

Redwood

National and State Parks

National Park Service
US Department of the Interior

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State of California

Redwood Creek Estuary Monitoring 2004 Annual Progress Report



David G. Anderson
Fish and Wildlife Branch
Resource Management and Science Division

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Introduction

This annual report summarizes Redwood National and State Parks' Fish and Wildlife Branch monitoring activities in the Redwood Creek estuary for calendar year 2004. Monitoring has occurred in the Redwood Creek estuary since 1980. The purpose of the estuary monitoring is to estimate fish population numbers and growth; measure and record estuary water quality and water elevations; and document breaching incidents. This report serves as the annual report for the parks' 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 km² in area. 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 25hp outboard motor. A blue mark was applied to the upper, middle, or lower caudal fin or anal fin of 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/fall 2004.

Growth Estimates – Fish fork lengths (mm) were measured to the nearest 1-mm of 200 each of chinook salmon (*Oncorhynchus tshawytscha*) and steelhead trout (*O. mykiss*), and wet weight (g) measurements were taken from 30 juveniles of each species. 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 as chinook or steelhead, were also measured and weighed. Seven growth estimates were conducted, four in conjunction with the population estimates, and three one day estimates between and after a population estimate.

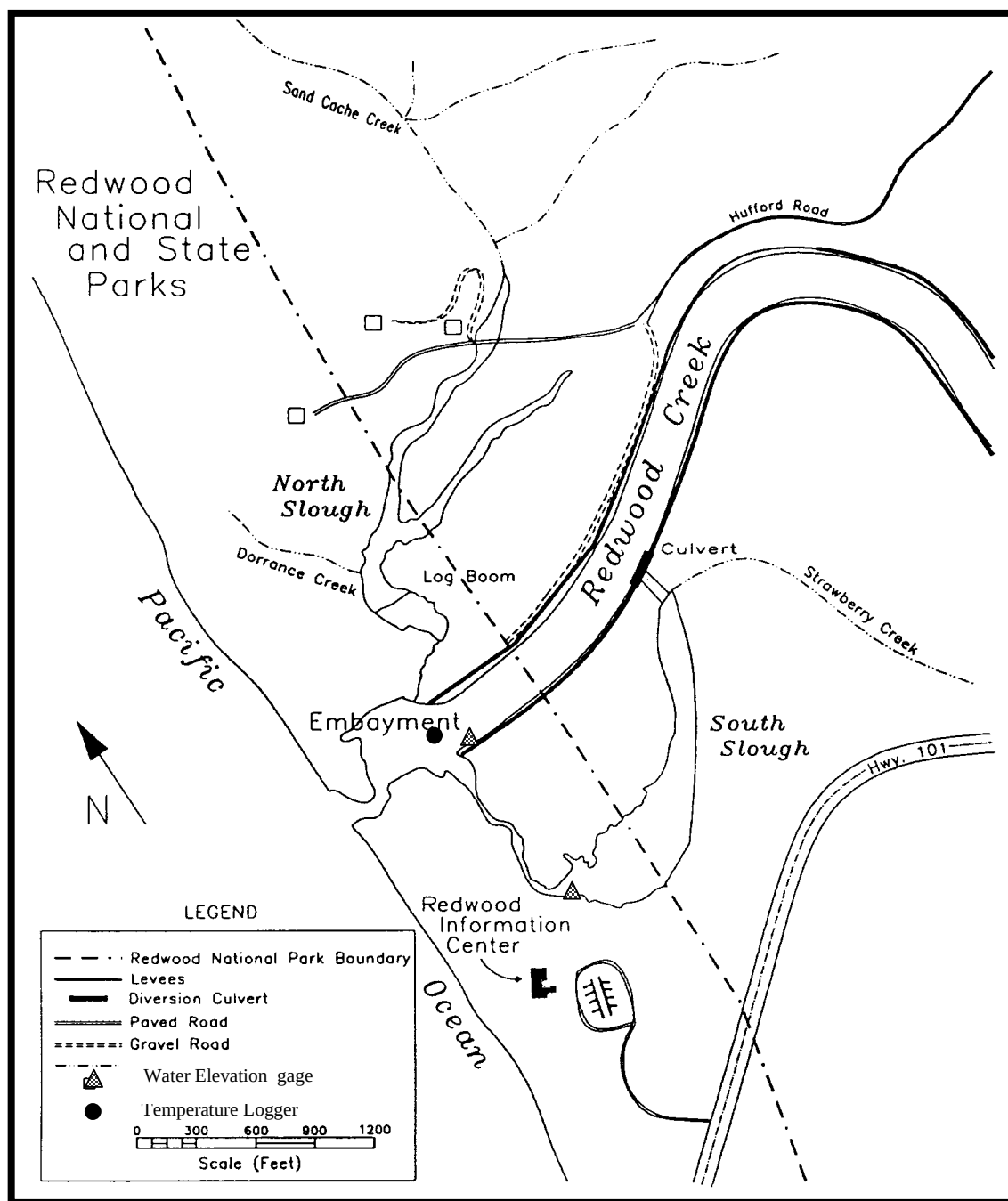


Figure 1. Map of the Redwood Creek Estuary, Humboldt County, California, including location of the embayment, north and south sloughs, and two water elevation gages and water temperature logger.

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, floated in the water column about one foot off the bottom substrate.

Tide and Stream Flow Data

Tide Data: Calendar year 2004 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). 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 2004 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 change. 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 Redwood Information 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

None of the five estuary cross sections were surveyed in 2004. Established 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 locates points in the embayment at breaks in slope. Another person continues 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 done in 2004. Special condition #4 of the 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 extends a minimum of 100 feet north of the estuary to 100 feet south of the Kuchel 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

Redwood Creek Downstream Migrant Trapping - Steelhead smolts marked by the California Department of Fish and Game at the upper migrant trap were recaptured in the estuary.

Humboldt County Levee Maintenance Army Corps of Engineers Permit - Permit was granted and work done upstream of the Highway 101 bridge.

2004 Results

Fish Monitoring

Presence – During the summer and fall of 2004, four salmonid species were seined in the Redwood Creek embayment; chinook and coho salmon, and steelhead and coastal cutthroat trout. In addition to the juvenile salmonid and steelhead trout, and adult cutthroat captured, six other fish species were captured. One amphibian, one reptile, 39 bird, four mammal, three invertebrates, and six insect species were observed. Of those, chinook, coho, and steelhead are federally listed as threatened and the brown pelican is listed as endangered. A complete list of all fish and other species captured or observed in and around the Redwood Creek estuary is presented in Table 1. No endangered tidewater gobies (*Eucyclogobius newberryi*) were captured during estuary seining in 2004.

Population Estimates - Four population estimates were conducted on Monday, Tuesday, and Thursday the weeks of June 21, July 19, August 16, and October 4 (Table 2). The mouth was open during the week of June 21. During the weeks of July 19, August 16 and October 4, and periods between, the mouth was closed. The number of fish marked, marked recaptures, total individuals captured in the ‘second sample’, and location of fin marks are presented in Appendix I.

The first juvenile chinook salmon estimate, the week of June 21 was 48,760 (95% Confidence Interval [CI] 39,020 to 58,510). During the week of July 19, the estimated number decreased to 39,530 (95% CI 16,580 to 62,470). By the week of August 16, the population decreased to 970 (95% CI 190 to 1,750). The population increased to 6,660 the week of Oct 4 (95% CI 4,440 to 8,890). The low number of chinook caught (159) the week of August 16 contributed to the low estimate.

For juvenile steelhead trout, the estimate the week of June 21 was 39,380 (95% CI 479 [actually caught] to 116,080). The population was 10,970 (95% CI 295 [actually caught] to 25,970) on July 19. The steelhead population declined to 2,540 (95% 770 to 4,300) the week of August 16. The last steelhead estimate on October 4 was similar to August, 2,590 (95% CI 2,100 to 3,090). The poor

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/winter 2004 fish sampling (X denotes presence).

Species	2004 Date						
	June 21 ^a	July 7	July 19 ^a	Aug 16 ^a	Sept 2	Oct 4 ^a	Dec 6
Salmonid Fish							
Coastal Cutthroat Trout (<i>Oncorhynchus clarki clarki</i>)	X		X	X		X	
Steelhead Trout * (<i>O. mykiss</i>)	X	X	X	X	X	X	
Chinook Salmon * (<i>O. tshawytscha</i>)	X	X	X	X	X	X	
Coho Salmon * (<i>O. kisutch</i>)	X		X				
Other Fish							
Three Spine Stickleback (<i>Gasterosteus aculeatus</i>)	X	X	X	X	X	X	X
Staghorn Sculpin (<i>Leptocottus armatus</i>)	X	X	X	X	X	X	X
Prickly Sculpin (<i>Cottus asper</i>)			X	X	X		
Sucker (<i>Catostomus occidentalis</i>)			X	X			
Starry Flounder (<i>Platichthys stellatus</i>)	X	X	X	X	X	X	X
Surf Smelt (<i>Hypomesus preiosus</i>)	X						
Amphibians							
Western Toad (Adults and tadpoles)			X	X	X	X	
Reptiles							
Garter Snake	X	X		X	X		
Birds							
Brown Pelican **	X	X	X	X	X	X	
Great Blue Heron				X			
Green Heron							
Double Crested Cormorant	X			X	X	X	
Turkey Vulture	X	X	X	X	X	X	
Osprey	X	X		X	X	X	
Peregrine Falcon						X	
Sanderlings						X	
Dowitcher					X		
Least Sandpiper							
Western Sandpiper			X	X	X		
Killdeer						X	
Semipalmated Plover			X	X			
Black Oystercatcher				X			
Surf Scoter						X	

Species	2004 Date						
	June 21 [*]	July 7	July 19 [*]	Aug 16 [*]	Sept 2	Oct 4 [*]	Dec 6
Bufflehead						X	
Scaup						X	
Gulls (Western, Heerman, California, Mew, and Ringbilled)	X	X	X	X		X	
Caspian Tern	X	X	X	X	X		
Least Tern				X			
Elegant Tern					X		
Violet Green Swallow	X	X		X	X		
Barn Swallow			X				
Belted Kingfisher				X		X	
Western Meadowlark							
Black Phoebe				X			
Corvids (Crows and Ravens)	X	X	X	X	X	X	
Redwinged Blackbird							
Wrentit			X	X			
American Goldfinch	X	X	X				
Song Sparrow	X		X				
Swainsons Thrush	X						
Canada Geese		X			X		
Geese (formations flying south)						X	
Common Merganser	X	X	X	X			
Mammals							
River Otter			X	X		X	
Coyote			X				
Gray Whale (offshore)	X						
Harbor Seal (outside mouth)	X						
Invertebrates							
Sipunculidae (peanut worms - dead)	X						
<i>Corophium</i>						X	
Sand Crab						X	
Butterflies							
American Painted Lady					X		
Cabbage White			X				
California Tortoiseshell		X					
Limniphilidae caddisfly larvae							
Dragonfly (adults)	X	X	X	X			
Bumble Bee				X			
Algae							
<i>Ulva</i> Algae	X						
^a = 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, and coastal cutthroat trout seined in the Redwood Creek estuary embayment, Humboldt County, California, summer/fall 2004. Mouth of creek denotes if Redwood Creek mouth was open or closed to the Pacific Ocean during the estimate.

2004 DATE	Mouth of Creek (Open or Closed)	Chinook Salmon		Coho Salmon	
		Population Estimate	95% Confidence Interval	Population Estimate	95% Confidence Interval
06/21, 22, 24	OPEN	48,760	39,020 - 58,510		
Coho estimate based on two days 6/21 & 22				120	24 ^a - 333
07/19, 20, 22	CLOSED	39,530	16,580 - 62,470	1 ^b	---
08/16, 17, 19	CLOSED	970	190 - 1,750	None caught	---
10/4, 5, 7	CLOSED	6,660	4,440 - 8,890	None caught	---
		Steelhead Trout		Cutthroat Trout	
06/21, 22, 24	OPEN	39,380	479 ^a - 116,080	1 ^b	---
07/19, 20, 22	CLOSED	10,970	295 ^a - 25,970	4 ^b	---
08/16, 17, 19	CLOSED	2,540	770 - 4,300	4 ^b	---
10/4, 5, 7	CLOSED	2,590	2,100 - 3,090	11 ^b	
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.					

confidence intervals the weeks of June 21 and July 19 were due to one and two, respectively, marked fish being recaptured.

A total of 25 juvenile coho salmon were caught in the estuary during summer 2004, 24 the week of June 21. Using the 4 day long methodology, no population estimate was possible for coho salmon as no marked fish were recaptured on the fourth day. However, based on two days, June 21 and 22, a population estimate of 120 coho (95% CI 24 [actually caught] to 333) was calculated. One coho was caught the week of July 19. No other coho were caught on any other population or grow estimate days.

No cutthroat trout population estimates were possible for any of the population estimates as no marked fish were recaptured. A total of 20 cutthroat were caught during the season, all during the week of population estimates, a period of greater sampling when compared to one-day growth estimates. One was caught the week of June 21, four the week of July 19, four the week of August 16, and 11 the week of October 4. One blue anal mark cutthroat caught on July 22 was a fish from a previous year as we did not use the blue anal mark until August 16 and 17, 2004.

Predators, river otter and mergansers, were seen throughout the season fishing. The flock of mergansers would line up and swim to shore driving fish into the shallows.

Growth Estimates – Seven growth estimates were conducted, four in conjunction with population estimates during the weeks of June 21, July 19, August 16 and October 4, and three growth estimates on July 7, September 2, and December 6 (Table 3). Though 200 length measurements of chinook and steelhead was the goal, we fell short during the week of August 16 for chinook.

The growth estimate on December 6 did not catch any salmonids, only starry flounders, threespine sticklebacks, and staghorn sculpins. It was the latest in the season we had sampled and though the mouth of the creek was closed, it had opened twice before, and breached the following day on December 7. December 6 was very windy and raining with one foot wind waves; however with the additional assistance of Dr. Tim Mulligan and his HSU Ecology of Marine Fish class, about 20 students including divers, we were able to do nine seines in the afternoon.

Chinook Salmon – From a total sample of 1,185 juvenile chinook salmon, mean fork length increased from 72 to 97mm, an increase of 25mm over 107 days between June 21 and October 5 (Table 3 and Figure 2). For the period June through October, the smallest fish measured was 53 mm, the largest fish 156mm. On June 21, the minimum and maximum fork lengths were 53 and 92mm, respectively, and increased to 75 and 156mm the week of October 4. Mean weight increased from 3.8g to 11.1g, a 7.3g increase, between June and October. Even without the large 156mm 38g fish, the mean weight for October was 10.2g. During the sample period, the minimum and maximum weight was 1.7 and 38.9g, respectively. For comparison, one juvenile chinook salmon was caught by beach seining Crescent Beach on July 18 by HSU graduate students conducting a marine resources study in RNSP. Its fork length was 104mm (Karah Cox, personal communication).

Table 3. Mean fork length (mm), mean weight (g), standard deviation, range, dates, and numbers sampled of juvenile chinook and coho salmon, and steelhead and coastal cutthroat trout seined in the Redwood Creek estuary embayment, Humboldt County, California, during summer/fall/winter of 2004 from June 21 to December 06, 2004. Mouth denotes if Redwood Creek mouth was open or closed to the ocean.

Growth - Redwood Creek Estuary – Summer/Fall 2004									
2004 DATE	MOUTH	FORK LENGTH (mm)				WEIGHT (g)			
		No. Measured	Mean	Std. Dev	Range	No. Weighed	Mean	Std. Dev.	Range
JUVENILE CHINOOK SALMON									
06/21	OPEN	205	72	6.7	53 - 92	30	3.8	0.9	2.3 - 5.5
07/07	CLOSED	205	74	6.3	57 - 91	30	4.5	1.1	1.7 - 6.9
07/19	CLOSED	205	76	5.9	57 - 90	30	4.8	1.6	2.1 - 9.1
08/16, 17, 19	CLOSED	158	79	5.2	60 - 93	30	5.0	1.0	2.7 - 7.8
09/02	CLOSED	205	84	5.4	62 - 100	30	5.9	1.5	2.3 - 9.5
10/04, 05	CLOSED	207	97	8.6	75 - 156	31	11.1	5.5	7.4 - 38.9
12/06	CLOSED*	0	---	---	---	0	---	---	---
JUVENILE COHO SALMON									
06/21, 22, 24	OPEN	24	112	11.9	46 - 90	24	15.4	4.5	8.2 - 24.5
07/07	CLOSED	0	---	---	---	0	---	---	---
07/20	CLOSED	1	130	---	---	1	19.4	---	---
08/16, 17, 19	CLOSED	0	---	---	---	0	---	---	---
09/02	CLOSED	0	---	---	---	0	---	---	---
10/04, 05, 07	CLOSED	0	---	---	---	0	---	---	---
12/06	CLOSED*	0	---	---	---	0	---	---	---
* Mouth previously open but closed before 12/06/2004 date.									

Growth – Redwood Creek Estuary – Summer/Fall 2004 (con't.)									
2004 DATE	MOUTH	FORK LENGTH (mm)				WEIGHT (g)			
		No. Measured	Mean	Std. Dev	Range	No. Weighed	Mean	Std. Dev	Range
JUVENILE STEELHEAD TROUT									
06/21, 22, 24	OPEN	212	114	25.9	53 - 173	32	20.3	10.5	2.1 - 42.8
07/07	CLOSED	205	103	25.8	53 - 156	30	11.6	9.6	1.9 - 35.0
07/19, 20, 22	CLOSED	204	107	29.1	58 - 171	30	17.1	14.0	2.2 - 47.7
08/16, 17	CLOSED	205	92	23.5	58 - 149	30	9.2	7.6	1.8 - 28.7
09/02	CLOSED	206	93	21.7	65 - 171	30	12.8	11.2	2.5 - 43.0
10/04	CLOSED	205	130	25.3	75 - 194	30	25.7	15.3	5.2 - 67.6
12/06	CLOSED*	0	---	---	---	0	---	---	---
CUTTHROAT TROUT									
06/24	OPEN	1	354	---	---	1	444	---	---
07/07	CLOSED	0	---	---	---	0	---	---	---
07/19, 20, 22	CLOSED	4	342	67.8	253 - 402	4	528	264.1	222 - 828
08/17, 19	CLOSED	4	333	60.4	244 - 372	4	453	209.5	158 - 612
09/02	CLOSED	0	---	---	---	0	---	---	---
10/04, 05, 07	CLOSED	11	301	55.9	245 - 438	11	386	287.1	145.1 - 1,178
12/06	CLOSED*	0	---	---	---	0	---	---	---
* Mouth previously open but closed before 12/06/2004 date.									

Coho Salmon - Of the 25 juvenile coho salmon measured, fork lengths ranged from 46 to 130mm. Mean fork length was 112mm the week of June 21, and 130mm for the one fish on July 20. Mean weight for the 24 fish in June was 15.4g and 19.4g for the one fish on July 20. During the sample period, the minimum and maximum weight was 8.2 and 24.5g, respectively.

Steelhead Trout – From a total sample of 1,237 juvenile steelhead trout, mean fork length started at 114mm in June, decreased to 92mm in mid-July, and increased to 130mm in early October. For the season, the smallest fish measured was 53mm, the largest fish 194mm. Several age classes were present (Table 3 and Figure 3). Mean juvenile steelhead weight ranged from 9.2 to 25.7g, increasing later in the season. During the sample period, the minimum and maximum weight was 1.8 and 67.6g, respectively.

Cutthroat Trout - From a sample of 20 cutthroat trout fork lengths, mean fork length ranged between 301mm and 342mm. The smallest cutthroat measured was 244mm, the largest 438mm. Mean weights ranged between 386 and 528g. During the sample period the smallest weight was 145.1g, the largest 1,178g.

Condition Factor (K') – Fish condition factors are presented in Table 4. Species mean conditions factors of each date remained approximately the same throughout the season. Mean chinook K' ranged from 1.149 to 1.313. The seasonal mean for all chinook was 1.229. Mean coho K' was 2.671 for June 21 and 2.325 for the one fish on July 19. The seasonal mean for all coho was 2.657. Mean steelhead K' ranged from 1.051 to 1.139. The seasonal mean for all steelhead was 1.082. Mean cutthroat K' ranged from 0.797 to 0.882, though the one fish on June 21 was 0.691. The seasonal mean for all cutthroat was 0.853.

Water Quality Monitoring

Water Temperature - In summer/fall/winter 2004, 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 22 through October 7, 2004 (Figure 4). Like other years, placement of the probe was delayed from June 1st until the water elevations in the embayment rose. It was also feared the probe would be stolen when exposed at low water levels. The maximum and minimum temperatures measured between June 22 and October 7 were 22.4°C (June 26, 6 and 7pm) and 14.4°C (June 28, 9 to 11 pm, and June 29 at 12am), respectively. The maximum temperature was the day before the mouth began to close and the water rose. The minimum temperatures were associated with above average high high tides. The average water temperature for this period was 18.3°C.

The maximum and minimum water temperatures from July 1 to August 31, the warmest times of the summer, were 21.9°C (on June 25 at 8pm, July 20 3pm to 5pm, and July 21 at 3 and 4pm) and 15.8°C (on June 23, 24, 26, 29 and July 4 between 12am and 12pm), respectively. The average water temperature for the period of was 19.0°C. Maximum diurnal range was 3.7°C on August 28, and the minimum diurnal range was 0.6°C on August 22.

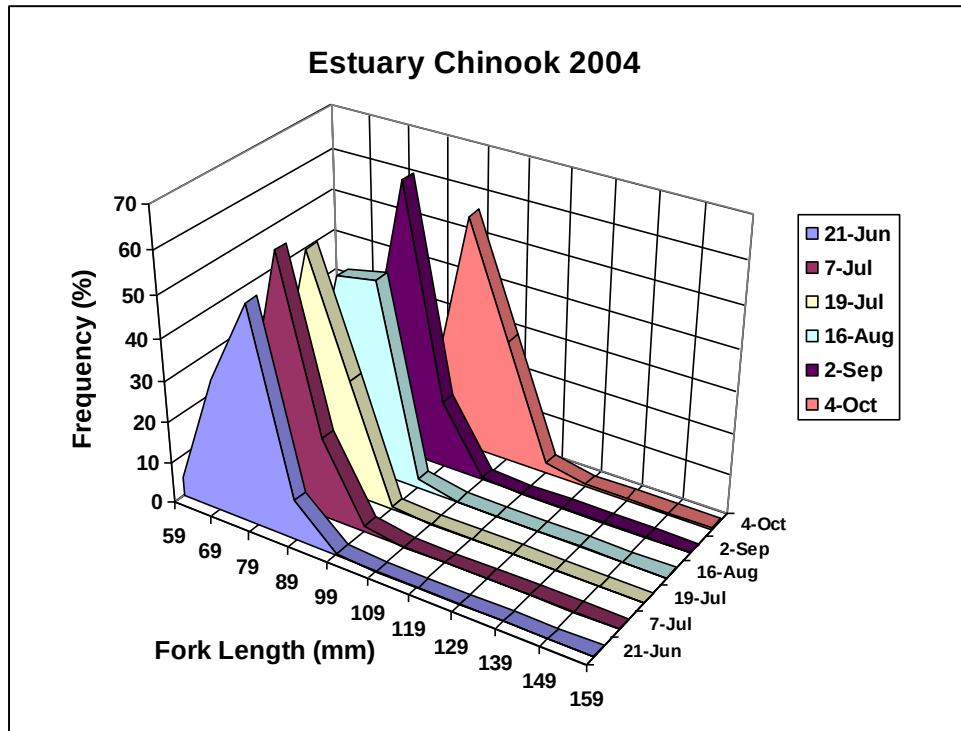


Figure 2. Fork length (mm) versus frequency (%) histogram of Redwood Creek estuary juvenile chinook sampled June 16 through October 23, 2003. The fork length classes were 10-mm increments.

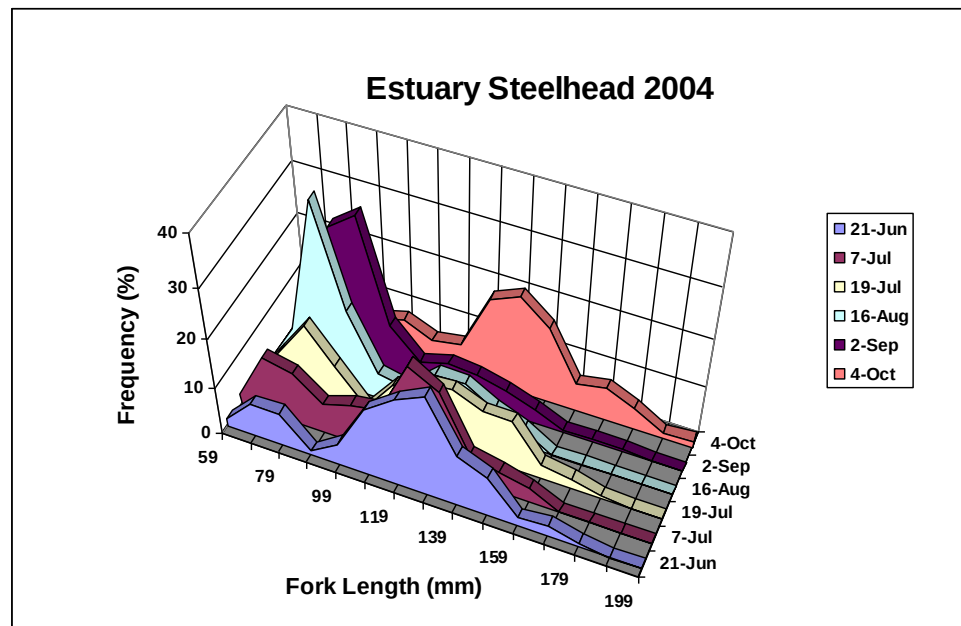


Figure 3. Fork length (mm) versus frequency (%) histogram of Redwood Creek estuary juvenile steelhead trout sampled June 16 through October 23, 2003. The fork length classes were 10-mm increments. Several age classes are present.

Table 4. 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 2004. 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 2004							
Date (week of)	6/21/2004	7/07/2004	7/19/2004	8/16/2004	9/02/2004	10/04/2004	Summer/ Fall 2004
Chinook Salmon (b = 2.923)							
Mean	1.233	1.237	1.313	1.149	1.193	1.249	1.229
Count	30	30	30	30	30	31	181
Standard Deviation	0.057	0.135	0.182	0.120	0.068	0.075	0.124
Minimum	1.125	1.052	1.026	0.743	1.039	1.077	0.743
Maximum	1.330	1.831	1.774	1.310	1.321	1.466	1.831
Coho Salmon (b = 2.623)							
Mean	2.671		2.325				2.657
Count	24	0	1	0	0	0	25
Standard Deviation	0.195		----				0.203
Minimum	2.172		2.325				2.172
Maximum	3.090		2.325				3.090
Steelhead Trout (b = 2.99)							
Mean	1.093	1.139	1.090	1.051	1.058	1.059	1.082
Count	32	30	30	30	30	30	182
Standard Deviation	0.064	0.218	0.190	0.141	0.053	0.048	0.138
Minimum	0.974	0.946	0.949	0.839	0.932	0.927	0.839
Maximum	1.234	2.038	2.020	1.643	1.142	1.160	2.038
Cutthroat Trout (b = 3.101)							
Mean	0.691		0.868	0.797		0.882	0.853
Count	1	0	4	4	0	11	20
Standard Deviation	---		0.092	0.030		0.112	0.103
Minimum	0.691		0.767	0.765		0.704	0.691
Maximum	0.691		0.988	0.838		1.031	1.031

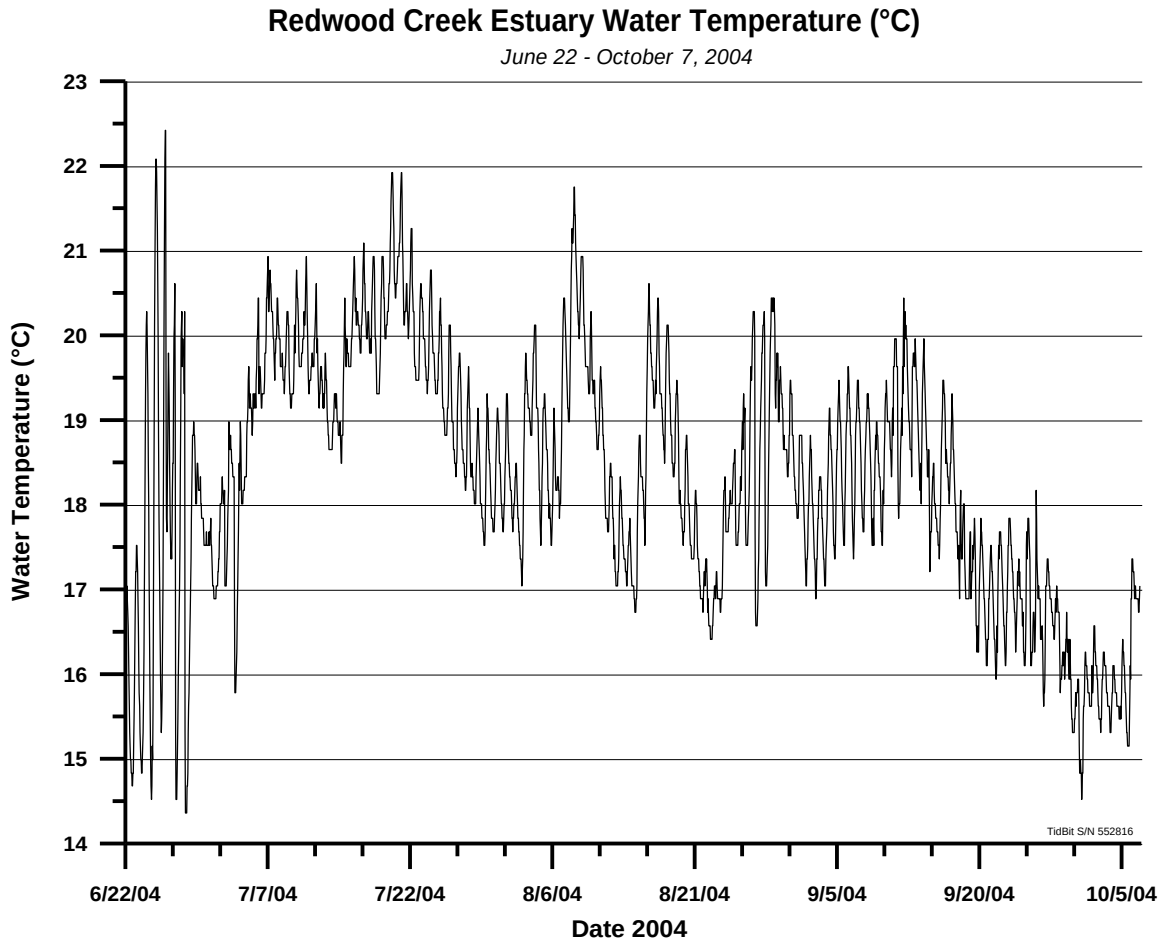


Figure 4. Redwood Creek estuary water temperatures (°C) measured by an Onset Tidbit temperature logger located in the embayment between the ends of the north and south flood control levees. The temperature logger, located one foot from the bottom, recorded water temperature every 1-hour from June 22 to October 7, 2004.

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 5.2 ft MSL and -6.2 ft MSL, respectively, a range of 11.4 feet. Tidal data is included in Figure 5.

Stream Flow - Calendar year 2004 stream flow data, January 1 through December 31, is presented in Appendix II. The maximum flow was 15,100 cfs on December 8, 2004. The gage measured a minimum flow of 6 cfs on September 17, 2004. The first appreciable flows of the fall occurred in three peaks of 206 cfs on October 20, 509 cfs on October 23, and 558 cfs on October 26, 2004. The flow data is provisional and subject to revision.

Estuary Water Level

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

South slough water elevations (feet MSL) were recorded every 30 minutes for the period January 1 to

December 31, 2003 (Figure 5). The temporary south levee/embayment gage was installed on July 1 and removed on December 9. It measured the water level every 15 minutes. Only the data to December 7, a previous download date, was used because after that date large incoming waves pushed the standing well pipe askew and pulled the cable causing the transducer to rise in the pipe.

The embayment site at the end of the south levee could measure 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/or sand deposited in the south slough outlet channel. Based on the 2004 south slough water elevation gaging data, before the south slough culverts were opened, the lowest south slough water elevation was limited to 3.26 ft MSL. With the culverts open, the lowest south slough elevation was limited to 2.6 ft MSL. The culvert opening (invert) is lower than the natural south slough channel thalweg. After the culverts were closed the lowest south slough elevation was limited to 3.58 ft MSL. The lowest embayment water elevation measured was 0.6 ft MSL (Figure 6). The south levee embayment gage had the potential to measure down to -0.44 ft MSL.

Closure, Breaching and Estuary Response

Based on field notes and recording water level gages in the south slough and embayment, the Redwood Creek estuary closed and breached three times during the fall of 2004 (Figures 5 and 6). The estuary mouth closed on June 27, and remained closed for 118.1 days, until opening on October 23. The mouth closed again on November 21 and remained closed for 7.1 day until opening on November 28, 2004. It closed on November 29 and remained closed for 7.7 days until opening on December 7, 2004. The estuary was closed for a total of 132.9 days in 2004, but the longest consecutive closure was 118.1 days.

June 27 Closure and October 23 Breach

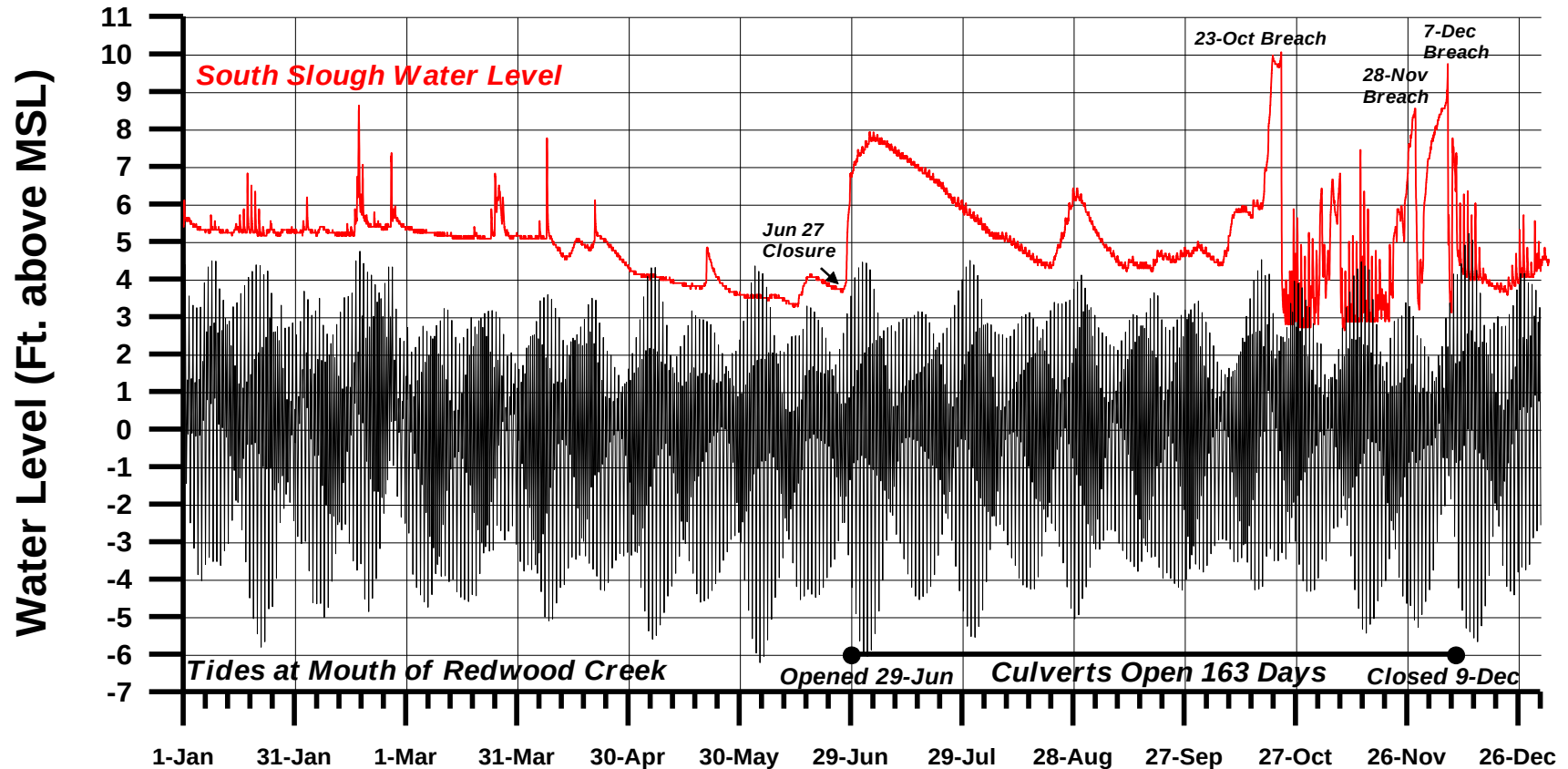
The mouth of the estuary first closed on June 27 at 3.7 ft MSL. Estuary water elevation peaked at 7.9 ft MSL on July 4 and proceeded to decline to 4.3 ft MSL on August 22nd. A secondary peak was 6.4 ft MSL on August 28. It declined to 4.2 ft MSL on September 11, then spiked and breached at 10.0 ft MSL (the highest recorded estuary water elevation for 2004) on October 23 at around 4am. The water elevation bottomed out at 0.6 ft MSL on October 25 (Figure 6). There were preceding rain/flow events that caused the estuary to breach. Prior to the breach there were two flow peaks recorded at the Orick gage upstream, 206 cfs on October 20, and 509 cfs on October 23 (Appendix II). On October 17, 0.72" of rain fell, and between October 17 and October 19, 1.44" of rain fell. Between October 22 at 3pm and October 23 at 4am, 1.88" of rain fell. The October 23rd low tide was -2.2 ft MSL at 2:30am and was increasing to a high high tide of 3.0 ft MSL at 8:48 am the morning of the breach. The estuary remained open to tidal influence until its second closure on November 21.

November 21 Closure and November 28 Breach

The estuary closed on November 21 at 2.9 ft MSL and breached 7.1 days later at 8.5 ft on November 28 at around 8:30am. It bottomed out at 3.2 ft MSL on November 29. The low tide on November 28 at 5:48am was -0.86 and the high high tide was 2.5 ft MSL at 11:42am. The Orick gage was reading 97 cfs when the breach occurred and 0.84" of rain had fallen between November 25 pm and November 28 8am. The estuary remained open about one day before closing on November 29.

South Slough Water Levels and Tides at Mouth of Redwood Creek

1/01/04 - 12/31/04



Date 2004

Figure 5. South slough water elevations (feet Mean Sea Level [MSL]) of the Redwood Creek estuary, Humboldt County for the period January 1 to December 31, 2004. Crescent City verified tidal elevations (ft. MSL) are corrected for the coastal locality at the mouth of Redwood Creek.

2004 South Slough and South Levee/Embayment Water Level Record

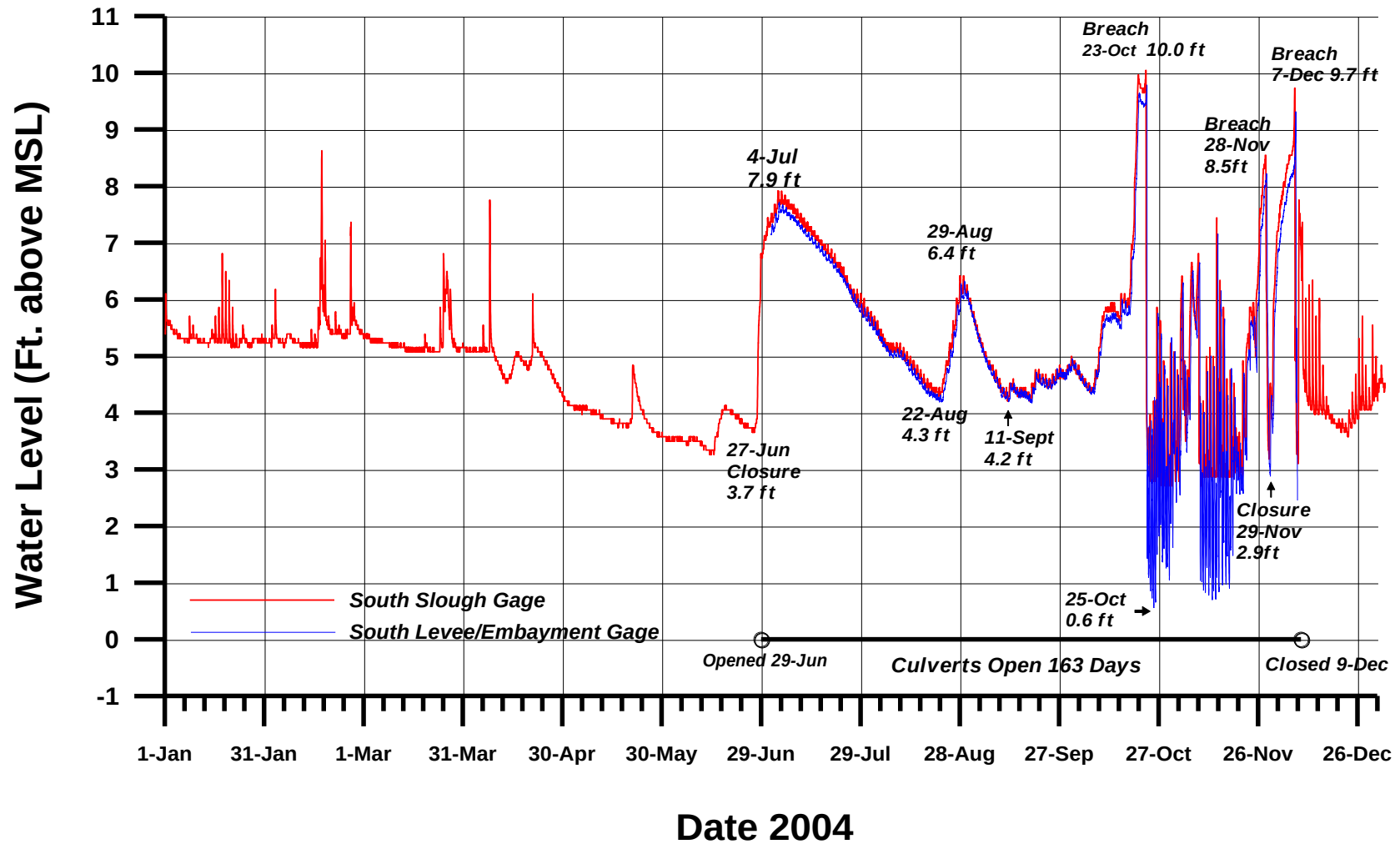


Figure 6. Water level elevations (ft. Mean Sea Level [MSL]) recorded in the south slough and at the end of the south levee of the embayment, Redwood Creek estuary, Humboldt County, California for calendar year 2004.

November 29 Closure and December 7 Breach

The estuary closed for the third time on November 29 at 2.9 ft MSL. It remained closed until it breached at 9.7 ft MSL on December 7, 2004 around 2 am. It initially bottomed out at 4.9 ft MSL, a 4.8 foot drop in 3.5 hours. The embayment later probably went lower, but the south levee/embayment gage was removed. The Orick flow gage read 1,410 at 2am December 7, but peaked at 15,100 at 2pm on December 8. Prior to the opening, there was a dry spell between December 1 and 6th, but between December 6 at 4am and December 7 at 2am 1.6" of rain fell. Low tide was -1.22 ft MSL at 12:48 am on December 7 going to high high tide of 3.4 ft MSL at 7:24am. The estuary remained open the rest of the calendar year.

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 opened on June 29. The water level between the river and south slough was the same so no water flowed out through the culverts when they were opened. The gates were closed on December 9 to prevent sedimentation in the south slough from large flow events. The gates were open for 163 days (Figure 5).

Other Activities

Redwood Creek Downstream Migrant Trapping

California Department of Fish and Game ran two downstream rotary migrant traps on Redwood Creek. The upper trap was located in Redwood Valley and the lower trap located on Redwood Creek upstream of Prairie Creek. The upper trap ran from March 24 to August 5 and the lower trap ran from April 2 through July 27. An estimated 629,847 0+ chinook, 41,434 1+ steelhead, and 5,778 2+ steelhead passed by the upper trap, and 554,890 0+ chinook, 77,221 1+ steelhead, and 24,095 2+ steelhead passed by the lower trap (Sparkman 2004).

A combined total of 800 1+ and 2+ steelhead smolts were marked under the jaw with a plastic elastomere at the upper trap located at river mile 33. We caught two elastomere steelhead in the estuary. One, a 128 mm long, 20.9 g steelhead with purple marks was caught on June 21. It was marked on June 9 and released on June 10 at the upper trap (Sparkman, personal communication). The second, a 136 mm long steelhead with green marks was caught in the estuary on September 2. It had been released at the upper trap on May 20.

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

Humboldt County Levee Maintenance Army Corps of Engineers 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 park had partnered with Humboldt County's five year levee maintenance permit application to include excavation of the channels at the north and south slough necks to improve slough connectivity and drainage. The park provided language for possible affected species, excavation calculations, digitized aerials, and drawings of the proposed work needed for the permit application. The plan was for the county to include the proposed four foot deep channels in the permit and if and when approved, the park would do the work with its own equipment.

However, the outlet excavation was not in the original application that went out for public notice, but in a revised application to the Corps. To include the excavation, a revised Corps public notice would have had to go out to the public again. This would have added more time to approval process, and delayed and possibly prevented any levee maintenance work in 2004. It was decided to withdraw the excavation of the slough necks from the maintenance project proposal. However, one plus is that the project biological opinion (NOAA NMFS 2004) included the excavation activities and can be used in the near future.

The Corps permit was granted and maintenance work, gravel and vegetation removal, was only done upstream of the Highway 101 bridge. Without a permit from the California Coastal Commission, work below the bridge which is in the coastal zone could not start. (The Coastal Commission approved the permit on April 15, 2005).

2004 Summary

- The Redwood Creek estuary was monitored in summer/fall/winter 2004. Four population estimates were conducted the weeks of June 21, July 19, August 16, and October 4. Seven growth estimates were conducted, four in conjunction with population estimates and three growth estimates on July 7, September 2, and December 6. Water level elevations in the south slough were measured from January 1 to December 31. Embayment water elevations were monitored from July 1 to December 9. A temperature logger recorded water temperature in the embayment every hour from June 22 through October 7.
- Juvenile chinook and steelhead populations decreased during the summer and fall and may reflect a low carrying capacity of the estuary and other physical and biological conditions that do not support larger numbers of rearing salmonids throughout the entire summer and fall season.
 - The estuary chinook population decreased 86% from 48,760 in late June to 6,660 in early October.
 - The estuary steelhead population decreased 93% from 39,380 in late June to 2,590 in early October.
 - A total of 25 juvenile coho salmon were caught in the estuary during summer 2004, 24 the week of June 21. This is similar to previous years (Anderson 1995).
 - A total of 20 cutthroat were caught during the 2004 season.
 - No salmonids were caught on December 6.
- Mean lengths and weights of chinook and steelhead increased during the summer. Fish that remained in the estuary were larger than those that emigrated to the ocean prior to the June 27 closure. The larger size would confer an increased survival in the ocean (Reimers 1973).
 - Mean chinook fork length increased from 72 mm to 97 mm.
 - Mean steelhead fork length increased to 130 mm in October.

- Water temperatures in the embayment were warm. The maximum and minimum temperatures measured between June 22 and October 7 were 22.4°C and 14.4°C, respectively. The average water temperature for this period was 18.3°C.
- The Redwood Creek estuary closed and breached three times during the fall and winter of 2004. The estuary closed on June 27 and remained closed for 118.1 days until opening on October 23. The estuary closed on November 21 and opened 7.1 days later on November 28. The estuary again closed on November 29 for 7.7 days, opening on December 7. The estuary was closed for a total of 132.9 days in 2004.
 - The highest recorded water elevation in the estuary was 10.0 ft MSL.

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[05/2005]*

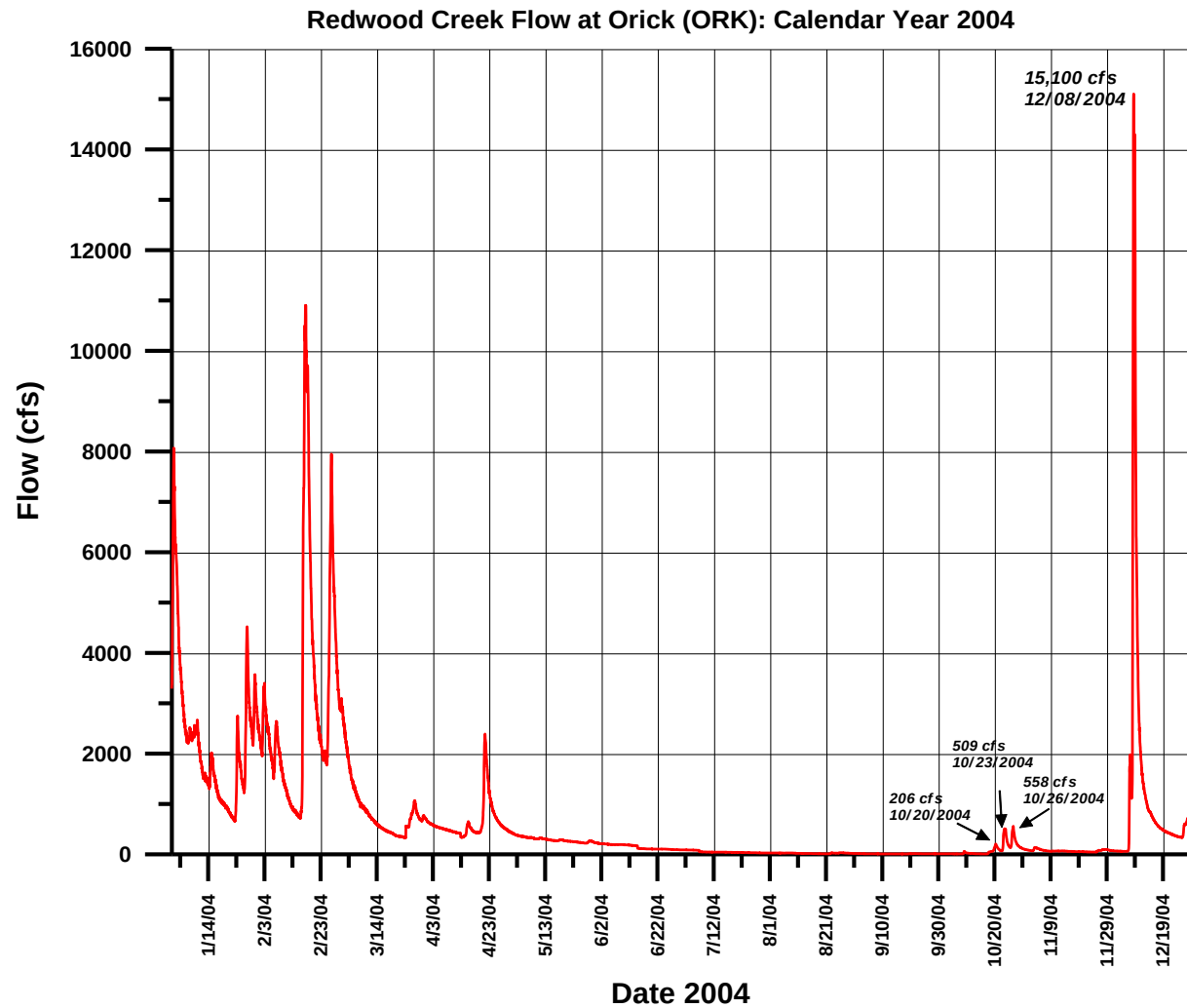
Appendix I. Number of salmonid fish marked, marked recaptures, and total individuals captured in the second sample from the RNSP Redwood Creek estuary mark and recapture population estimates during the summer/fall of 2004. Fish fins, top, middle, and bottom caudal, and anal fins were marked with a Panjet 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.

2004 Date		Number of Fish Marked ^a Marked Fish Recaptured ^b Total No. of Fish Captured in Second Sample ^c				Panjet Fin Marks
		Chinook	Coho	Steelhead	Cutthroat	
June 21 & 22	a	1,709	22 ^a	105	0	Top Caudal - All Fish
July 24	b	88	0	1	0	
	c	2,511	2	375	1	
July 19 & 20	a	933	1	138	1	Bottom Caudal - All Fish
July 22	b	11	0	2	0	
	c	466	0	159	2	
Aug 16 & 17	a	118	0	237	3	Blue Anal - All Fish
Aug 19	b	5	0	7	0	
	c	41	0	75	1	
Oct 4 & 5	a	383	0	622	8	Middle Caudal - All Fish
Oct 7	b	30	0	70	0	
	c	522	0	292	3	
a. On 7/22 one marked and seven unmarked coho were caught.						

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

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

Appendix II. Hourly Redwood Creek flow data for calendar year 2004, January 1 through December 31, 2004. 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.



2004 Acknowledgements

David Anderson, RNSP fishery biologist, led estuary monitoring in the field, analyzed data, and wrote the annual report. Others assisted, and/or contributed to the various estuary monitoring activities (e.g., seining, helping install or remove monitoring equipment, etc.).

Estuary Biological Monitoring (seining)

Fish and Wildlife Branch: David Anderson, Baker Holden, Terry Hines, Kyle Max, Keith Bensen, Jeanne Mayer, Greg Holm, Grant Alban, Carol Wilson, and Kim McFarland

Resource Management Labor Support Crew: Keith Richey, and Tim Tanno

Roads and Trails: Tobias Rexer and Michele Stover

Klamath Network Office: Becky Miller

Volunteer-in-the-Parks: Paul Paradine (Vegetation Branch)

CDFG: Mike Sparkman,

HSU Fisheries Biology Department: Dr. Tim Mulligan, Rebecca Studebaker, Ecology of Marine Fish class (~20 students)

Estuary Water Level Monitoring

Geological Services: 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, and Kyle Max

Water Temperature Monitoring

Fish and Wildlife Branch: David Anderson, Kyle Max

Culverts Opening or Closing

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

Seine Net Repair

Fish and Wildlife Branch: Spotted Owl Crew