ESTUARINE MANAGEMENT AND RESEARCH ACTIVITIES
MOUTH OF REDWOOD CREEK
1986

Redwood National Park
Crescent City, California
May 1987

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 rearing habitat remained and to prevent flooding of private property resulting from natural embayment formation.

Summary Evaluation for 1986

The overall objective of activities undertaken in 1986 was to maintain 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 numbers 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 further aggravated by park water level control activities. Nevertheless, juvenile chinook salmon, steelhead, and cutthroat trout did spend an extended period in the embayment. During this period, rearing salmon and steelhead grew substantially. Such growth enhances their chances of survival during the ocean stage of their life cycle.

Slough necks excavated in 1983 to restore embayment volume and to improve fish access to the sloughs were resurveyed. The resurvey shows that sand deposition has occurred in the areas of excavation although the channel bottoms of the slough necks remain below pre-excavation levels.

Proposed Activities for 1987

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. 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 also 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. If necessary for construction purposes (See number 6. below) water levels may be maintained below 5.0 feet above mean sea level.

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 soughs 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 rates be monitored.

5. It is proposed the park expand interpretation and public dissemination of information regarding park management activities at the estuary.

6. It is proposed that a controlled flood gate be installed through the south levee to allow Redwood Creek flows to enter the south slough.

   Improving water circulation and quality in the south slough would improve this area as summer rearing habitat for juvenile salmonids. The project would be funded by the California Department of Transportation as mitigation for fisheries losses from construction of the U.S. Highway 101 Bypass project.

7. It is proposed that detailed studies of the patterns of water circulation in the south slough be conducted before and after the controlled flood gate is constructed.

Documenting patterns of circulation in the south slough will provide data necessary to evaluate the effectiveness of the culvert and will establish the new circulation patterns that will exist after the culvert is completed. These data will also be useful in the evaluation of long term restoration options.

MANAGEMENT, RESEARCH AND MONITORING ACTIVITIES IMPLEMENTED IN 1986

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 areas excavated are shown in Figure 1. Profiles were surveyed across the neck areas before and after excavations to document the amount of material removed and to determine final channel configuration. Profile locations are shown in Figure 2.

The resurvey shows the excavated channels have undergone readjustment and filling with sand in most areas. Circulation between each slough and the mouth of Redwood Creek is controlled by the highest channel-bottom elevation in the connecting neck. This "limiting elevation" prevents circulation and fish movement when the backwater of Redwood Creek falls near or below pre-excavation levels:

Limiting Elevations (above mean sea level)

	Before (1983)	After (1983)	1 Yr. (1984)	2 Yrs. (1985)	3 Yrs. (1986)
North Slough	6.58	3.10	2.17	2.36	3.68
South Slough	2.85	.07	1.24	1.24	1.97

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.

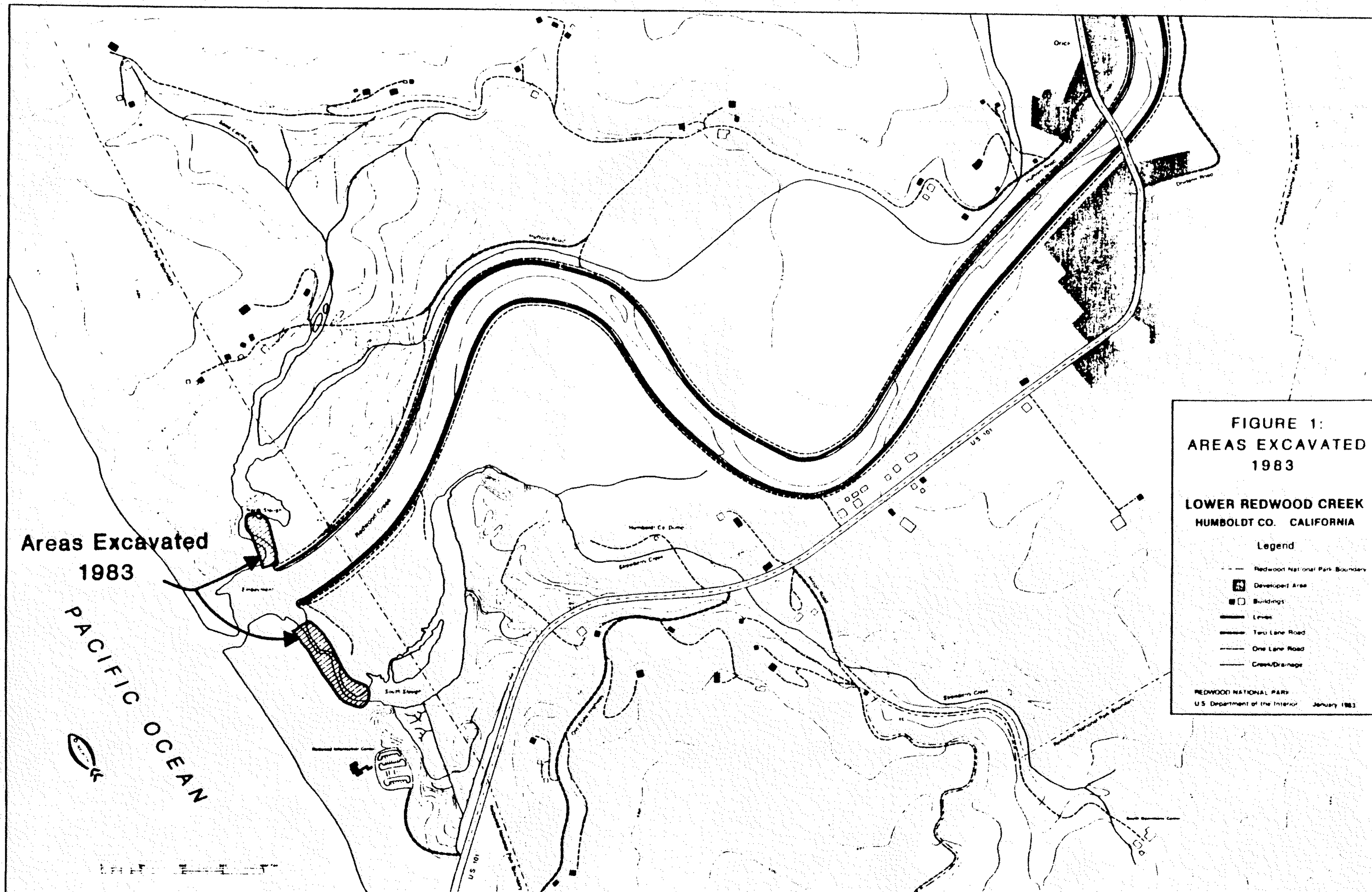


FIGURE 1:
AREAS EXCAVATED
1983

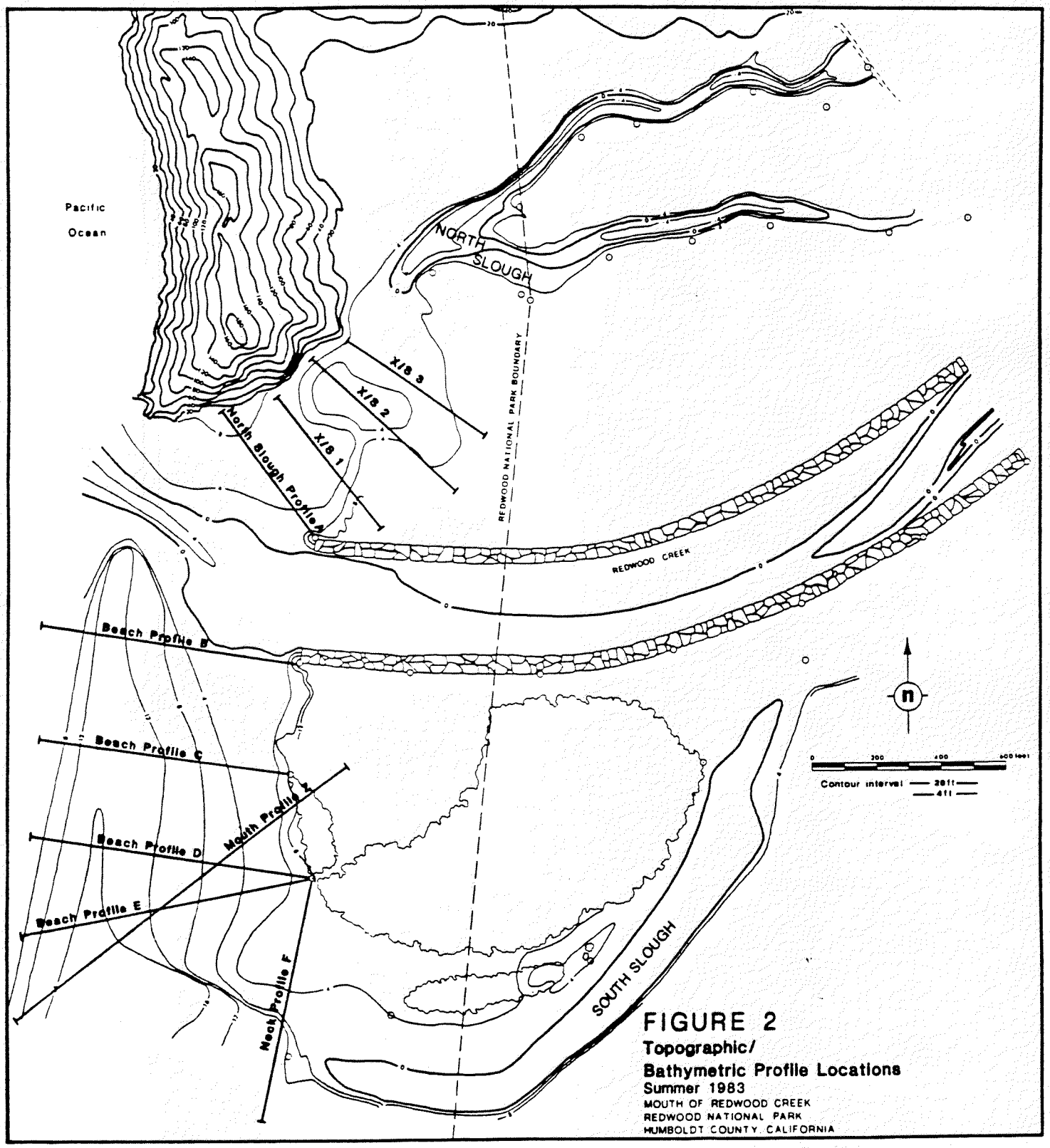


FIGURE 2

Topographic/
Bathymetric Profile Locations
Summer 1983
MOUTH OF REDWOOD CREEK
REDWOOD NATIONAL PARK
HUMBOLDT COUNTY, CALIFORNIA

Water levels were manipulated by controlled breaching a total of seven times from July 22 through September 18. 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, four different times from June 23 to August 28. Poorest water quality was observed in the north slough where temperature and dissolved oxygen levels were limiting at certain times and depths. In the south slough water quality was generally better than in previous years, but temperatures were elevated early in the summer. In the embayment, neither water temperature nor dissolved oxygen was limiting.

The embayment alternated between a fresh and brackish water system. High tides and ocean overwash caused short periods when brackish conditions prevailed. 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. Three estimates were made from June 23 through August 11. Growth was monitored five times by seining and measuring each fish captured from June 23 through September 11. Scales were collected from 30 individuals of each species.

The major area utilized by juvenile salmonids was the embayment. Fish avoided the saltwater layer on the embayment bottom and area adjacent to the ocean berm during periods of overwash, preferring water of lower salinity. Few fish utilized the sloughs.

Population estimates and growth for juvenile chinook salmon and steelhead trout are shown in the following table that shows downstream

migrating salmonids found favorable habitat in the estuary as soon as an embayment began to form.

Date	CHINOOK SALMON Estimated Population	CHINOOK SALMON Fork Length (mm)	STEELHEAD TROUT Estimated Population	STEELHEAD TROUT Fork Length (mm)
6/22/86	4,533	82.6	19,914	115.3
7/ 9/86	1,215	90.9	13,289	120.8
7/21/86	2,025	94.1	25,404	107.3
8/12/86	-	100.8	-	103.9
9/11/86	-	104.4	-	121.7

Juvenile salmon growth in the estuary during the summer was substantial. Fork length averaged 82.6 mm on June 23 and 104.4 mm on September 11. The low number of juvenile chinook salmon in the estuary, as compared to other years, was probably due to scouring of spawning beds by extremely high flows that occurred in Redwood Creek and tributaries in February.

Patterns of estuarine use by juvenile steelhead trout were similar to that of salmon. That is, when habitat was available, steelhead spent an extended period in the estuary. The decrease in calculated average fork length of steelhead on July 21 and August 12 was due to an increase in the number of smaller size juveniles entering the embayment. The influx of smaller fish may have been due to reduced upstream flows and/or elevated stream temperatures in Redwood Creek and tributaries causing the fish to move downstream.

1986 Cost Summary

Management and Monitoring Activities

Water Level Control	$1,631
Resurvey of Excavated Areas	1,000
Water Quality Monitoring	600
Fish Population and Growth Monitoring	3,300
Total	$6,531

SOUTH SLOUGH INTAKE STRUCTURE
PROJECT DESCRIPTION

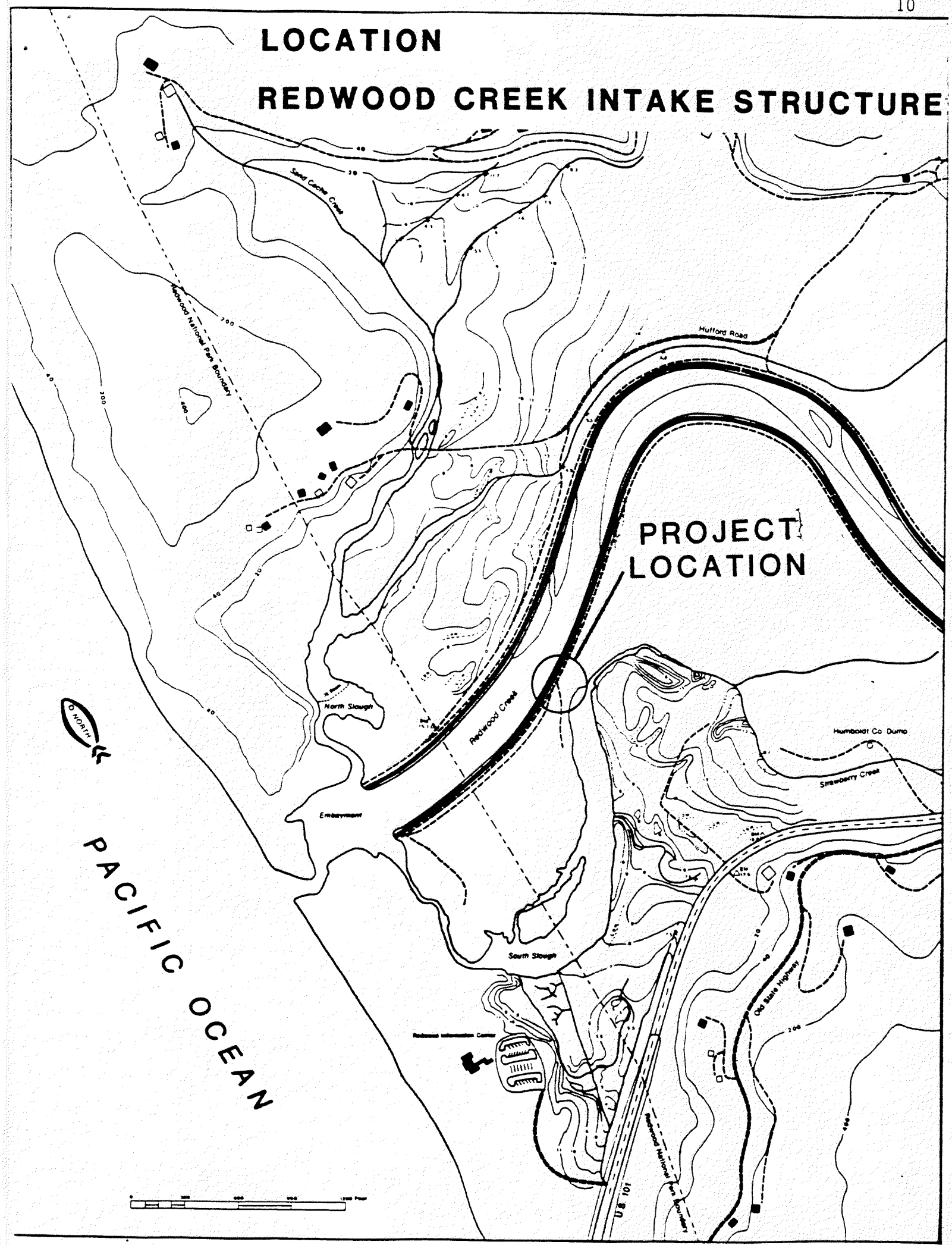
The proposed culverts are intended to partially offset the fisheries losses resulting from construction of the U.S. 101 Bypass project. By diverting a portion of Redwood Creek's flow through the former main channel of the creek (now the South Slough), summer rearing habitat for juvenile steelhead and chinook salmon will be improved (see attached drawings).

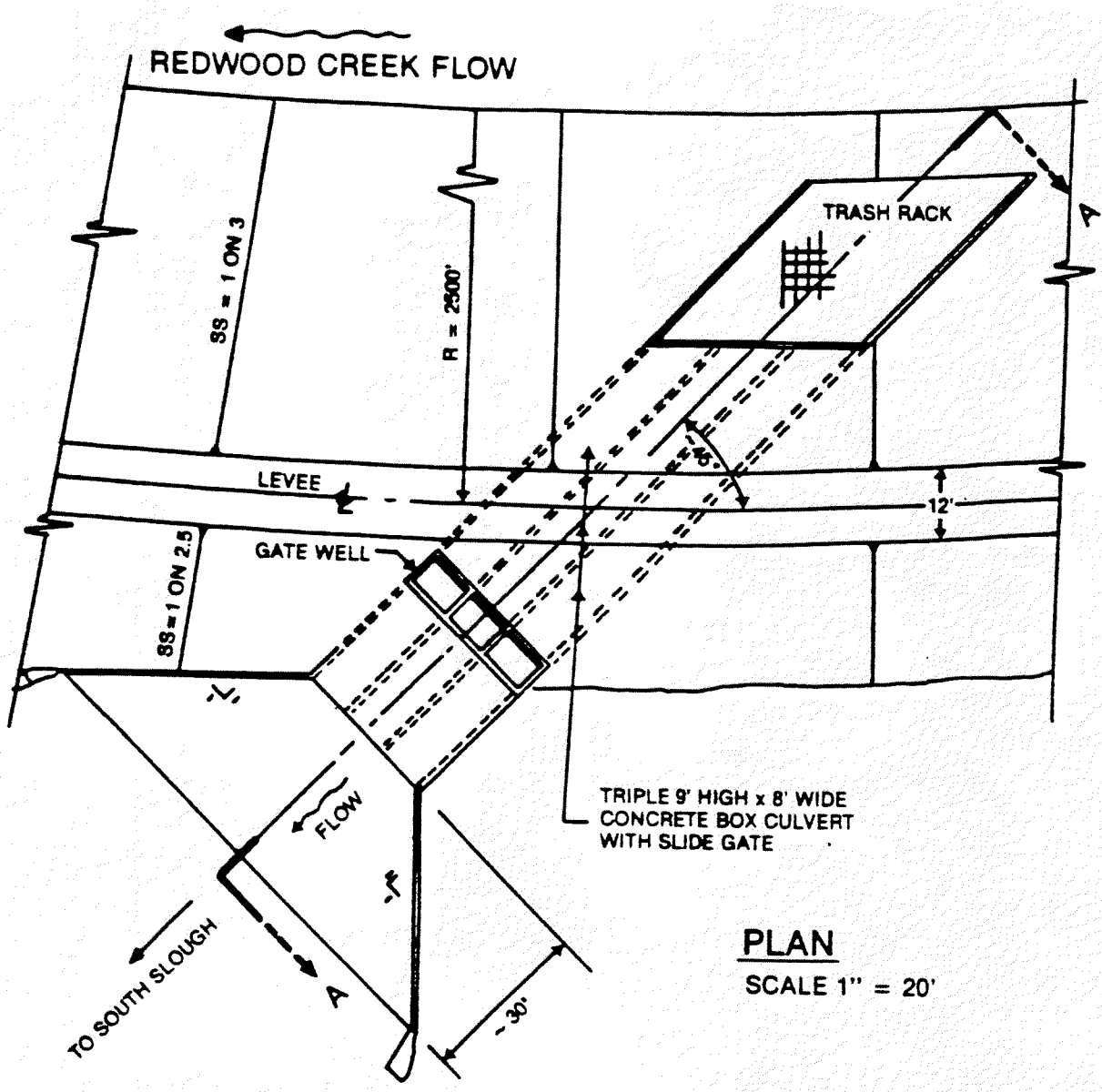
Through an agreement with the National Park Service, the culverts will be designed and constructed by the Corps of Engineers. The National Park Service is responsible for obtaining necessary permits and the Service will also own and operate the culverts when construction is complete. The California Department of Transportation is obtaining the rights-of-way and is funding the project.

The culverts will consist of three, eight-foot by nine-foot concrete boxes with manually operated gates on each culvert. The culverts will be approximately 83 feet long, with a trash screen on the upstream end and an apron and rip-rap channel on the downstream end to direct discharge. The culverts will require approximately 2.2 acres while temporary storage of equipment and material will require an additional 3.8 acres.

Construction of the culverts will require removal of a portion of the existing levee at the upper end of the South Slough. The existing levee material, which consists of rock and soil, will be sorted on-site and partially reused during construction. Cofferdams will be constructed in Redwood Creek and the South Slough to prevent backwater flooding from interfering with construction. The culverts will be built in place and the levee material will be placed on the sides and over the top of the boxes, and used as fill material on the access road to the park's South Operation Center. At the conclusion of the work, the rip rap channel extending from the culverts to the South Slough, will be an obvious change in the existing levee configuration.

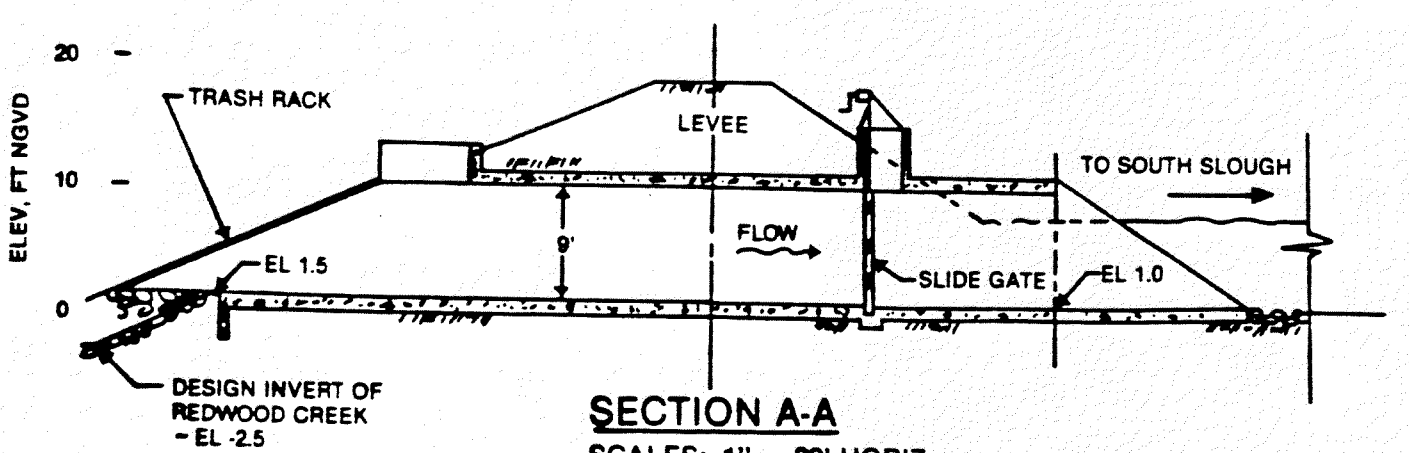
After the project is completed, water level management activities will continue at the mouth of Redwood Creek to maintain rearing habitat for juvenile salmonids while preventing flooding of adjacent private property. If necessary, a small (2-3 foot high), seasonal gravel berm will be created in Redwood Creek to divert the low summer flow into the South Slough. The berm would be pushed up using heavy equipment in early summer and allowed to wash away with winter rains.


LOCATION
REDWOOD CREEK INTAKE STRUCTURE
PROJECT LOCATION
PACIFIC OCEAN
NORTH
Hufford Road
Redwood National Park Boundary
Redwood Creek
North Slough
South Slough
Humboldt Co Dump
Strawberry Creek
Old State Highway
US 101
Redwood National Park Boundary



PLAN

SCALE 1" = 20'



SECTION A-A

SCALES: 1" = 20' HORIZ.
1" = 10' VERT.

SOUTH SLOUGH INTAKE STRUCTURE ON REDWOOD CREEK, ORICK, CA.