

REDWOOD CREEK ESTUARY MONITORING  
1992 Progress Report  
Redwood National Park

by David Anderson

During the summer and fall of 1992, fishery personnel of the Fish and Wildlife Branch of Research and Resource Management continued the study initiated in 1980 on Redwood Creek estuary planning and monitoring. The study is designed to provide information of salmonid utilization of the estuary, monitor the effects of management activities, and develop, modify, and implement management and restoration strategies. The objectives are:

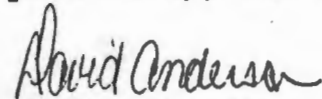
- I. To estimate the numbers of juvenile salmonids, utilizing the estuary throughout the summer-fall season.
- II. To determine the mean growth of the juvenile salmonids utilizing the estuary.
- III. To monitor the water quality of the estuary during the summer and fall.
- IV. To manage the water level of estuary to maintain fish habitat, but without flooding adjacent private landowners.
- V. To develop estuarine restoration alternatives.

N1423

Date: August 13, 1993  
To: Fish and Wildlife Ecologist  
From: Fishery Biologist  
Subject: 1992 Estuary Annual Report

Attached is an interim 1992 Redwood Creek Estuary monitoring annual progress report for work done in estuary during the summer and fall of 1992. As per our discussion, I am substituting the Army Corps monitoring report that was required by our special conditions of the Corps permit.

The following page outlines the subjects that are usually covered in the annual estuary monitoring report, many which are covered to some extent in the Corps report. I have included a table of minimum and maximum water quality parameters measured in the estuary in summer/fall 1992. What still needs to be done are some graphics (water quality and fish lengths, numbers, comparisons with past data), and water quality analysis.

  
David Anderson

## South Slough Trapping

### Methods

Fish trapping in the South Slough does not estimate populations, but does exhibit utilization of the slough by salmonids. Two fyke nets are placed in the South Slough so that the hoops are submerged in water, usually at the RNP boundary line in the remnant creek channel. One net is oriented facing upstream (toward the culvert) and the other facing downstream (toward the slough neck). The fyke nets have six 3-foot diameter hoops, with two 15-foot long wing nets set at a 90° angle. The mesh size is 1/4 inch, and the opening in each net funnel trap is 2 1/2 by 2 1/2 inches. Both nets are in place for approximately 24 hours before being retrieved. All fish species are counted and salmonids measured (fork length - mm).

### Results

South slough trapping was done five times, 6/29-30, 7/15-16, 8/17-18, 8/19-20, and 9/14-15/92 (Table 1).

A combined total of 7,684 fish were caught, the majority, three spine stickleback (Table 2). A total of 2 chinook, 13 steelhead, and 2 coastal cutthroat trout were caught. No coho salmon were trapped. One steelhead trout, trapped 6/29-30/92 had a top caudal blue mark, meaning that a fish marked on 6/22-23/92 in the embayment had migrated into the south slough, and was indicative of some embayment salmonids utilizing the south slough. Because the culvert gates were not opened til 7/7/92, the marked steelhead must have entered the south slough via the south slough channel.

and endangered in California or elsewhere by the California Native Plant Society (Smith, J.P. and R. York. 1988. Inventory of Rare and Endangered Vascular Plants of California. September 1988 Special Publication No. 1. Fourth Edition. CNPS. Berkeley. CA.) Excavation may affect a small portion of this localized population. The plant, an annual, would not transplant well because it is in sand (personal communication with L. Arguello.) Reproduction is by seed. It has been suggested that we could try transplanting the few plants that may be affected by scooping the sand, the sand verbenas, and all and moving the whole thing out of the channel area.

Though not a primary reason to lower the north slough, water is backed up and flooding private adjacent property. Most of the water is within the area fenced off by the California Department of Fish and Game/California Conservation Corps for re-establishment of riparian vegetation and not on accessible pasture. Water is also on land on the north side of Hufford Road. This project would remove water from these fields and the fenced riparian area.

- (6) PROPOSED PROJECT: Exact location and statement of work, including location and project maps, methods, equipment, personnel, acreage or approximate dimensions, construction standards, need for follow-up notification and monitoring.

Work is to be done at the western end of the north levee in the Redwood Creek estuary, specifically in the north slough channel, an area of sand separating the north slough and the estuary embayment. A map (Figure 1) is enclosed showing the general area as well as a cross section of the north slough channel (Figure 2).

Several possible techniques may be used to lower the water level (consultation with Earl Whetsell).

1. Use of the RNP dozer would create a 30 foot wide swath and take about 2 days. The channel would be about 325 feet long in length. The volume of sand excavated would be 400 yd<sup>3</sup> to 1,200 yd<sup>3</sup>, depending upon channel excavation to the high or low tide marks, respectively.
2. The RNP backhoe would create a 10 foot wide swath and take about 1 day, depending upon if no large buried obstructions such as boulders and large logs, were uncovered. The channel would be about 325 feet long in length. The volume of sand excavated would be 130 yd<sup>3</sup> to 390 yd<sup>3</sup>, depending upon channel excavation to the high or low tide marks, respectively.
3. A 4 - 6" PVC buried pipe about 450 feet long would be used to siphon or pump water out of the north slough. A pump would be needed for either option. It was estimated pumping would take 2 to 3 days.

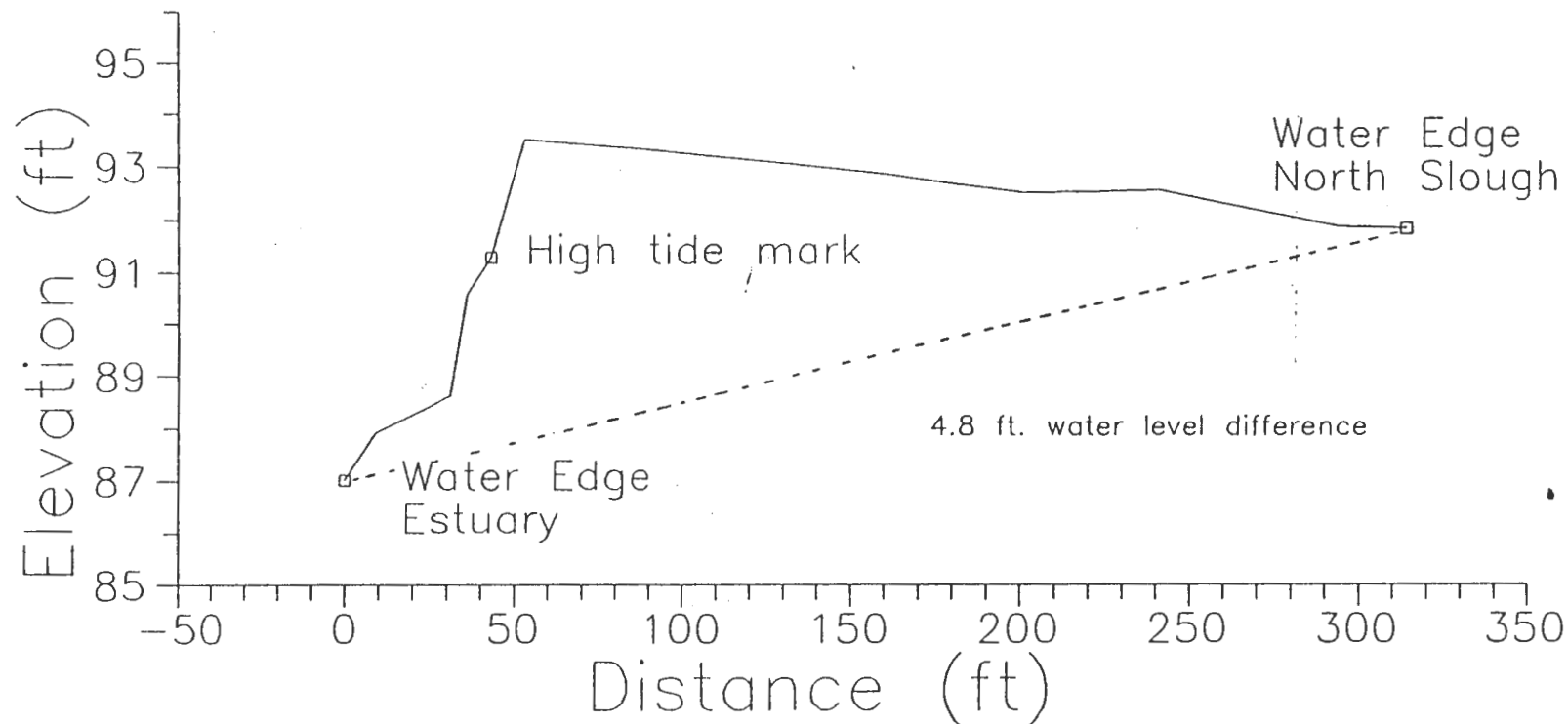
Monitoring would entail recording the lowering of the water level through daily readings of the north slough staff gauge or the installation of an automatic recording device. The present staff gauge needs to be verified and/or replaced with another that reads with more precision.

The final method used would be decided after comments are received and a 'show me' tour.

(8) JUSTIFICATION FOR PROPOSED PROJECT:

The project benefits will relieve riparian vegetation flooding and drowning, possibly improve water quality and thereby improve fish habitat, and drain flooded adjacent private land.

North Slough Channel  
Redwood Creek Estuary  
03/24/92



Cross section of North Slough Channel, Redwood Creek Estuary, Humboldt County, California, on March 24, 1992.

(Dotted line represents channel excavation.)

FIGURE 2.

On 8/17, the water was at 4.35 ft MSL, and off the pastures and riparian vegetation, a decrease of ~3 ft of head from March, when flooding was a problem. This was a natural loss of ~16 acre feet of water. This natural loss did not improve water quality. I believe water loss by this project will be offset by an improvement in water quality. Because the water quality presently is very poor, the risk to aquatic resources will be minimal. The more poor quality water that is flushed out, the better for the fisheries. What is left will be diluted by fresh water from winter rains and ocean tidal action. To exchange the poor quality water with ocean water, the channel will have to be lowered to a point where water would be exchanged during tidal fluctuations. We will attempt to excavate a channel that is as deep as physically possible given the constraints of the equipment and site. If ocean processes partially fill the channel in with sand again, the water level will increase, and the water quality should be better than before. Hopefully the winter flows will keep the excavated channel open to prevent water from flooding the riparian vegetation again.

2) Historic vegetation and Maintenance Program - The project clearance was referring to the drowning of the pre-levee vegetation. However, most of the large trees are already gone, and grazing has removed much of the valuable riparian vegetation of the south fork and south bank of the north fork. The Fish and Game fencing project, which was supported by the park, was designed to restore the historic riparian vegetation. As to the park getting into an annual maintenance program to protect the new plantings behind the cattle enclosure, the point is a good one. The location of the plants was on land that the landowner was willing to 'take out of pasture' and have fenced for riparian protection. It is probably true that the plants may not be in the most appropriate spot, given that there is no outlet for the north slough. However, these present conditions were artificially caused by the levees. The planting program is a good one if the north slough outlet is kept open. We will be updating the Estuary Management Plan and Environmental Assessment this winter. It will involve evaluating interim and long-term management alternatives for the north slough. Until then, we do not know if we will maintain the excavation and manage for a water level that keeps water off the riparian vegetation and pastures. The U.S. Army Corps of Engineers and other agency input will affect our decision.

3) Alternatives and Water Quality - The preferred alternative is 1, the use of the dozer to excavate the channel. It will provide a better longer-lasting hydrologic connection between the slough and estuary than the other alternatives. If the excavation had been implemented in the summer, the 'better' quality water would have drained out. If done in the fall, the combination of increased freshwater flow from Sand Cache Creek, tidal circulation, and overturn of the water column, will negate the effect of initial surface water drainage.

4) Water Quality Monitoring - Water quality of the north slough will be monitored periodically, in addition to water levels. Monitoring began in June 1992 and will continue into winter and spring to evaluate the management effects.

5) Disposal of Excavated Sand - Excavated sand will be placed adjacent to the channel. Eventually it will be transported out into the embayment and ocean as the excavated channel adjusts and scours.

Geologist Randy Klein

Randy recommended that the original channel profiles be modified to show elevations above mean sea level (MSL) and that the design grade be determined from these.

The original (3/24/92) and a more recent (8/17/92) channel profile have been modified to show elevations above mean sea level (MSL) in order to evaluate

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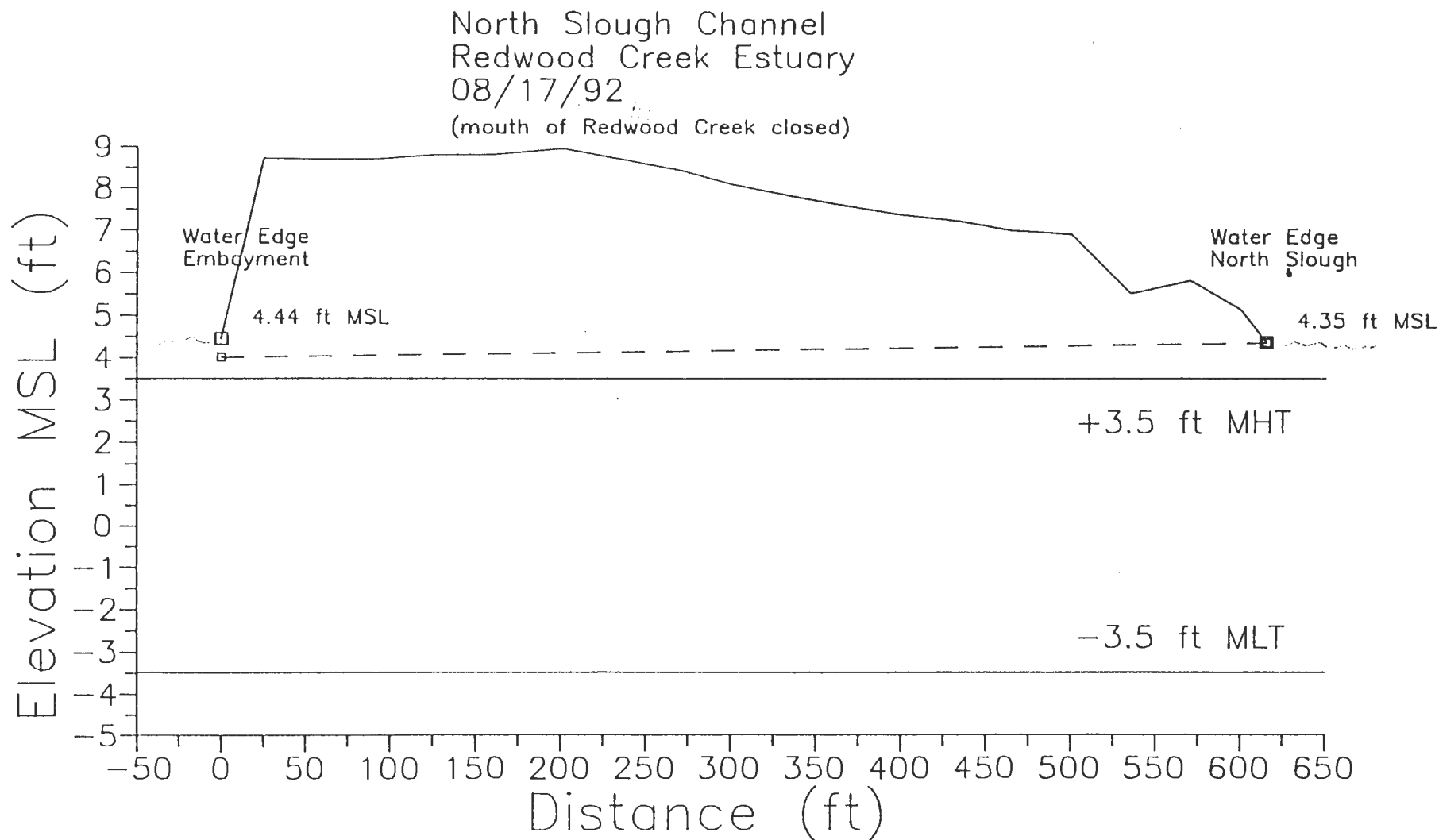
Deputy Superintendent

Chief, Research and Resources Management

Branch Chiefs, Research and Resources Management

Environmental Specialist

LONG PROFILE OF PROPOSED NORTH SLOUGH EXCAVATED CHANNEL, REDWOOD CREEK ESTUARY, HUMBOLDT COUNTY, CALIFORNIA, ON AUGUST 17, 1992. (Dotted line represents minimum channel excavation.)  
MSL = Mean Sea Level, MHT = Mean High Tide, MLT = Mean Low Tide.



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Table 1. Dates of south slough trapping in the Redwood Creek estuary; condition of mouth and south slough culverts, open or closed; hours the fyke nets fished; and water elevation (ft mean sea level [MSL]) when the traps were deployed and retrieved.

| DATE       | MOUTH  | S. SLOUGH<br>CULVERTS | TIME (HRS)                              | CULVERT GAGE (FT MSL) |                   |
|------------|--------|-----------------------|-----------------------------------------|-----------------------|-------------------|
|            |        |                       |                                         | IN                    | OUT               |
| 6/29-30/92 | OPEN   | CLOSED                | 23.9 <sup>a</sup><br>23.8 <sup>b</sup>  | 3.04                  | 3.22              |
| 7/15-16/92 | OPEN   | OPEN                  | 24.25 <sup>a</sup><br>24.9 <sup>b</sup> | 2.86                  | 2.96              |
| 8/17-18/92 | CLOSED | OPEN                  | 24.2 <sup>a</sup><br>24.2 <sup>b</sup>  | 4.42 <sup>c</sup>     | 4.37 <sup>c</sup> |
| 8/19-20/92 | CLOSED | OPEN                  | 24.2 <sup>b</sup><br>24.5 <sup>b</sup>  | 4.22                  | 4.14              |
| 9/14-15/92 | CLOSED | OPEN                  | 24.5 <sup>a</sup><br>24.5 <sup>b</sup>  | 3.42                  | 3.44              |

<sup>a</sup> Upstream facing net, <sup>b</sup> Downstream facing net, <sup>c</sup> RIC staff gage

Table 2. Numbers and percentages of fish and other species trapped in the south slough, Redwood Creek estuary during the summer and fall of 1992.

| SPECIES                 | 6/29-30 |      | 7/15-16 |      | 8/17-18 |      | 8/19-20 |      | 9/14-15 |      | 1992 Season |      |
|-------------------------|---------|------|---------|------|---------|------|---------|------|---------|------|-------------|------|
|                         | No.     | %    | No.     | %    | No.     | %    | No.     | %    | No.     | %    | No.         | %    |
| Three Spine Stickleback | 4,036   | 91.7 | 1,930   | 95.8 | 14      | 66.7 | 675     | 89.5 | 415     | 83.5 | 7,070       | 92.0 |
| Shiner Surfperch        | 293     | 6.7  | 4       | 0.2  | -       | -    | -       | -    | -       | -    | 297         | 3.9  |
| Prickly Sculpin         | 37      | 0.8  | 70      | 3.5  | 3       | 14.3 | 44      | 5.8  | 76      | 15.3 | 230         | 3.0  |
| Staghorn Sculpin        | 18      | 0.4  | 10      | 0.5  | 4       | 19.0 | 31      | 4.1  | 5       | 1.0  | 68          | 0.9  |
| Steelhead Trout         | 12      | 0.3  | -       | -    | -       | -    | -       | -    | 1       | 0.2  | 13          | 0.2  |
| Chinook Salmon          | 2       | 0.1* | -       | -    | -       | -    | -       | -    | -       | -    | 2           | 0.1* |
| Coho Salmon             | -       | -    | -       | -    | -       | -    | -       | -    | -       | -    | 0           | 0    |
| Coastal Cutthroat Trout | 1       | 0.1* | -       | -    | -       | -    | 1       | 0.1  | -       | -    | 2           | 0.1* |
| Surfsmelt               | 1       | 0.1* | -       | -    | -       | -    | -       | -    | -       | -    | 1           | 0.1* |
| Frog tadpole            | -       | -    | -       | -    | -       | -    | 3       | 0.4  | -       | -    | 1           | 0.1* |

\* < 0.1 %

Table 30. Minimum and maximum water quality values of temperature(°C), salinity (o/oo), specific conductivity (umhos @ 25°C), dissolved oxygen (ppm), pH measured in the Redwood Creek estuary during the summer and fall of 1992.

| ESTUARY WATER QUALITY - YEAR 1992<br>MINIMUM & MAXIMUM VALUES MEASURED |                  |      |                 |      |                      |        |
|------------------------------------------------------------------------|------------------|------|-----------------|------|----------------------|--------|
| Station                                                                | TEMPERATURE (°C) |      | SALINITY (o\oo) |      | CONDUCTIVITY (umhos) |        |
|                                                                        | LOW              | HIGH | LOW             | HIGH | LOW                  | HIGH   |
| NORTH SLOUGH                                                           |                  |      |                 |      |                      |        |
| NS1                                                                    | 13.5             | 23.5 | 0.0             | 0.0  | 217                  | 448    |
| NS2                                                                    | 13.5             | 25.5 | 0.0             | 6.0  | 217                  | 10,128 |
| NS3                                                                    | 13.5             | 23.0 | 0.0             | 0.0  | 219                  | 769    |
| EMBAYMENT                                                              |                  |      |                 |      |                      |        |
| EMB4                                                                   | 14.0             | 20.0 | 0.0             | 22.0 | 166                  | 34,220 |
| EMB5                                                                   | 14.0             | 20.0 | 0.0             | 19.5 | 121                  | 30,581 |
| EMB6                                                                   | 14.0             | 20.0 | 0.0             | 21.0 | 166                  | 35,438 |
| SOUTH SLOUGH NECK                                                      |                  |      |                 |      |                      |        |
| SS7                                                                    | 14.5             | 22.5 | 0.0             | 10.0 | 286                  | 16,787 |
| SS8                                                                    | 14.0             | 25.5 | 0.0             | 8.0  | 173                  | 13,596 |
| SS9                                                                    | 14.0             | 21.5 | 0.0             | 11.0 | 137                  | 17,304 |
| SOUTH SLOUGH                                                           |                  |      |                 |      |                      |        |
| SS10                                                                   | 14.5             | 22.5 | 0.0             | 9.0  | 371                  | 14,664 |
| SS11                                                                   | 14.5             | 25.5 | 0.0             | 23.5 | 531                  | 36,000 |
| SS12                                                                   | 14.5             | 23.5 | 0.0             | 21.0 | 531                  | 32,627 |

Dates Measured: 6/18/92, 7/15/92, 8/13/92, 9/14/92, 10/28/92\*

\* North Slough stations not monitored on this date.

Table 4. Minimum and maximum water quality values of temperature(°C), salinity (o/oo), specific conductivity (umhos @ 25°C), dissolved oxygen (ppm), pH measured in the Redwood Creek estuary during the summer and fall of 1992 (continued).

| ESTUARY WATER QUALITY YEAR 1992<br>MINIMUM & MAXIMUM VALUES MEASURED |                        |      |     |      |
|----------------------------------------------------------------------|------------------------|------|-----|------|
| Station                                                              | DISSOLVED OXYGEN (ppm) |      | pH  |      |
|                                                                      | LOW                    | HIGH | LOW | HIGH |
| <b>NORTH SLOUGH</b>                                                  |                        |      |     |      |
| NS1                                                                  | 0.2                    | 7.2  | 6.2 | 7.2  |
| NS2                                                                  | 0.2                    | 11.0 | 6.3 | 7.1  |
| NS3                                                                  | 0.3                    | 5.7  | 6.3 | 7.2  |
| <b>EMBAYMENT</b>                                                     |                        |      |     |      |
| EMB4                                                                 | 5.0                    | 9.9  | 6.9 | 7.4  |
| EMB5                                                                 | 4.8                    | 12.1 | 6.8 | 7.5  |
| EMB6                                                                 | 5.0                    | 10.0 | 6.8 | 7.4  |
| <b>SOUTH SLOUGH NECK</b>                                             |                        |      |     |      |
| SS7                                                                  | 0.5                    | 15.8 | 6.8 | 9.1  |
| SS8                                                                  | 6.9                    | 12.3 | 7.0 | 9.2  |
| SS9                                                                  | 6.7                    | 12.0 | 6.8 | 7.9  |
| <b>SOUTH SLOUGH</b>                                                  |                        |      |     |      |
| SS10                                                                 | 1.1                    | 11.7 | 6.8 | 7.4  |
| SS11                                                                 | 0.3                    | 20.0 | 6.6 | 8.7  |
| SS12                                                                 | 0.3                    | 17.1 | 6.7 | 9.2  |
| Dates Measured: 6/18/92, 7/15/92, 8/13/92, 9/14/92, 10/28/92*        |                        |      |     |      |
| * North Slough stations not monitored on this date.                  |                        |      |     |      |

## 1992 Redwood Creek Estuary Annual Monitoring Report

Redwood National Park  
P.O. Box 7  
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This report, required by the special conditions of permit no. 18974N36 (Appendix A), details the 1992 estuary resource management activities of Redwood National Park and steps followed to pursue a long-term solution to the problems of the Redwood Creek Estuary.

### Project Location

The Redwood Creek estuary is located 2.5 miles west of Orick, California. Flood control levees completed in 1968 channelize the lower 3.2 miles of Redwood Creek and extend into the estuary (Figure 1). The levees have changed the circulation and sedimentation patterns in the estuary. The last oxbow of the river, now called the South Slough was bypassed by the south levee, and later reconnected in 1987 by gated culverts; a mitigation project to offset fish losses of the U.S. Highway 101 Park Bypass. The North Slough channel is filled with sand. The permit authorizes water level management in the estuary when the level exceeds 6.0 ft Mean Sea Level (MSL). This event occurs during the summer and fall when the mouth closes and results in flooding of adjacent private land. The permit also allows for the deepening and widening of the channels of the North and South sloughs.

### Fish Monitoring

The Peterson mark and recapture method is used to estimate juvenile salmonid fish numbers in the Redwood Creek estuary. A blue mark is applied to the caudal or anal fin using a Panjet needleless injector and Alcian Blue dye. Fish are seined using a 150 foot long, 15 foot wide, 1/4 inch mesh beach seine. Fish are 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. In addition, length measurements are obtained from each of 200 chinook salmon and steelhead trout juveniles, and weight measurements taken from 30 juveniles of each species. Other salmonid species, cutthroat trout and coho salmon, which were uncommon, were also measured.

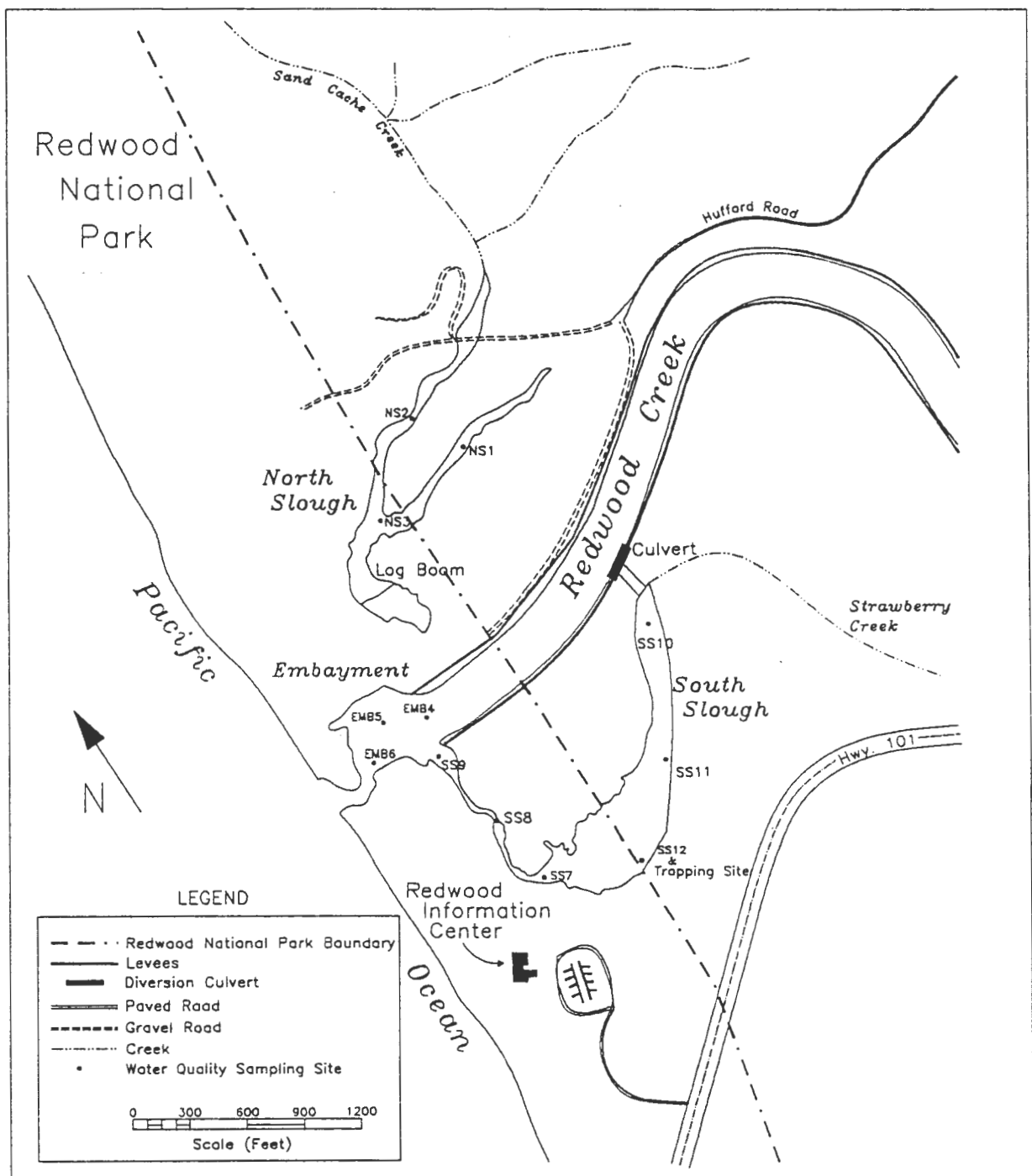


Figure 1. Map of the Redwood Creek Estuary, Humboldt County, California, including the embayment, north and south sloughs.

During the 1992 summer-fall field season, four population estimates and seven length/weight measurements were conducted between June 22 and October 8, 1992. The chinook salmon population declined during the summer and increased during the fall, and the steelhead population increased, then declined, before increasing again in the fall (Table 1). It is believed the low August estimate of both chinook and steelhead was a result of most of the fish occupying the upper estuary/lower Redwood Creek area and not the embayment proper where the sampling took place. The mean forklength of all fish increased during the summer and fall (Table 2). The steelhead forklength increase is variable because the mean includes several age classes, however, the minimum length of each sampling period increased over the season.

### Activities Conducted to Meet Long-Term Management Goals.

#### **Meetings with Landowners and Other Parties**

Two meetings were held with adjacent landowners, other agencies and interested parties on March 4 and July 28, 1992. The first meeting served to inform the landowners of the present condition of the Redwood Creek estuary, past management activities, the 1992 Corps permit, and its the special conditions and future ramifications. At the meeting, landowners, California Department of Fish and Game, California Conservation Corps, Humboldt County, Northcoast Flyfishers, and Redwood National Park were represented. It was agreed to meet again and discuss specific alternatives for the restoration of the estuary and invite the Corps and other interested parties and agencies to the meeting.

The July 28th meeting included an indepth presentation by the U.S. Army Corps of Engineers of potential study/project authorities for modifying the Redwood Creek Project; including Section 1135 of the Water Resources Development Act of 1986, Section 216 of the Flood Control Act of 1970, and Congressionally authorized general investigations, and the time lines involved. The problems in the estuary, summer and winter flooding, fish resource and landowner concerns, possible solutions, and how to proceed were discussed. It was emphasized management agencies will not allow activities that cause negative impacts on aquatic resources to continue. Present were adjacent private landowners, Corps of Engineers, California Department of Fish and Game, Redwood National Park, Trout Unlimited, and California Trout. Most people there recognized the need for a long-term solution and are willing to work together. However, one adjacent landowner still questioned the importance of fish versus agriculture and did not want to lose any land to any proposed solution. We agreed to meet again, discuss specific alternatives and plans (e.g., partial or total estuary levee removal), and come to a consensus as one group in advancing and lobbying for a specific solution. Prior to the public meeting Redwood National Park personnel, including the Superintendent, met with the Corps representatives.

Table 1. Population estimates and 95 % confidence intervals of juvenile chinook salmon (Oncorhynchus tshawytscha) and steelhead trout (O. mykiss) utilizing the Redwood Creek estuary, Humboldt County, California, during the summer and fall of 1992.

| WEEK OF  | STATUS OF CREEK MOUTH | CHINOOK SALMON      |                         | STEELHEAD TROUT     |                         |
|----------|-----------------------|---------------------|-------------------------|---------------------|-------------------------|
|          |                       | Population Estimate | 95% Confidence Interval | Population Estimate | 95% Confidence Interval |
| 06/22/92 | OPEN                  | 43,830              | 29,930 - 57,740         | 6,350               | 3,060 - 9,650           |
| 07/20/92 | OPEN                  | 29,170              | 13,650 - 44,690         | 15,440              | 3,330 - 27,560          |
| 08/24/92 | CLOSED                | 5,450               | 3,550 - 7,360           | 8,860               | 1,280 - 16,430          |
| 10/05/92 | CLOSED                | 22,470              | 12,660 - 32,280         | 28,730              | 22,090 - 35,380         |

Table 2. Mean fork length (mm), standard deviation, and range of juvenile chinook salmon, steelhead trout, coho salmon, and coast cutthroat trout seined in the Redwood Creek estuary, Humboldt County, California, during the summer and fall of 1992. MOUTH denotes if mouth of Redwood Creek was open to the ocean or closed.

| DATE     | MOUTH  | CHINOOK SALMON |                      |           |          | STEELHEAD TROUT |                      |           |          |
|----------|--------|----------------|----------------------|-----------|----------|-----------------|----------------------|-----------|----------|
|          |        | # Sampled      | Mean Forklength (mm) | Std. Dev. | Range    | # Sampled       | Mean Forklength (mm) | Std. Dev. | Range    |
| 06/22/92 | OPEN   | 206            | 72.8                 | 5.3       | 55 - 84  | 204             | 130.9                | 17.9      | 63 - 190 |
| 07/08/92 | OPEN   | 266            | 82.2                 | 5.8       | 59 - 99  | 107             | 134.2                | 19.8      | 67 - 200 |
| 07/20/92 | OPEN   | 220            | 89.3                 | 6.2       | 71 - 110 | 231             | 140.2                | 22.7      | 70 - 240 |
| 08/11/92 | CLOSED | 90             | 91.6                 | 5.7       | 77 - 104 | 120             | 142.1                | 16.7      | 82 - 170 |
| 08/24/92 | CLOSED | 225            | 96.1                 | 5.5       | 73 - 114 | 229             | 129.2                | 23.1      | 83 - 189 |
| 09/10/92 | CLOSED | 212            | 99.0                 | 6.1       | 77 - 134 | 230             | 145.5                | 21.8      | 89 - 255 |
| 10/05/92 | CLOSED | 230            | 106.6                | 5.1       | 95 - 120 | 206             | 133.1                | 20.3      | 93 - 184 |

| DATE     | MOUTH  | COHO SALMON |                      |           |           | CUTTHROAT TROUT |                      |           |           |
|----------|--------|-------------|----------------------|-----------|-----------|-----------------|----------------------|-----------|-----------|
|          |        | # Sampled   | Mean Forklength (mm) | Std. Dev. | Range     | # Sampled       | Mean Forklength (mm) | Std. Dev. | Range     |
| 06/22/92 | OPEN   | 5           | 127.1                | 16.3      | 67 - 150  | 4               | 210.5                | 19.3      | 187 - 234 |
| 07/08/92 | OPEN   | 2           | 134.0                | 7.1       | 129 - 139 | 1               | 177                  | -         | --        |
| 07/20/92 | OPEN   | 0           | -                    | -         | --        | 5               | 254.8                | 12.8      | 236 - 268 |
| 08/11/92 | CLOSED | 0           | -                    | -         | --        | 1               | 285                  | -         | --        |
| 08/24/92 | CLOSED | 0           | -                    | -         | --        | 0               | -                    | -         | --        |
| 09/10/92 | CLOSED | 0           | -                    | -         | --        | 0               | -                    | -         | --        |
| 10/05/92 | CLOSED | 1           | 136.0                | -         | --        | 8               | 273.0                | 29.8      | 228 - 323 |

### **Section 1135 (Water Resources Development Act of 1986)**

Redwood National Park has terminated the Section 1135 process on the Redwood Creek estuary. After a discussion with Corps staff on July 28, the decision was made to terminate it because of problems with acquiring land or easements on adjacent private property, the lack of funds by the non-federal local sponsor (State of California - Department of Fish and Game), and the cost of the solution to completely restore the estuary to a naturally functioning system exceeded the project's expenditure cap. The Redwood National Park preferred alternative of completely removing the lower levees would likely exceed the \$2,000,000 Federal project allowance and not achieve the habitat restoration purpose of the 1135 authority.

### **Other Activities**

In March, Superintendent William Ehorn sent The Conservation Fund an updated estuary briefing statement and parcel maps of Redwood Creek estuary lands, and formally requested their consideration of these lands for possible acquisition.

Preliminary plans and specifications for tide gates to be retrofitted onto the south slough levee culverts to improve water circulation in the south slough were drafted and reviewed by a consulting engineer. They are to be fabricated over the winter and installed in spring of 1993.

Our intent is to continue to coordinate with the affected landowners, the U.S. Army Corps of Engineers, and other interested parties, in an attempt to come to a consensus on a solution that will benefit the resource.

### **Water Level Management**

Estuary water level management was not performed in 1992. No artificial breaching by the National Park Service occurred. The water level in the estuary was monitored by a recording gage in the south slough, starting on June 22, 1992 (Figure 2). The graph depicts the south slough water level and Pacific Ocean tides at the mouth of Redwood Creek. The tides are corrected for the area of Redwood Creek and adjusted to Mean Sea Level (MSL). Since the level of the south slough is controlled by height of the sill at the mouth of the south slough channel, the water level in the main embayment was lower, < 3 ft. MSL, at lower tidal fluctuations when the mouth of Redwood Creek was open. However, when open, estuary water level does not exactly follow the tides because of the height of the sand sill at the open mouth, the discharge capacity of the mouth, river flow, and the size of the tidal prism.

The mouth of Redwood Creek closed during a period when the recording gage malfunctioned, between July 23 and August 6. Prior to that period the mouth opened and closed twice. On October 30 it opened after reaching a height of 8.48 ft MSL, and opened and

# REDWOOD CREEK ESTUARY South Slough Water Level Record 6/22/92 - 12/31/92

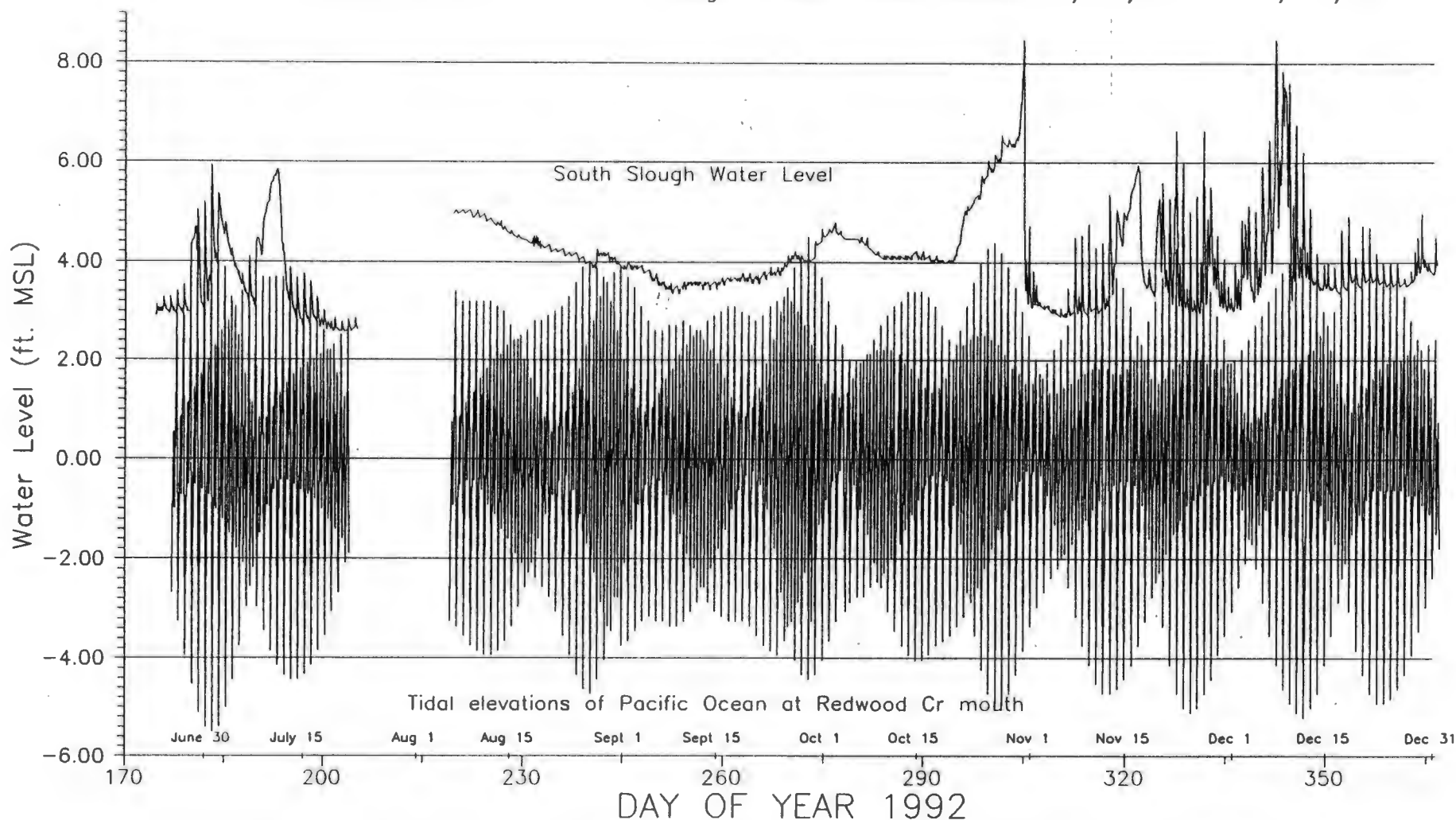


Figure 2. South slough water elevations (ft. Mean Sea Level (MSL)) and tidal elevations of the Pacific Ocean at Redwood Creek mouth for the period of June 22 to December 31, 1992, excluding July 23 to August 6, 1992 when the recording gage malfunctioned. Tidal elevations are corrected for the area of Redwood Creek and adjusted to MSL.

closed several times on its own till after December 11, when it remained open. The highest water level recorded in the south slough, 8.48 ft MSL, occurred on October 30 and December 7. The water level exceeded 6.00 ft MSL in 11 separate incidents during the period of record (Table 3). No evidence of unauthorized breaching was observed, however if it did occur, the evidence (e.g., mounds of sand, tire tracks) is usually washed away when the channel widens and deepens.

Aerial photos taken on June 21, 1992 depict the Redwood Creek configuration (Figure 3). The mouth is open and situated to the south, and the north slough is not connected to the embayment.

#### **South Slough Culvert Gates**

The three gates of the south slough culvert were slightly opened on July 7, 1992 to allow for the gradual release of water from the south slough. The water was black in color and smelled of hydrogen sulfide. On July 16, the gates were opened all the way and remained open till they were closed on October 29, 1992.

#### **North Slough**

On March 24, 1992 the water level in the north slough was 6.94 ft. MSL, but had receded to 4.35 ft. MSL on August 17, 1992. The decrease was probably due to evaporation and underground seepage into the embayment. December 1992 storms raised the water level of the north slough. Overwash from waves entering the estuary was also flowing into the north slough. On December 16, 1992, the north slough breached. This was thought to be a natural breach because the water level of the slough had risen in the previous week from intense rainfall and continuing storms. However, on February 18, 1993, it was learned through sources that a person had dug a channel. On February 22, 1993, the water level was 7.25 ft MSL, even with the existing open channel.

A Redwood National Park project clearance (no. 92-06) for excavation of a north slough channel to lower the water level in the north slough had been completed (see Appendix B) and excavation had been scheduled for January 12, 1993. One difference between the planned channel and what occurred in December, was that the channel went through an area where a pink sand verbena (Abronia umbellata breviflora) population has established. Pink sand verbena is defined as a candidate species for federal listing as a threatened species. The planned channel had skirted this area, but still allowed for lowering of the north slough water level. The present channel was further modified using a backhoe by Redwood National Park on February 23, 1993 to lower the water level.

Table 3. Dates of closure and opening of the Redwood Creek mouth where the water level of the estuary exceeded 6.00 ft MSL. Record is for the period from June 22 to December 31, 1992, excluding July 23 to August 6 when the recording equipment malfunctioned. Record based on equipment located in the South Slough.

| Date        | Julian Date |        | Maximum<br>Elevation<br>(ft MSL) |
|-------------|-------------|--------|----------------------------------|
|             | From        | To     |                                  |
| 10/25/92    | 299.57      | 299.57 | 6.05                             |
| 10/26-30/92 | 300.47      | 304.91 | 8.48                             |
| 11/22/92    | 327.35      | 327.47 | 6.64                             |
| 11/26/92    | 331.48      | 331.58 | 6.64                             |
| 12/06/92    | 341.34      | 341.52 | 6.45                             |
| 12/07/92    | 342.25      | 342.66 | 8.48                             |
| 12/07-08/92 | 342.99      | 343.02 | 6.06                             |
| 12/08-09/92 | 343.31      | 344.13 | 7.85                             |
| 12/09/92    | 344.34      | 344.53 | 7.62                             |
| 12/10/92    | 345.41      | 345.52 | 6.76                             |
| 12/11/92    | 346.49      | 346.54 | 6.21                             |

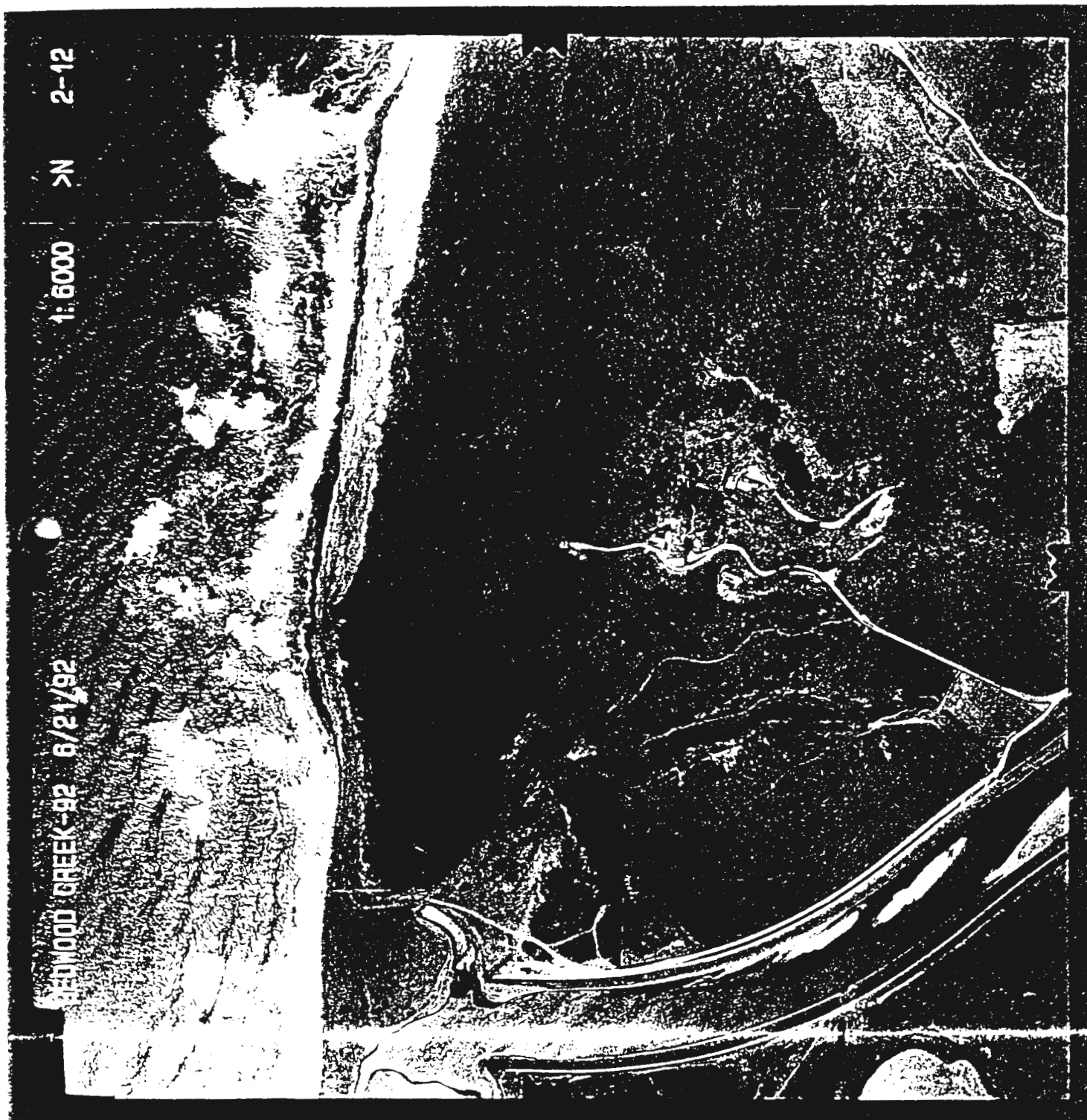


Figure 3a.

Aerial photo of Redwood Creek Estuary, Humboldt County, California, taken on June 21, 1992 showing the North Slough and Embayment.



Figure 3b.

Aerial photo of Redwood Creek Estuary, Humboldt County, California, taken on June 21, 1992 showing the Embayment and the South Slough.

#### APPENDIX A

U.S. Army Corps of Engineers Permit No. 18974N36 to  
Department of the Interior (Redwood National Park).  
Purpose: Breaching of the north and south sloughs and  
mouth of Redwood Creek: Flood control and habitat  
enhancement, In: Redwood Creek Estuary, At: Orick,  
County of: Humboldt County, State: CA.

DEPARTMENT OF THE ARMY PERMIT

Permittee United States Department of Interior (Redwood National Park)

Permit No. 18974N36

Issuing Office San Francisco District

NOTE: The term "you" and its derivatives, as used in this permit, means the permittee or any future transferee. The term "this office" refers to the appropriate district or division office of the Corps of Engineers having jurisdiction over the permitted activity or the appropriate official of that office acting under the authority of the commanding officer.

You are authorized to perform work in accordance with the terms and conditions specified below.

Project Description: You are hereby authorized to perform water level management in the Redwood Creek Estuary including: (1) open and close the sandbar at the mouth of Redwood Creek; (2) excavate 23,000 cubic yards of sand and sediment from the south slough channel of Redwood Creek; (3) excavate 45,000 cubic yards of sand and sediment from the north slough channel of Redwood Creek; and (4) dispose of all excavated material on beach/dune areas adjacent to the excavated areas to allow removal by natural tidal currents; near the Town of Orick in Humboldt County, California, in accordance with the attached drawings:  
"PURPOSE: BREACHING OF NORTH AND SOUTH SLOUGHS AND MOUTH OF REDWOOD CREEK: FLOOD CONTROL & HABITAT ENHANCEMENT, IN: REDWOOD CREEK ESTUARY, AT: ORICK, COUNTY OF: HUMBOLDT, STATE: CA, APPLICATION BY: U.S. DEPT. OF INTERIOR, REDWOOD NATIONAL PARK," in two sheets dated 31 May 1988.

Project Location: Redwood Creek Estuary, Orick, Humboldt County

Permit Conditions:

General Conditions:

1. The time limit for completing the work authorized ends on January 1, 1994. If you find that you need more time to complete the authorized activity, submit your request for a time extension to this office for consideration at least one month before the above date is reached.
  2. You must maintain the activity authorized by this permit in good condition and in conformance with the terms and conditions of this permit. You are not relieved of this requirement if you abandon the permitted activity, although you may make a good faith transfer to a third party in compliance with General Condition 4 below. Should you wish to cease to maintain the authorized activity or should you desire to abandon it without a good faith transfer, you must obtain a modification of this permit from this office, which may require restoration of the area.
- If you discover any previously unknown historic or archeological remains while accomplishing the activity authorized by this permit, you must immediately notify this office of what you have found. We will initiate the Federal and state coordination required to determine if the remains warrant a recovery effort or if the site is eligible for listing in the National Register of Historic Places.

4. If you sell the property associated with this permit, you must obtain the signature of the new owner in the space provided and forward a copy of the permit to this office to validate the transfer of this authorization.

5. If a conditioned water quality certification has been issued for your project, you must comply with the conditions specified in the certification as special conditions to this permit. For your convenience, a copy of the certification is attached if it contains such conditions.

6. You must allow representatives from this office to inspect the authorized activity at any time deemed necessary to ensure that it is being or has been accomplished in accordance with the terms and conditions of your permit.

Special Conditions: See attached sheet 2A for Special Conditions for Permit #18974N36

Further Information:

1. Congressional Authorities: You have been authorized to undertake the activity described above pursuant to:

(X) Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403).

(X) Section 404 of the Clean Water Act (33 U.S.C. 1344).

( ) Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972 (33 U.S.C. 1413).

2. Limits of this authorization.

a. This permit does not obviate the need to obtain other Federal, state, or local authorizations required by law.

b. This permit does not grant any property rights or exclusive privileges.

c. This permit does not authorize any injury to the property or rights of others.

d. This permit does not authorize interference with any existing or proposed Federal project.

3. Limits of Federal Liability. In issuing this permit, the Federal Government does not assume any liability for the following:

a. Damages to the permitted project or uses thereof as a result of other permitted or unpermitted activities or from natural causes.

b. Damages to the permitted project or uses thereof as a result of current or future activities undertaken by or on behalf of the United States in the public interest.

c. Damages to persons, property, or to other permitted or unpermitted activities or structures caused by the activity authorized by this permit.

d. Design or construction deficiencies associated with the permitted work.

SPECIAL CONDITIONS FOR PERMIT NO. 18974N36

1. Authorization is given for controlled breaching at the mouth of Redwood Creek, and for dredging the mouths of the north and south sloughs, for a period not to exceed two years.
2. Within that two-year period, a long-term solution to water level management shall be established. This solution shall not include breaching the bar, but may include the set-back of levees, conservation easements, raising the county road above flood elevation or out-right land purchase.
3. Material excavated from the creek mouth and/or dredged from the slough mouths shall be disposed of on the adjacent beach/dune areas (as shown on Sheet 2 of 2 attached to the permit) where it would eventually be transported by tidal action back to the Pacific Ocean.
4. A maximum water surface elevation of no less than + 6.0 feet Mean Sea Level (MSL) shall be established. The controlled breaching proposed may not occur before that level is reached.
5. Construction of a summer diversion dam intended to divert additional water into the upstream entrance of the south slough is not authorized.
6. The National Park Service shall regularly monitor water levels and depths in the estuary and document all instances of both controlled and natural breaching, as well as any observations of unauthorized breaching. Aerial photographs showing initial and final water levels in the estuary following each event shall be taken. Fish usage of the estuary before, during and after controlled breaching events shall also be documented. This information, including a discussion of steps taken to resolve land-use conflicts and meet long-term management goals, shall be provided in an annual monitoring report distributed to the Corps, EPA, NMFS, CA Dept. of Fish and Game by December 31st.

- e. Damage claims associated with any future modification, suspension, or revocation of this permit.
4. Reliance on Applicant's Data: The determination of this office that issuance of this permit is not contrary to the public interest was made in reliance on the information you provided.
5. Reevaluation of Permit Decision. This office may reevaluate its decision on this permit at any time the circumstances warrant. Circumstances that could require a reevaluation include, but are not limited to, the following:
- a. You fail to comply with the terms and conditions of this permit.
  - b. The information provided by you in support of your permit application proves to have been false, incomplete, or inaccurate (See 4 above).
  - c. Significant new information surfaces which this office did not consider in reaching the original public interest decision.

Such a reevaluation may result in a determination that it is appropriate to use the suspension, modification, and revocation procedures contained in 33 CFR 325.7 or enforcement procedures such as those contained in 33 CFR 326.4 and 326.5. The referenced enforcement procedures provide for the issuance of an administrative order requiring you to comply with the terms and conditions of your permit and for the initiation of legal action where appropriate. You will be required to pay for any corrective measures ordered by this office, and if you fail to comply with such directive, this office may in certain situations (such as those specified in 33 CFR 209.170) accomplish the corrective measures by contract or otherwise and bill you for the cost.

6. Extensions. General condition 1 establishes a time limit for the completion of the activity authorized by this permit. Unless there are circumstances requiring either a prompt completion of the authorized activity or a reevaluation of the public interest decision, the Corps will normally give favorable consideration to a request for an extension of this time limit.

Your signature below, as permittee, indicates that you accept and agree to comply with the terms and conditions of this permit.

William H. Ehorn  
(PERMITTEE)

12-9-91  
(DATE)

This permit becomes effective when the Federal official, designated to act for the Secretary of the Army, has signed below.

Stanley G. Phernambucq  
(DISTRICT ENGINEER)  
STANLEY G. PHERNAMBUCQ  
LTC(P) EN

1-3-92  
(DATE)

When the structures or work authorized by this permit are still in existence at the time the property is transferred, the terms and conditions of this permit will continue to be binding on the new owner(s) of the property. To validate the transfer of this permit and the associated liabilities associated with compliance with its terms and conditions, have the transferee sign and date below.

\_\_\_\_\_  
(TRANSFeree)

\_\_\_\_\_  
(DATE)

APPENDIX B

Redwood National Park: Park project clearance No. 92-06,  
North Slough Water Level Manipulation.

REDWOOD NATIONAL PARK

PARK PROJECT CLEARANCE

PROJECT NAME North Slough Water Level Manipulation YEAR 1992 NO. 92-06  
 PROPOSED TARGET  
 WORK LOCATION Redwood Creek Estuary STARTING DATE ASAP COMPL. DATE 1-2 days  
 Prepared by: David Anderson 4/27/92 Submitted by: Terry H. Hyster 4/28/92  
 Name Date Name (Division Chief) Date

(1) ROUTE TO SUPERINTENDENT FOR ADVANCE NOTIFICATION:

William H. Egan 5-1-92 William H. Egan 4/30/92  
 Superintendent Date Deputy Superintendent Date

(2) ROUTE FOR REVIEW (A): CONCUR (B): COMMENTS ATTACHED (C):

|                                           | (A) | (B) | (C) | SURNAME/DATE |
|-------------------------------------------|-----|-----|-----|--------------|
| INTERPRETATION                            | ✓   |     |     |              |
| MAINTENANCE                               | ✓   |     |     |              |
| PROTECTION                                | ✓   |     |     |              |
| RESEARCH & RESOURCES MGMT                 |     |     |     |              |
| MANAGEMENT SUPPORT (PURK)                 | ✓   |     |     |              |
| ADMINISTRATION                            |     |     |     |              |
| SUPERVISORY BOTANIST <sup>Pocence</sup>   | ✓   |     |     |              |
| FISH & WILDLIFE ECOLOGIST                 | ✓   |     |     |              |
| ARCHEOLOGIST                              | ✓   |     |     |              |
| ENVIRONMENTAL SPECIALIST                  | ✓   |     |     |              |
| LANDSCAPE ARCHITECT                       |     |     |     |              |
| SAFETY OFFICER                            | ✓   |     |     |              |
| ACCESS COORDINATOR                        |     |     |     |              |
| GEOLOGIST OR MGMT GEOL <sup>Spieter</sup> | ✓   |     |     |              |
| RANDY KLEIN                               | ✓   |     |     |              |

(3) DECISION: The project is in compliance with all applicable Executive Orders, laws, and regulations. Based on the analysis of environmental consequences, the National Park Service has determined that the project is not a major federal action significantly affecting the human environment. Therefore, no additional environmental compliance will be necessary prior to implementation.

APPROVED: William H. Egan 10-2-92  
 Superintendent Date

(4) SUPERINTENDENT'S COMMENTS: