiled from Anderson 1999, 2000, 2001, 2002, and 2003)

| Water Elevation (ft MSL) | 1998 Volume (ft3) | 1999 Volume (ft3) | 2000 Volume (ft3) | 2001 Volume (ft3) | 2002 Volume (ft3) | 2005 Volume (ft3) |
|--------------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| 11                       | 10,441,569        | 3,872,874         | 4,177,581         | 3,993,996         | 4,101,465         | 4,111,692         |
| 10                       | 4,976,663         | 3,809,759         | 3,496,947         | 3,227,290         | 3,478,444         | 3,523,017         |
| 9                        | 4,216,846         | 3,059,301         | 2,917,624         | 2,586,978         | 2,945,105         | 3,027,564         |
| 8                        | 3,491,578         | 2,450,967         | 2,580,270         | 2,091,913         | 2,484,680         | 2,923,147         |
| 7                        | 2,843,996         | 1,981,568         | 2,139,865         | 1,713,288         | 2,116,909         | 2,495,629         |
| 6                        | 2,320,103         | 1,617,018         | 1,754,518         | 1,388,538         | 1,784,138         | 2,107,012         |
| 5                        | 1,886,777         | 1,296,799         | 1,408,439         | 1,094,115         | 1,471,633         | 1,748,891         |
| 4                        | 1,495,882         | 1,014,197         | 1,097,161         | 827,395           | 1,179,381         | 1,417,772         |
| 3                        | 1,134,128         | 760,089           | 819,706           | 592,615           | 910,060           | 1,105,980         |
| 2                        | 798,888           | 527,405           | 572,810           | 394,905           | 658,224           | 814,142           |
| 1                        | 464,790           | 332,726           | 362,282           | 231,135           | 426,413           | 545,994           |
| 0                        | 226,903           | 171,681           | 182,379           | 98,823            | 234,313           | 314,511           |
| -1                       | 53,794            | 63,343            | 57,126            | 20,454            | 114,795           | 129,990           |
| -2                       |                   | 22,052            | 13,012            | 7,012             | 32,459            | 38,450            |
| -3                       |                   | 5,733             | 540               | 2,254             | 1,939             | 12,842            |
| -4                       |                   |                   |                   | 90                |                   | 1,543             |

## Other Activities

CDFG Redwood Creek Downstream Migrant Trapping - Steelhead smolts passive integrated transponders (PIT) tagged by the California Department of Fish and Game at the upper rotary screw trap were recaptured in the estuary. Several fish were recaptured in the estuary (Table 8). A chinook salmon was captured at the lower Redwood Creek CDFG rotary screw trap on June 16, 2005 with a top caudal blue mark from the Redwood Creek estuary. It would have been marked on either June 6 or 7 and migrated upstream approximately 6.5 km.

Table 8. List of upstream pit tagged fish recaptured in the Redwood Creek estuary in 2005.

| Date released | Tagged Fish Release site | Age/Sp. | Pit Tag # | Initial Size |      | Date of recapture | Captured | Size at recapture |      |
|---------------|--------------------------|---------|-----------|--------------|------|-------------------|----------|-------------------|------|
|               |                          |         |           | FL mm        | Wt g |                   |          | FL mm             | Wt g |
| 6/17/05       | Upper RCRST05            | 1+SH    | 02033517  | 110          | 13.9 | 9/19/05           | Estuary  | 178               | 59.3 |
| 6/24/05       | Upper RCRST05            | 2+SH    | 01949055  | 124          | 19.4 | 9/19/05           | Estuary  | 180               | 69.3 |
| 6/7/05        | Estuary 05               | 2+SH    | 01872677  | 119          | 16.5 | 9/19/05           | Estuary  | 167               | na   |

Downstream migrant trapping on upper Redwood Creek, the sixth consecutive year was conducted from March to August. Estimates were lower than previous years. An estimated 39,614 0+ chinook passed by the upper trap, 90% less than the five year average. An estimated 26,175 1+ steelhead (down 40% from five year average) and 2,364 2+ steelhead (down 64% from five year average) passed by the upper trap.

At the lower trap, an estimated 131,164 0+ chinook (versus 554,890 in 2004), 32,901 1+ steelhead (versus 77,221 in 2004), 8,754 2+ steelhead (versus 19,353 in 2004), and 183 1+ coho (versus 535 in 2004) passed by (Mike Sparkman - CDFG personal communication).

Data from monitoring projects, the estuary, and upper and lower traps will be analyzed together.

RNSP/OMSI Seining in Lower Redwood - On July 19, with the help of Oregon Museum of Science and Industry salmon camp students, lower Redwood Creek below the 101 bridge was seined in three locations using a small beach seine with attached poles at each end. Redwood Creek discharge was 141 cfs at the time of sampling.

At river kilometer 1.95, at the first bend upstream of the estuary, two seine hauls resulted in zero fish. At river kilometer 2.35, four seines resulted in 3 three spine stickleback (range 33 to 53 mm TL), one staghorn sculpin (64 mm), and one steelhead juvenile (72 mm FKL). At river kilometer 3.35, behind the Shoreline Deli, one seine resulted in no fish.

Humboldt County Levee Maintenance Permit - The Humboldt County Department of Public Works applied for a Corps permit for levee maintenance, the removal of vegetation and gravel, to maintain the flood conveyance capacity of the project and prevent overtopping and flooding of Orick during high flows. The Corps permit was granted and maintenance work was only done upstream of the Highway 101 bridge in 2004 because a Coastal Commission permit was still pending.

Coastal Commission Permit - A permit from the California Coastal Commission was approved on April 15 for work below the bridge which is in the coastal zone. Orick ranchers rented 2 four-wheel

drive dump trucks and used some of their own equipment to remove 5,642 yd<sup>3</sup> of gravel (of 6,581 yd<sup>3</sup> approved by pre-extraction surveys) from the left side of the channel adjacent to the Shoreline Deli (Humboldt County Department of Public Works, 2005). The county assisted with personnel, fuel, and equipment. Above the 101 bridge at the upstream beginning of the levees, Hufford Sand and Gravel removed only 2,706 yd<sup>3</sup> of the 14,037 yd<sup>3</sup> approved for extraction. Continuation of the upper gravel extraction was stopped out of concern for high water and adult spawners.

*Hello all,*

*I thought I would let everyone know that gravel extraction operations in Redwood Creek are done for 2005. I received a request from NOAA Fisheries on Wednesday to call it quits for the year due to the fear of the mouth of Redwood Creek breaching. The fear of the mouth breaching stems from repeated attempts by unknown persons to manually dig a trench through the sand berm separating Redwood Creek from the ocean. The potential for the mouth to breach and the current rain event seemed like a reasonable rationale to call it quits for the year.*

*We will be sending out a final report as soon as we get our post extraction cross sections completed.*

*Thanks again for everyone's efforts on this project.*

*~Rob*

*Robert Darby -Humboldt County Department of Public Works 10/28/2006 email*

U.S. Army Corps of Engineers Visits - On February 24, Lieutenant Colonel Philip T. Feir, commander of the San Francisco District of the Corps and his staff met with the park and estuary landowners at SOC and toured the flood control project and estuary. On November 10, Brigadier General Joseph Schroedel of the Corp's South Pacific Division and San Francisco District staff, met with the park, estuary landowners, and local elected officials at SOC. He then went out to the estuary at the end of the north levee. Quoted in the November 12, 2005 issue of the Times-Standard, he said "We would never have built it that way today" describing the Redwood Creek project and the Corps new focus on environmental sustainability. The meetings gave an opportunity for everyone to share with the Corps their concerns about the project and lobby for a General Investigation study, the first step toward a Feasibility Study and estuary restoration.

HSU Oceanography Senior Field Cruise Project - The projects were finished and reports will be forthcoming.

HSU River Restoration Class - Dr. Walt Duffy's River Restoration class visited the park on September 24 for an estuary field trip. They attended an estuary power point presentation from the park, and landowner tours of the Sand Cache Creek bridge at Hufford Road; South Slough, levee culverts, and lower Strawberry Creek at Zubers'; Strawberry Creek at Barlows'; South Slough outlet channel near KVC; and the Hilton Road culvert. The class, divided into groups, will report on restoration alternatives.

## 2005 Summary

The Redwood Creek estuary was monitored in summer/fall/winter 2005. Four population estimates were conducted the weeks of June 6, July 11, August 22, and September 19. Seven growth estimates were conducted, four in conjunction with population estimates and three single day growth estimates on June 23, August 9, and October 18. Water level elevations in the south slough were measured from January 1 to October 24, minus the period between January 3 and 31. Embayment water elevations were monitored from July 1 to November 16. A temperature logger recorded water temperature in the embayment every hour from June 9 through October 20.

- Estimated estuary juvenile chinook and steelhead populations in the estuary were low at the beginning of June and decreased through the summer.
  - The estuary chinook population decreased 99 % from 4,660 in June to 50 in late September.
  - The estuary steelhead population was low, less than a thousand.
  - A total of seven juvenile coho salmon were caught in the estuary during summer 2005, four during the week of June 6. This is similar to previous years (Anderson 1995).
  - A total of 99 cutthroat were caught during the 2005 season.
  - Only one chinook and steelhead were caught on October 18.
  - A chinook salmon with a top caudal blue mark was captured at the CDFG rotary screw trap on lower Redwood Creek on June 16, 2005. It had been marked in the Redwood Creek estuary on either June 6 or 7.
  - CDFG trapping data at both the upper and lower migrant traps indicated lower populations than previous years for steelhead and chinook.
- Mean lengths and weights of chinook, steelhead, and cutthroat increased during the summer. Fish that remained in the estuary were larger than those that emigrated to the ocean prior to the September 7 closure. The larger size would confer an increased survival in the ocean (Reimers 1973).
  - Mean chinook fork length increased from 61 mm in June to 114 mm in September.
  - Mean steelhead fork length increased to 120 mm in June to 159 mm in September.
- Water temperatures in the embayment were warm. The maximum and minimum temperatures measured between June 9 and October 20 were 22.3°C and 12.0°C, respectively. The average water temperature for this period was 15.9°C.
  - Diurnal water temperatures, minimums and maximums, were related to the tidal cycle when the mouth was open.
- The Redwood Creek estuary closed late and was illegally breached after two unsuccessful attempts. The estuary closed on September 7 and remained closed for 57 days until being illegally breached on November 3.
  - The highest recorded water elevation in the estuary was 10.3 ft MSL, the lowest 0.15 ft MSL.

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## Personal Communications

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*[03/2006]*



Processing fish at the ‘Coho Cabana’, Redwood Creek Estuary, summer 2005.

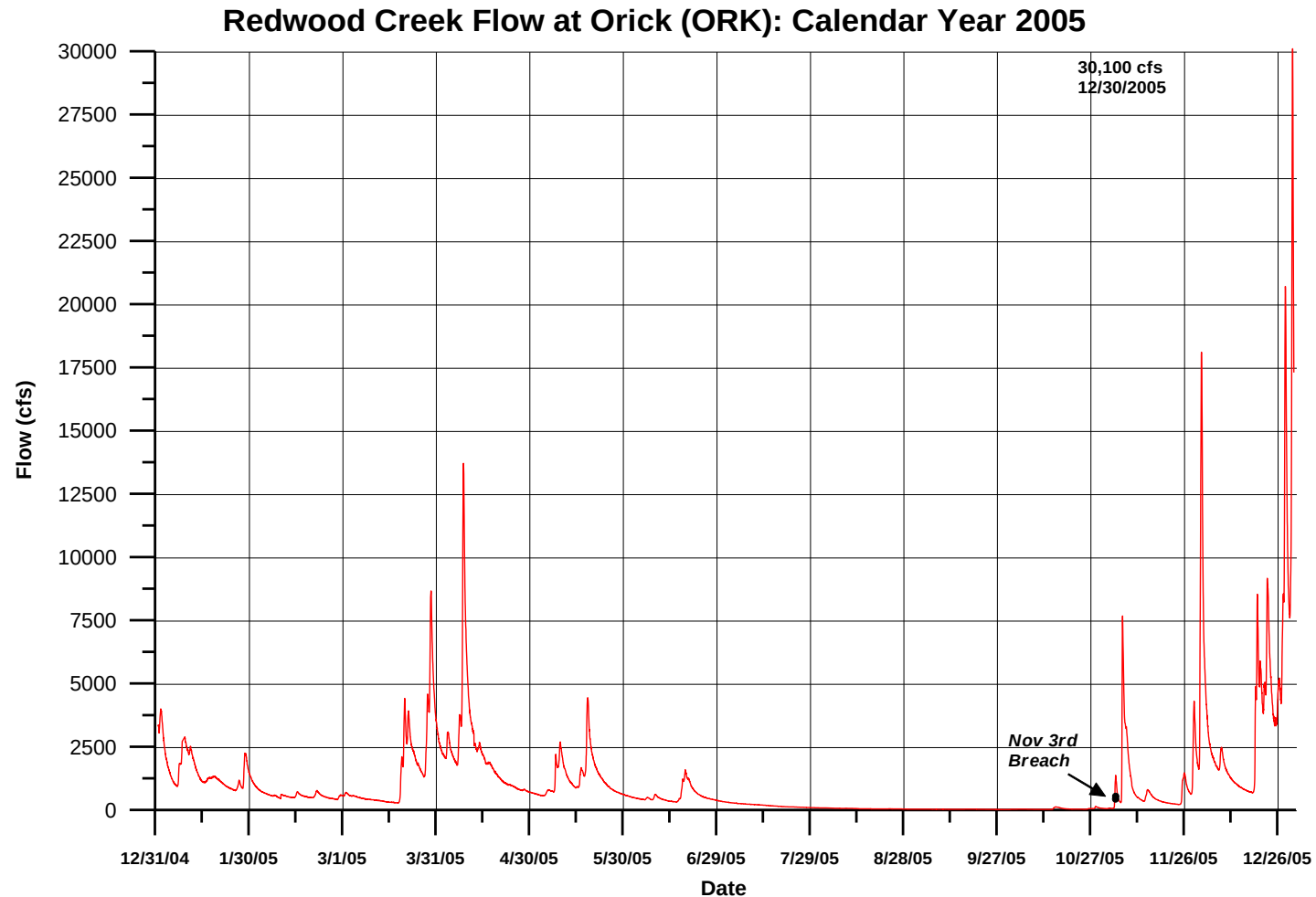
Appendix I. Number of salmonid fish marked, marked recaptures, total individuals captured in the second sample, and total number of seines from the RNSP Redwood Creek estuary mark and recapture population estimates during the summer/fall of 2005. Fish fins, top, middle, and bottom caudal, and anal fins were marked with a Panjet needleless injector using Alcian Blue dye. Mark appearance ranged from a blue dot to a pigment streak along the fin rays. Formulas used to calculate population estimate and its 95% confidence interval.

| 2005<br>Date                         |   | Number of Fish Marked <sup>a</sup><br>Marked Fish Recaptured <sup>b</sup><br>Total No. of Fish Captured in Second Sample <sup>c</sup> |      |           |           | Total<br>No. of<br>Seines | Panjet Fin<br>Marks      |
|--------------------------------------|---|---------------------------------------------------------------------------------------------------------------------------------------|------|-----------|-----------|---------------------------|--------------------------|
|                                      |   | Chinook                                                                                                                               | Coho | Steelhead | Cutthroat |                           |                          |
|                                      |   |                                                                                                                                       |      |           |           |                           |                          |
| June 6,7                             | a | 565                                                                                                                                   | 4    | 29        | 1         | 32                        | Top<br>Caudal            |
| June 9                               | b | 32                                                                                                                                    | 0    | 0         | 0         |                           |                          |
|                                      | c | 264                                                                                                                                   | 0    | 13        | 2         |                           |                          |
| July 11,12                           | a | 34                                                                                                                                    | 0    | 58        | 12        | 36                        | Bottom<br>Caudal<br>blue |
| July 14                              | b | 0                                                                                                                                     | 0    | 2         | 1         |                           |                          |
|                                      | c | 0                                                                                                                                     | 0    | 33        | 2         |                           |                          |
| August 22,23                         | a | 1                                                                                                                                     | 0    | 101       | 26        | 34                        | Anal                     |
| August 25                            | b | 0                                                                                                                                     | 0    | 4         | 5         |                           |                          |
|                                      | c | 1                                                                                                                                     | 0    | 12        | 9         |                           |                          |
| September<br>19,20                   | a | 20                                                                                                                                    | 0    | 141       | 4         | 34                        | Middle<br>Caudal         |
| September 22                         | b | 4                                                                                                                                     | 0    | 5         | 0         |                           |                          |
|                                      | c | 10                                                                                                                                    | 1    | 19        | 1         |                           |                          |
| June 7- 49 marked Chinook recaptured |   |                                                                                                                                       |      |           |           |                           |                          |

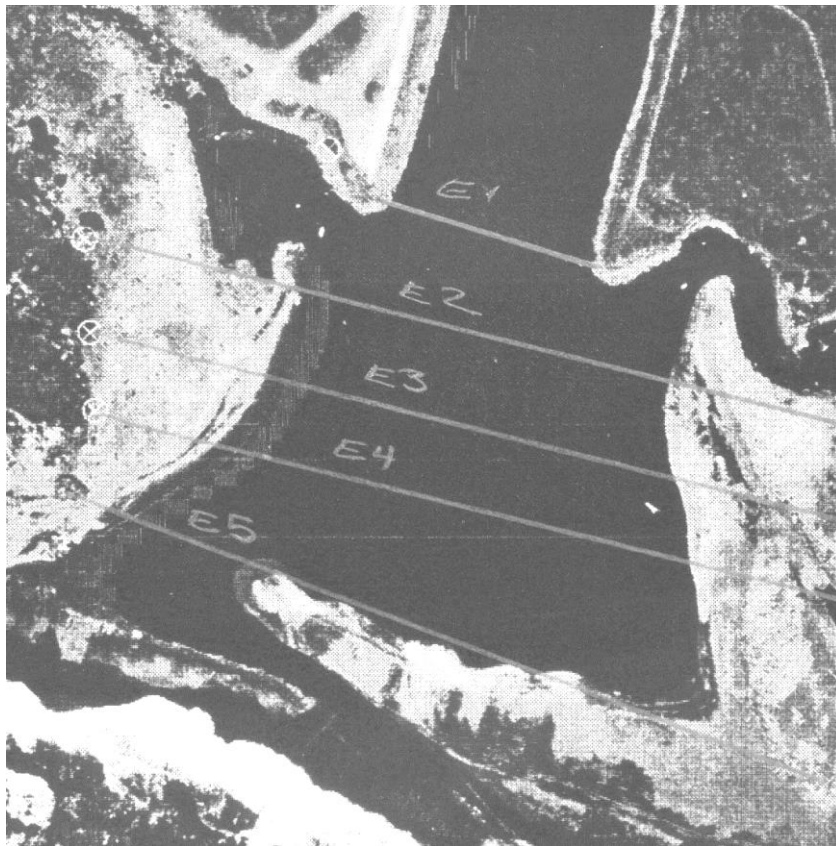
$$\text{Population Estimate (N)} = \frac{(\text{No. of fish marked}) \times (\text{total no. captured in second sample})}{(\text{No. of marked fish recaptured in second sample})}$$

$$95\% \text{ CI} = \pm 1.96 \times \sqrt{\frac{(N^2) \times (N - \text{no. marked}) \times (N - \text{no. in second sample})}{(N - 1) (\text{No. marked}) \times (\text{no. in second sample})}}$$

Appendix II. Hourly Redwood Creek flow data for calendar year 2005, January 1 through December 31. Data is from the California Department of Water Resources Orick (ORK) gaging station located on Redwood Creek downstream of the confluence of Prairie Creek and north of Orick, California. (The flow data is provisional and subject to revision by the California Department of Water Resources.)

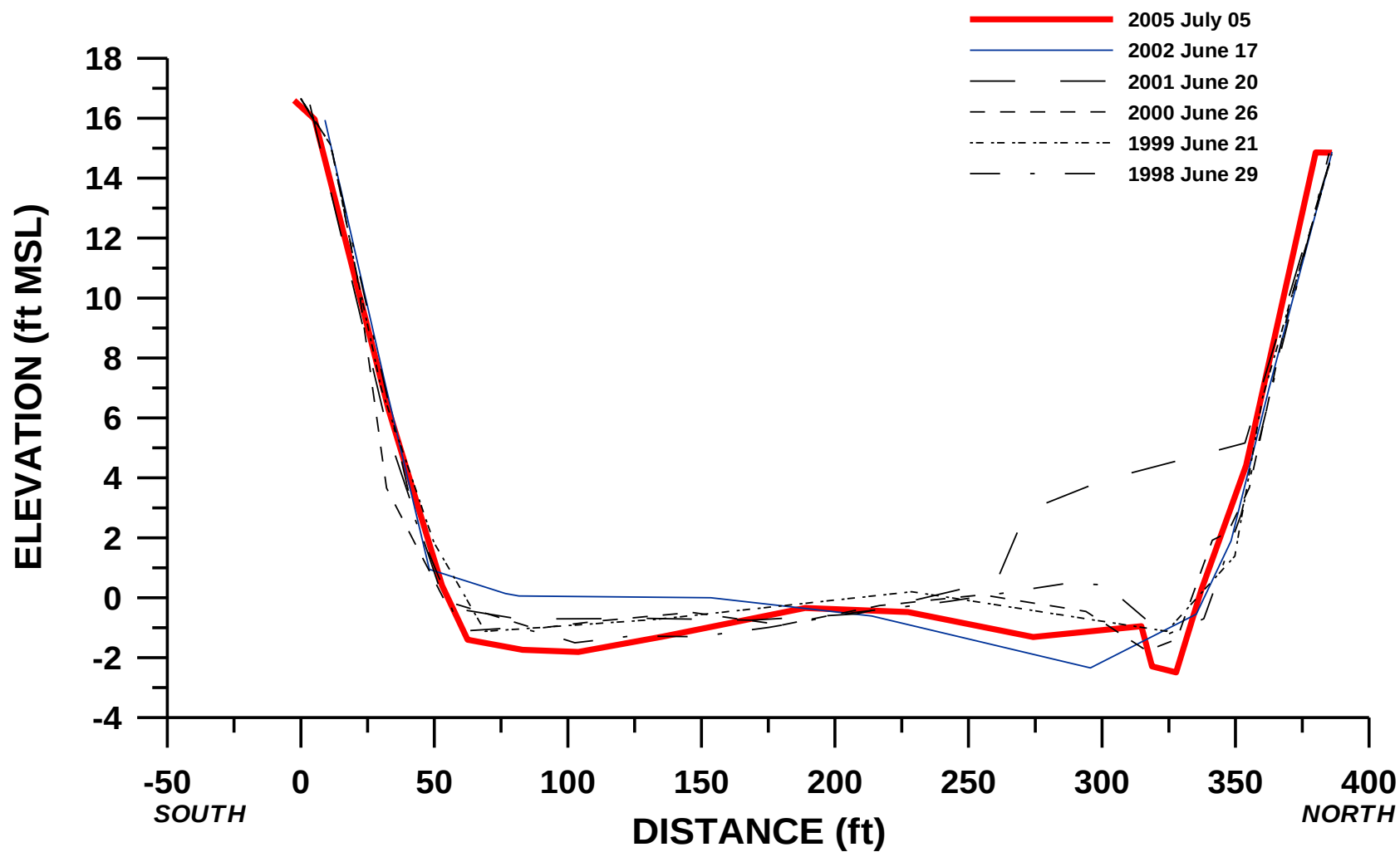


Appendix III. Five permanent cross-sections (E-1 through E-5) surveyed July 5, 2005 in the Redwood Creek estuary embayment perpendicular to the channel. Established in 1998, each cross-section was shot at a bearing of 170° from the north endpoints through the embayment to the sand dunes on the south. The five parallel cross-sections start between the ends of the levees with E-1 and end at the west with E-5 at the sea stack adjacent to the beach. The 2005 surveys are graphed with those from 1998, 1999, 2000, 2001, 2002, and 2003 (Anderson 1999, 2000, 2001, 2002, 2003). None were surveyed in 2004 and E-1 was not surveyed in 2003.

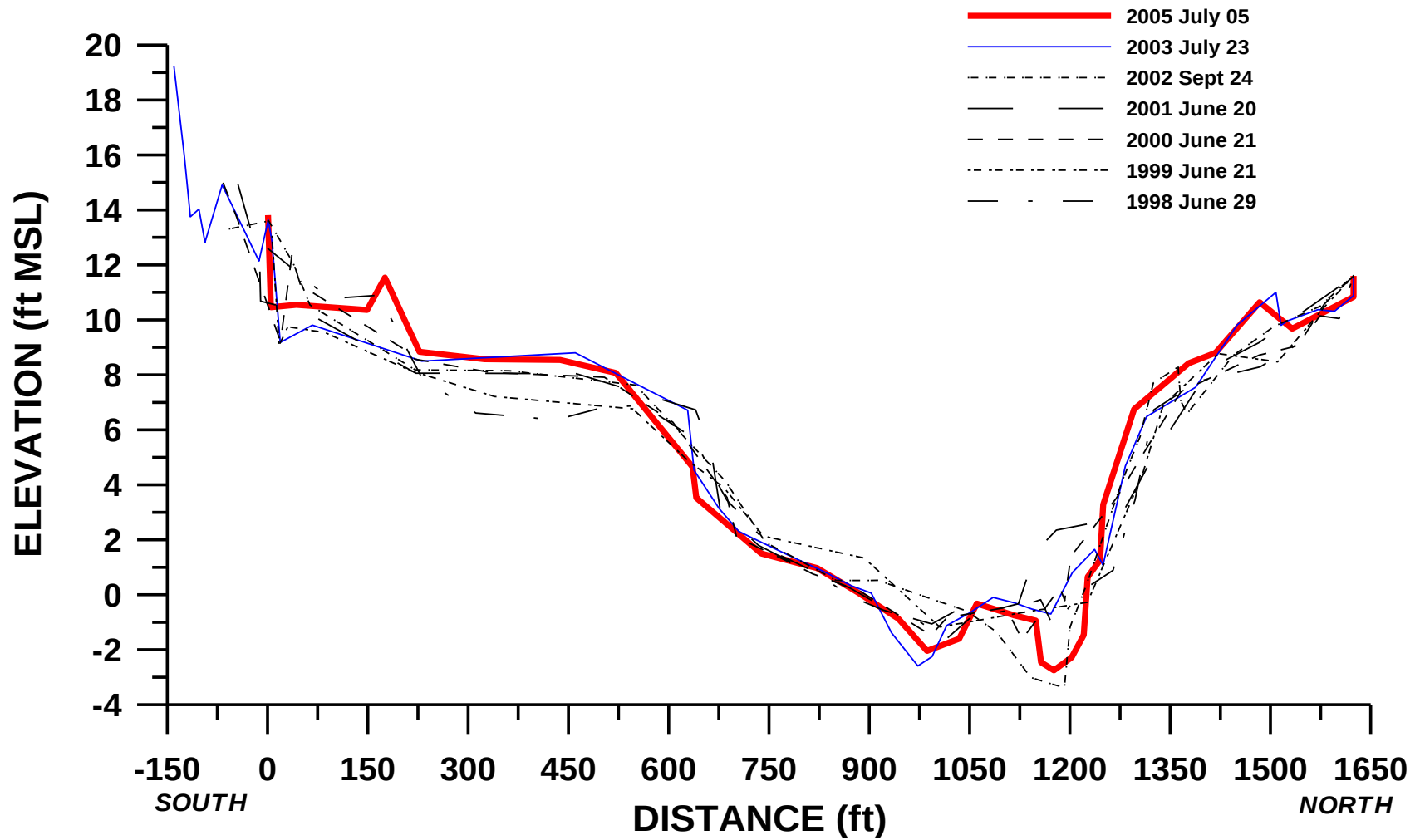


Aerial photo of Redwood Creek embayment with superimposed cross sections.

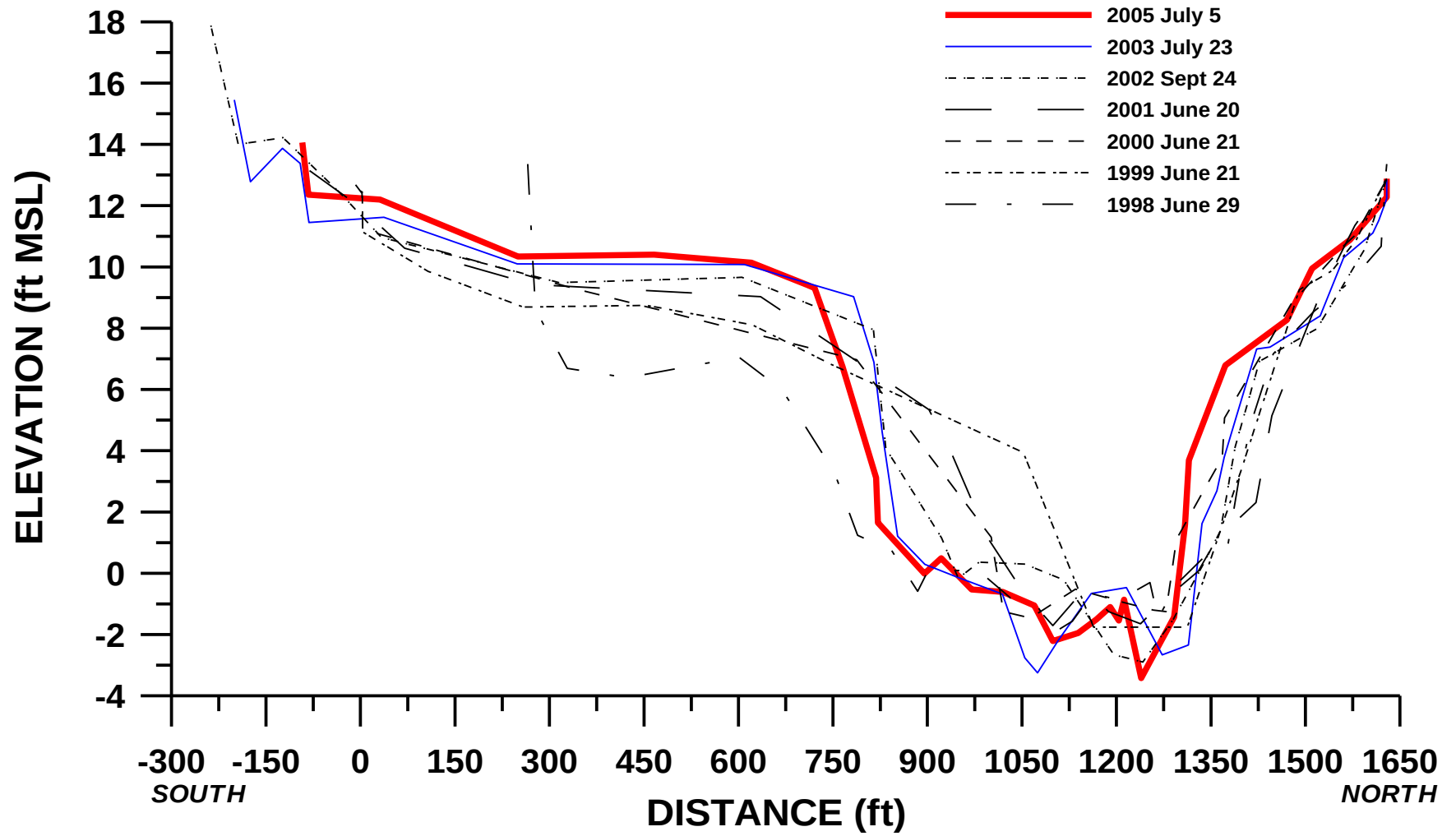
## ESTUARY CROSS SECTION E-1



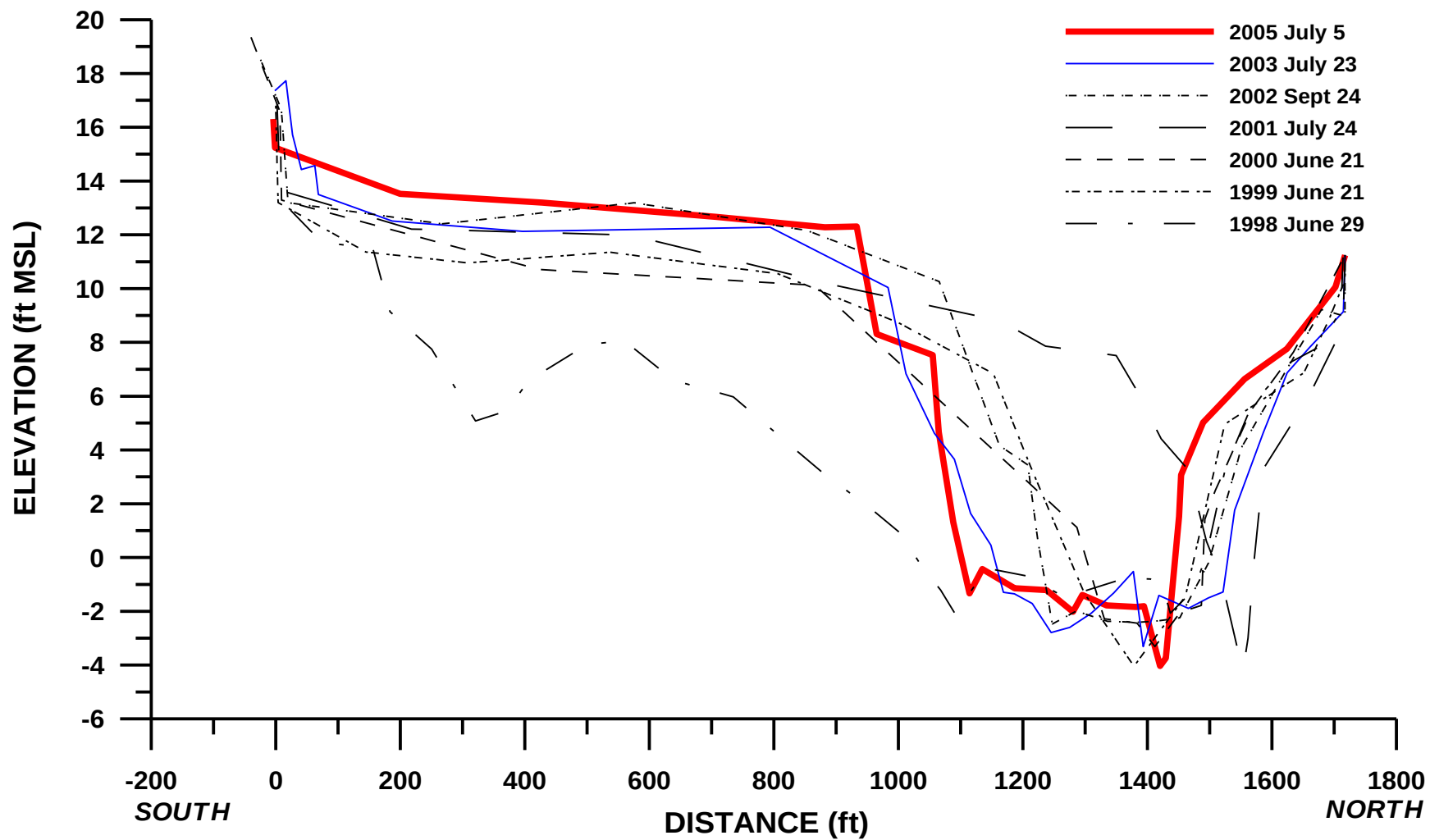
## ESTUARY CROSS SECTION E-2



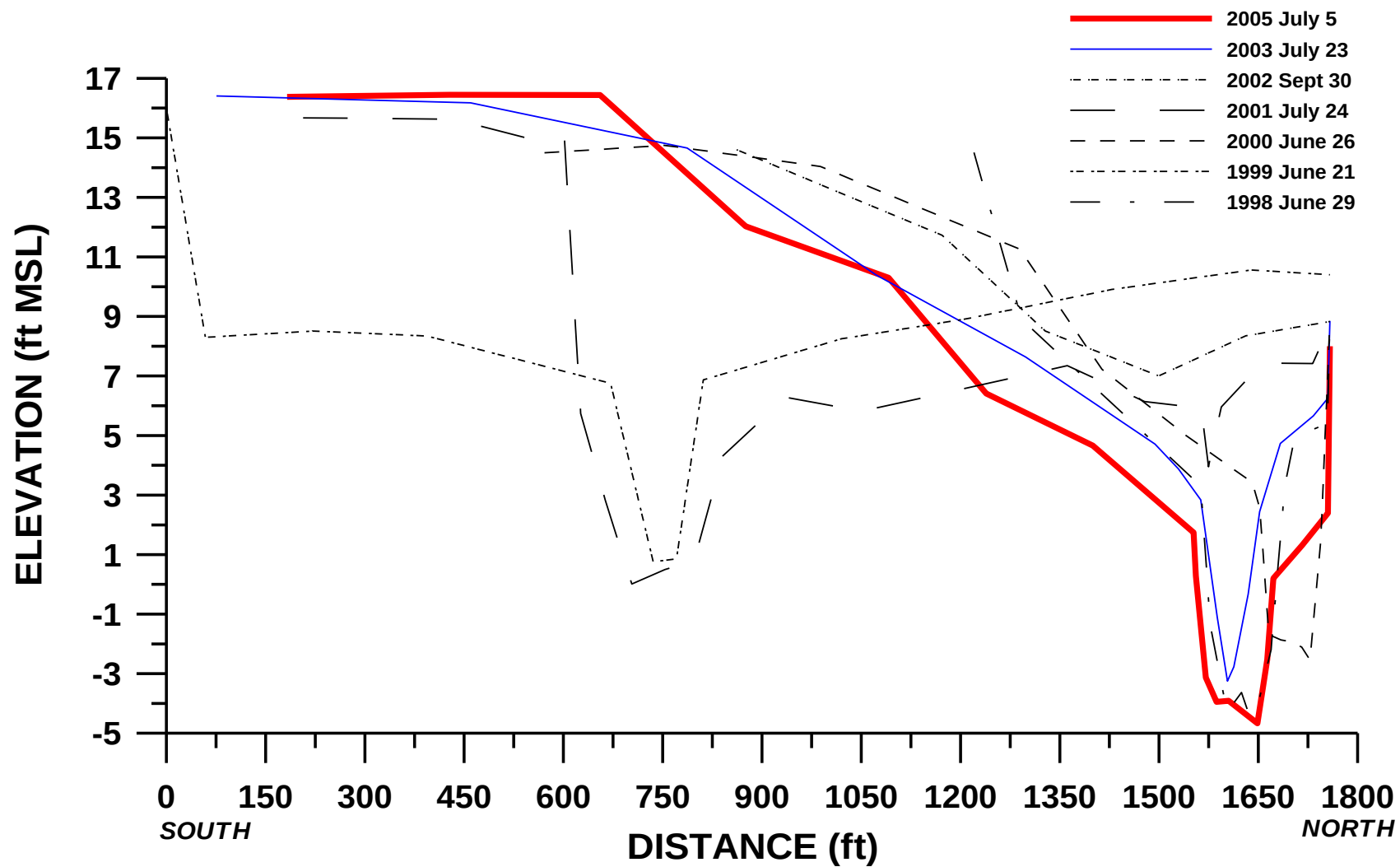
## ESTUARY CROSS SECTION E-3



## ESTUARY CROSS SECTION E-4

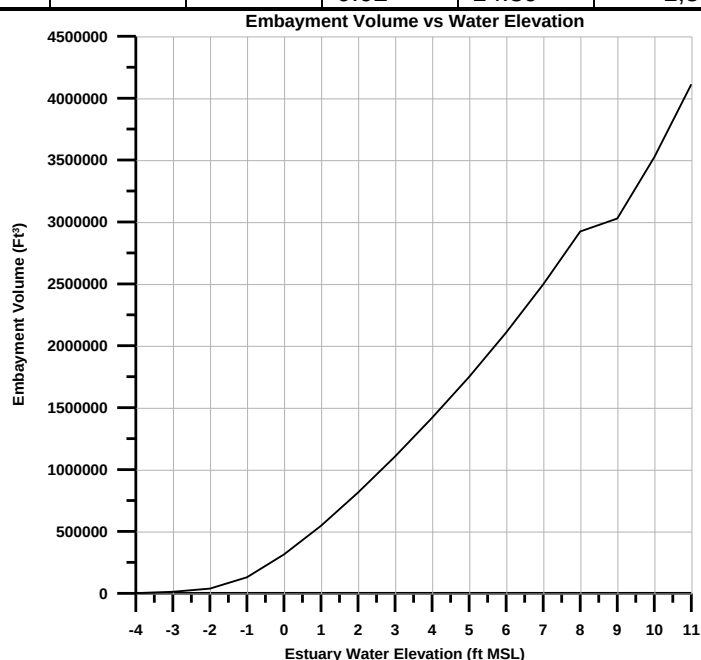


## ESTUARY CROSS SECTION E-5

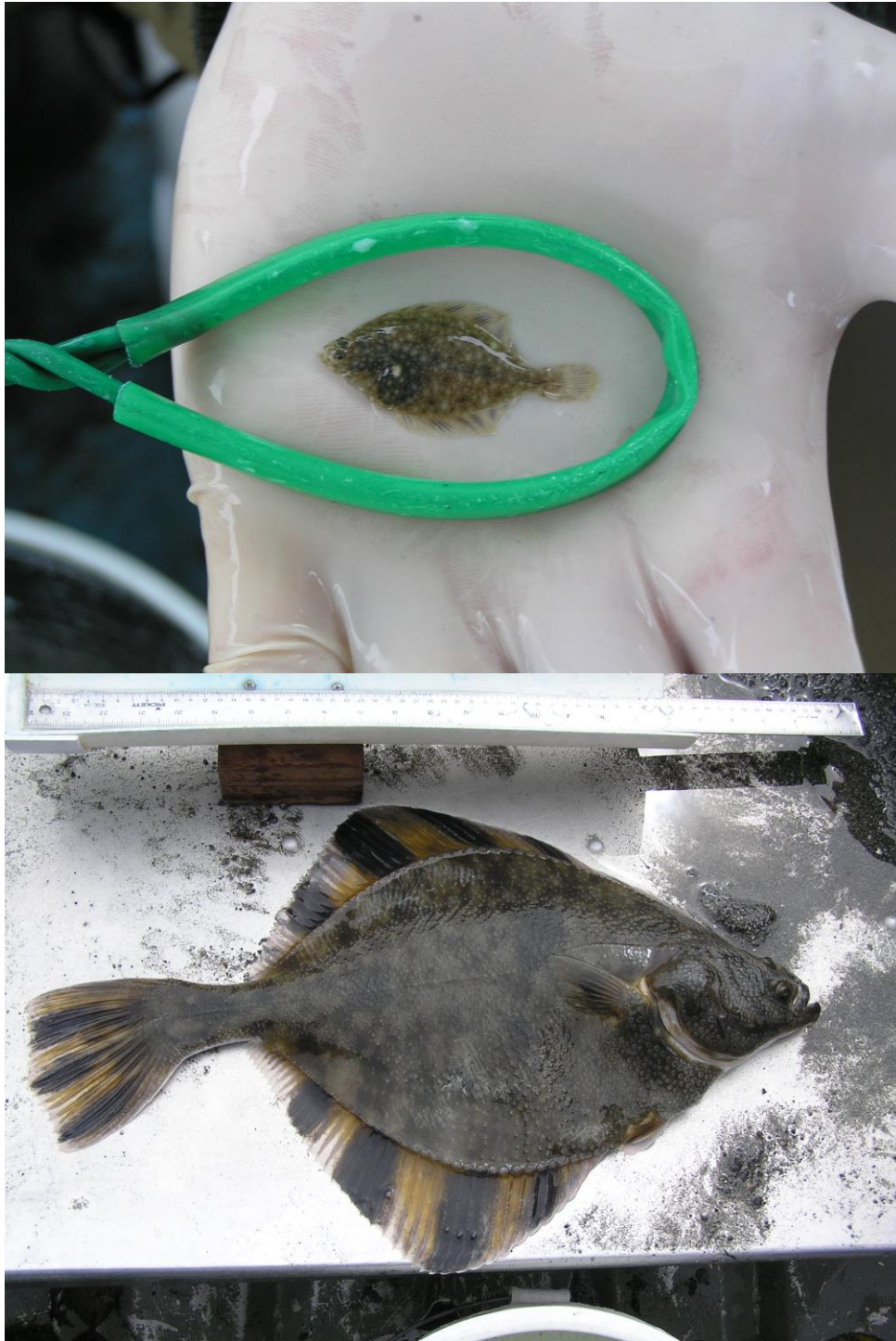


Appendix IV. Top: Calculated wet width (ft) and volume (ft<sup>3</sup> and yd<sup>3</sup>) of the Redwood Creek embayment at water elevations of -4 to 11ft MSL based of the five cross sections E-1 through E-5 surveyed on July 5,2005. Volume of embayment is defined as the area west of the ends of the north and south levee and not including the north or south outlet channels or sloughs. Bottom: Embayment volume versus water elevation.

| Redwood Creek Estuary 2005 - Width and Volume for Varying Water Elevations |                      |                      |                      |                      |                      |                                   |                                   |
|----------------------------------------------------------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|-----------------------------------|-----------------------------------|
| Water Elev. (ft MSL)                                                       | X/S e1 Wet Area (ft) | X/S e2 Wet Area (ft) | X/S e3 Wet Area (ft) | X/S e4 Wet Area (ft) | X/S e5 Wet Area (ft) | Estuary Volume (ft <sup>3</sup> ) | Estuary Volume (yd <sup>3</sup> ) |
| 11                                                                         | 3820.86              | 8974.29              | 7503.97              | 6094.30              |                      | 4,111,692                         | 152,285                           |
| 10                                                                         | 3472.5               | 7509.93              | 6305.51              | 5334.22              |                      | 3,523,017                         | 130,482                           |
| 9                                                                          | 3129.48              | 6275.03              | 5498.97              | 4606.89              |                      | 3,027,564                         | 112,132                           |
| 8                                                                          | 2791.82              | 5269.19              | 4759.39              | 3926.62              | 3100.98              | 2,923,147                         | 108,265                           |
| 7                                                                          | 2459.51              | 4476.47              | 4091.83              | 3361.97              | 2540.49              | 2,495,629                         | 92,431                            |
| 6                                                                          | 2132.58              | 3756.16              | 3492.1               | 2869.00              | 2023.03              | 2,107,012                         | 78,037                            |
| 5                                                                          | 1811.41              | 3083.91              | 2926.88              | 2421.86              | 1588.77              | 1,748,891                         | 64,774                            |
| 4                                                                          | 1496.28              | 2452.60              | 2395.03              | 2008.11              | 1238.45              | 1,417,772                         | 52,510                            |
| 3                                                                          | 1188.34              | 1847.04              | 1892.72              | 1619.25              | 943.11               | 1,105,980                         | 40,962                            |
| 2                                                                          | 887.85               | 1289.78              | 1400.91              | 1246.40              | 703.15               | 814,142                           | 30,153                            |
| 1                                                                          | 594.81               | 797.32               | 923.36               | 882.98               | 531.36               | 545,994                           | 20,222                            |
| 0                                                                          | 309.37               | 423.58               | 505.28               | 532.56               | 401.46               | 314,511                           | 11,649                            |
| -1                                                                         | 75.2                 | 155.63               | 201.99               | 211.58               | 290.26               | 129,990                           | 4,814                             |
| -2                                                                         | 4.06                 | 26.91                | 41.07                | 47.73                | 186.81               | 38,450                            | 1,424                             |
| -3                                                                         |                      |                      | 3.24                 | 15.53                | 91.52                | 12,842                            | 476                               |
| -4                                                                         |                      |                      |                      | 0.02                 | 14.39                | 1,543                             | 57                                |



Photos: Selected photos associated with the Redwood Creek Estuary, summer/fall 2005.



Starry Flounder (*Platichthys stellatus*) seined in the Redwood Creek embayment. Top: Juvenile (August 25, 2005 RNSP). Bottom: Adult at 545 mm [total length] adjacent to 700 mm ruler (July 11, 2005 RNSP).



Large coastal cutthroat trout (*Oncorhynchus clarki*) seined from the Redwood Creek embayment (July 12, 2005 RNSP)



Chinook salmon (*O. tshawytscha*) captured at the CDFG rotary screw trap on lower Redwood Creek on June 16, 2005. It had been marked with a top caudal blue mark in the Redwood Creek estuary on either June 6 or 7 (June 16, 2005 Mike Sparkman-CDFG)



American shad (*Alosa sapidissima*) seined in the Redwood Creek embayment (June 23, 2005 RNSP).



Bay pipefish (*Syngnathidae leptorhynchus*) seined in Redwood Creek embayment by south levee (August 25, 2005 RNSP)



Half-Pounder steelhead (*O. mykiss*) seined from the Redwood Creek embayment (August 25, 2005 RNSP)



Single seine haul of cutthroat trout (*O. clarki*) from the Redwood Creek embayment (August 9, 2005 RNSP).



Juvenile chinook salmon (*O. tshawytscha*) beach seined at low tide at Gold Bluffs Beach on August 19, 2005. Its aqua green color scheme was very different from chinook seined in the estuary (RNSP).



Shiner surfperch (*Cymatogaster aggregata*) (Left) and walleye surfperch (*Hyperprosopon argenteum*) (Right) seined from the Redwood Creek embayment (August 23, 2005 RNSP)



Coho salmon (*O. kisutch*) juvenile at 115 mm fork length seined from the Redwood Creek embayment on September 22, 2005 (RNSP)



Mouth of Redwood Creek with oxbow channel that was cut off by a shorter channel to the mouth (August 17, 2005 RNSP)

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OMSI: Dan Calvert (leader), 2 instructors, and 5 students (7/11 & 14/2005)

### Estuary Water Level Monitoring

Geology Branch: Carrie Jones (South Slough data collection and synthesis, gage maintenance).

Fish and Wildlife Branch: David Anderson (South Levee data collection and synthesis)

### Installation/Removal of South Levee Water Elevation Recording Gage

Fish and Wildlife Branch: David Anderson, Terry Hines, Kyle Max, Baker Holden

Support Crew: Tim Tanno, Keith Richey

### Water Temperature Monitoring

Fish and Wildlife Branch: David Anderson, Kyle Max, Baker Holden (placement and retrieval)

Geology Branch: Carrie Jones (data download, calibration of probes)

### Culverts Opening/Closing

Fish and Wildlife Branch: David Anderson, Terry Hines, and Kyle Max (opening); Baker Holden (closing)

### Lower River Seining

Fish and Wildlife Branch: David Anderson and Terry Hines

OMSI: Dan Calvert (leader), 2 instructors, and 5 students

### Embayment Cross-Sections

Fish and Wildlife Branch: David Anderson (rod)

Geology Branch: Carrie Jones (instrument), Vicki Ozaki (rod)

### Seine Net Repair

Fish and Wildlife Branch: Spotted Owl Crew

### Additional Mouth of Redwood Creek Observations-

Geology Branch: Tom Marquette