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FSN 90466

ESTUARINE MANAGEMENT AND RESEARCH ACTIVITIES  
MOUTH OF REDWOOD CREEK  
1987

Redwood National Park  
Crescent City, California  
May 1988

## INTRODUCTION

### Background

During late spring and early summer months, as water discharge in Redwood Creek decreases, ocean waves often build a sand berm at the mouth of the creek. By providing habitat for optimal growth and marine acclimation, the embayment is a critical element in the life history of anadromous salmonids, particularly chinook salmon. However, the morphology and productivity of the embayment were adversely altered by the construction of a flood control project on the lower 3.2 miles of Redwood Creek in 1968. In addition, as the embayment forms and water level exceeds 5.0 feet above mean sea level, adjacent private farmlands are flooded. Draining of the embayment to prevent flooding removes fish habitat and can prematurely wash fish into the ocean. A detailed discussion of the problem and alternatives are discussed in Management Alternatives for the Redwood Creek Estuary, March 1983, Redwood National Park.

The park has actively managed the remnant Redwood Creek embayment since 1982. Management actions were designed to maintain what little fish rearing habitat remained and to prevent flooding of private property resulting from natural embayment formation.

### Summary Evaluation for 1987

The overall objective of activities undertaken in 1987 was to maintain some of the summertime estuarine habitat for rearing juvenile salmonids while preventing flooding of adjacent private property. Management and research activities included topographic and bathymetric surveys, embayment water level control, water quality monitoring, and population estimating and growth monitoring of juvenile salmonids utilizing the embayment.

Flooding of private property was prevented. Water levels fluctuated greatly and were generally marginal as far as fish habitat was concerned. However, tolerable embayment conditions were maintained so that some habitat was available for juvenile salmonids. Invertebrate production in the embayment and its value as salmonid rearing habitat is limited by unstable substrate. Bottom instability resulting from tidally influenced water level fluctuations was aggravated by park water level control activities. Further, reducing the level water in the embayment reduces the volume of available fish rearing habitat. Nevertheless, juvenile chinook salmon and steelhead trout spent a period rearing in the embayment although not as long as in most previous years. During this period, rearing salmon and steelhead increased in length which enhances their chances of survival during the

ocean stage of their life cycle. The population estimates of juvenile chinook salmon were greater than in any previously monitored year.

Slough necks excavated in 1983 to restore embayment volume and to improve fish access to the sloughs were resurveyed however these data are not available at this time.

A controlled flood gate was constructed through the south levee. This project is to recover a portion of the south slough volume as juvenile salmonid rearing habitat by restoring circulation patterns and improving water quality.

A contract with Humboldt State University has resulted in development of hydrodynamic models of the south slough that will be used in developing restoration alternatives.

#### Proposed Activities for 1988

1. It is proposed as a short term solution that embayment water levels be regulated by the NPS by controlled breaching.

Under certain summertime, low flow conditions, embayment water levels can be controlled to prevent flooding of private property while maintaining some juvenile fish habitat. Embayment water level control is an expensive and time consuming method of dealing with the flooding/fish habitat issue and diminishes the fish rearing capacity of the embayment. However, as long as adjacent private property can not be permitted to flood by natural embayment formation, water levels must be controlled in a manner which protects fish habitat as much as possible.

Water levels will be maintained as close to 5.0 feet above mean sea level as possible. This is the elevation which maximizes fish habitat without flooding adjacent pasturelands.

2. It is proposed that the north and south slough necks be resurveyed.

A resurvey of the slough necks would identify the degree of winter sediment accumulation in excavated areas. An evaluation could then be made of fish accessibility to the sloughs during 1987.

3. It is proposed that the park continue to evaluate long range restoration alternatives for the estuary.

The park will work with other agencies and organizations in

developing alternatives for the restoration of the estuary to a more naturally functioning, self-sustaining system.

4. It is proposed that estuarine water quality, and embayment fish numbers and growth be monitored.
5. It is proposed the park continue to expand interpretation and public dissemination of information regarding park management activities at the estuary.
6. It is proposed the park begin operation of the controlled flood gates (culvert) installed in the south levee during 1987.

Operation of the culvert should improve water circulation and quality in the south slough thereby restoring this area as summer rearing habitat for juvenile salmonids. The operation of the culvert and improvement of south slough aquatic habitat is to serve as mitigation for upstream fishery losses expected to occur as a result of construction of the U.S. Highway 101 Bypass project.

7. It is proposed that detailed studies and modeling of water circulation patterns in the south slough be continued.

Documenting patterns of circulation in the south slough will provide data necessary to evaluate the effectiveness of the culvert and identify the new circulation patterns that will exist when the culvert is operated. Modeling efforts will provide the capability to simulate various culvert operational scenarios before they are actually implemented. These data will also be useful in the evaluation of long term restoration options.

8. It is proposed to analyze alternatives for repair/replacement of the log boom in the neck of the north slough.

The log boom prevents floating logs and other large organic material from entering the north slough during winter high water conditions. Prior to installation of the log boom, organic material covered a large portion of the surface area of the north slough, impacting water quality and depositing on adjacent private property during flood conditions.

## MANAGEMENT, RESEARCH AND MONITORING ACTIVITIES IMPLEMENTED IN 1987

### South and North Slough Resurvey

Accumulated sand was excavated from the slough necks to restore embayment volume and improve access for juvenile salmonids to the main slough areas in 1983. The slough necks were resurveyed in 1987 but the data are not available at this time.

### Embayment Water Level Control

The objective was to maintain embayment water levels to protect adjacent private lands from flooding while retaining sufficient water to provide habitat for juvenile salmonids. Water levels were to be maintained as high as possible without exceeding 5.0 feet above mean sea level, when pastures begin to flood. An operations plan was developed by Resource Management Division outlining objectives, methods, and responsibilities.

Water levels were manipulated by controlled breaching a total of 19 times by the park from June 1 through August 11. Water levels were lowered two times by the contractor constructing the controlled flood gates on August 24 and November 16. Flooding of private property was prevented.

### Water Quality Studies

Monitoring was conducted to determine if and when estuarine (embayment and sloughs) water quality was a limiting factor for juvenile salmonids. Parameters measured at twelve sites in the north and south sloughs and the embayment included conductivity, temperature, salinity, and dissolved oxygen. A vertical profile from surface to bottom was determined for each parameter, at each station, five different times from July 15 to September 17. Poorest water quality was observed in late July in the north and south sloughs where water temperatures decreased the quality of fish habitat. No water quality parameters measured in the embayment limited fish use.

The embayment alternated between a fresh and brackish water system. High tides and ocean overwash caused short periods of brackish water conditions. A dense salt water layer remained on the slough bottoms throughout the summer. A salt water layer also existed at times on the embayment bottom, but its depth varied with tides, ocean conditions, and mouth configuration.

## Fish Monitoring

This program was directed at determining numbers and growth of juvenile salmonids utilizing the embayment.

Embayment fish populations were estimated by seining and marking captured fish. The ratio of marked versus unmarked fish captured two days later was utilized in calculating population estimates. Four attempts were made from June 18 through August 27 to estimate fish numbers. Growth was monitored five times between June 15 and September 22 by seining and measuring each fish captured. Scales were collected from 30 individuals of each species.

The major area utilized by juvenile salmonids was the embayment. Population estimates and growth for juvenile chinook salmon and steelhead trout are shown in the following table.

Date	CHINOOK SALMON		STEELHEAD TROUT	
	Estimated Population	Fork Length (mm)	Estimated Population	Fork Length (mm)
6/18/87	117,218	74.9	N/A*	95.9
7/ 9/87	67,849	74.5	N/A*	107.6
7/22/87	-	77.6	-	114.6
7/30/87	66,690	-	25,458	-
8/27/87	N/A*	86.8	18,836	115.8
9/22/87	-	98.5	-	133.9

\*N/A - Population estimate attempted but not valid.

Juvenile salmon fork length averaged 74.9 mm on June 18 and 98.5 mm on September 22, an average increase in size of 23.6 mm. The estimated population of juvenile chinook salmon was greater than in previous years but the young fish spent a shorter period rearing in the estuary. This may be due to the numbers of fish exceeding the capacity of the embayment to provide quality rearing habitat. That is, the volume and quality of fish habitat available during summers when water level control activities are required may be insufficient to rear large numbers of juvenile salmon.

Patterns of estuarine use by juvenile steelhead trout are more difficult to discern for summer of 1987. Only two reliable population estimates were obtained for steelhead because the numbers captured were too small to reliably estimate abundance in June and July.

Nevertheless, the growth of rearing steelhead increased steadily throughout the summer.

South Slough Intake Structure

Construction on the South Slough intake structure began in July 1987 and was completed in January 1988 and is intended to partially offset the fisheries losses resulting from construction of the U.S. 101 Bypass project. The project was funded by the California Department of Transportation, designed and constructed by the U.S. Army Corps of Engineers, and will be maintained and operated by Redwood National Park. The project as constructed consists of three, eight-foot by nine-foot concrete culverts with manually operated gates on each culvert. By reconnecting flows from the mainstem of Redwood Creek with the slough, the project will improve circulation patterns and water quality in the backwater slough area. A plan will be developed for operation of the project.

South Slough Hydrodynamic Modeling

A hydrodynamic and water quality study of the south slough was conducted for the park by the Environmental Resources Engineering Department at Humboldt State University. The project resulted in development of a two-dimensional hydrodynamic model for the south slough that can be used to predict the results of operation of the controlled flood gates. The model was developed from field data where actual circulation patterns in the slough were measured.

Also developed was a model that allows analysis of different management strategies for river flows and analysis of restoration alternatives for the entire lower Redwood Creek.

1987 Cost Summary

Management and Monitoring Activities

Water Level Control . . . . .	\$8,128
Resurvey of Excavated Areas . . . . .	1,300
Water Quality Monitoring . . . . .	700
Fish Population and Growth Monitoring . . . . .	3,600
	Total \$13,128

Construction of controlled flood gate. . . . . \$635,000

Contract for hydrodynamic modeling (HSU). . . . . \$21,000