ESTUARINE MANAGEMENT AND RESEARCH ACTIVITIES
MOUTH OF REDWOOD CREEK
1984

Redwood National Park
Crescent City, California
April 1985

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, forming an embayment east of the beach. 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 farm lands 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 1984

The overall objective of activities undertaken in 1984 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, log boom repair, embayment water level control, water quality monitoring, aquatic invertebrate sampling, trapping of downstream migrating juvenile salmon, steelhead, and cutthroat trout, 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. 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.

Invertebrate fish food production appeared greatest in the north and south sloughs. Relative to the embayment, these areas were not utilized by young rearing salmonids. Invertebrate production in the embayment and its value as salmonid rearing habitat was limited by unstable substrate. Bottom instability resulting from tidally influenced water level fluctuations was further aggravated by park water level control activities.

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 considerably below pre-excavation levels.

However, fish utilization of the sloughs was limited by poor water quality (for example, low dissolved oxygen and high temperatures).

Proposed Activities for 1985

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.

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 1985. Recommendations for further sediment removal would follow this evaluation.

3. It is proposed that the park continue to evaluate alternatives to improve circulation patterns in the sloughs.

   Poor summertime water quality in the sloughs will limit fish habitat until circulation patterns are improved. Alternatives to improve water quality, such as installation of gated culverts in the south levee, should be pursued.

4. It is proposed that estuarine water quality, and embayment fish numbers and growth rates be monitored.

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

MANAGEMENT, RESEARCH AND MONITORING ACTIVITIES IMPLEMENTED IN 1984

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 area excavated is 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. These profiles were resurveyed in 1984 as shown in Figures 3 through 12.

The resurvey shows the excavated channels have undergone some readjustment and filling with sand. Sand deposition was greatest near the mouths of both sloughs, however, channel bottom elevations are still lower at these sites than farther up each neck. Therefore, sediment accumulation at the slough mouths is not yet a problem and is likely to fluctuate both higher and lower in future years.

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" limits circulation and fish movement when the backwater of Redwood Creek falls near or below that level. Limiting elevations remain considerably below pre-excavation levels:

Limiting Elevations (above mean sea level)

	May, 1983 (Before Excavation)	July, 1983 (After Excavation)	July, 1984 (After First Winter)
South Slough	3.0	0	1.0
North Slough	5.0	2.0	2.0

Log Boom Repair

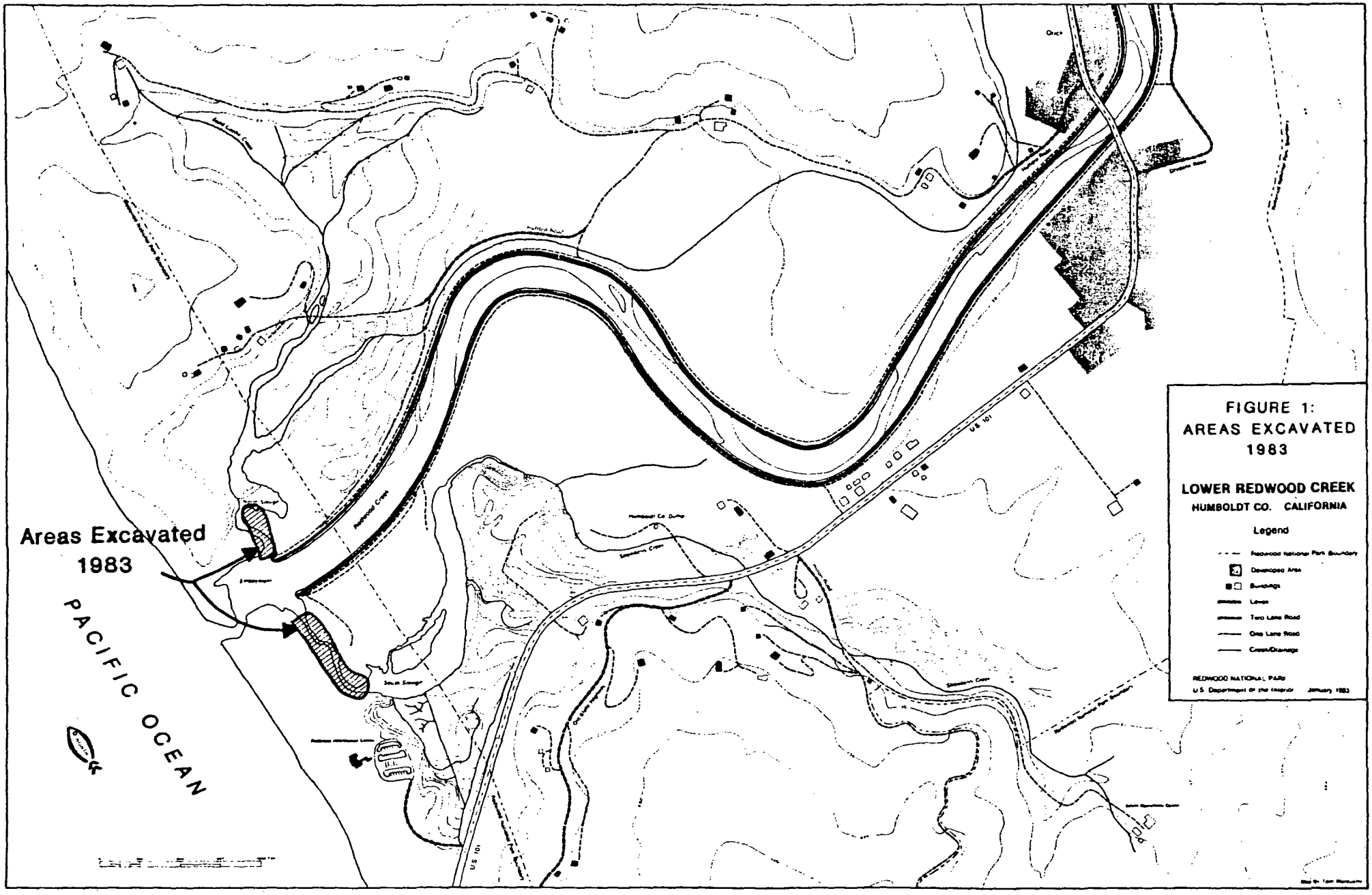
Repair was necessary to one of the anchors on the east end of the log boom. Constructed during October 1981, the boom prevents woody debris from entering the north slough. This debris often settles on adjacent private lands during high water.

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 Resources Management Division outlining objectives, methods, and responsiblities.

Water levels were manipulated by controlled breaching a total of 19 times from July 22 through October 26 using either manual labor and/or heavy equipment.

In conjuction with embayment water level control, a record of water levels and other observations was maintained by Resources Management. Entries included


Areas Excavated
1983
PACIFIC OCEAN
FIGURE 1:
AREAS EXCAVATED
1983
LOWER REDWOOD CREEK
HUMBOLDT CO. CALIFORNIA
Legend
REDWOOD NATIONAL PARK
U.S. Department of the Interior January 1983

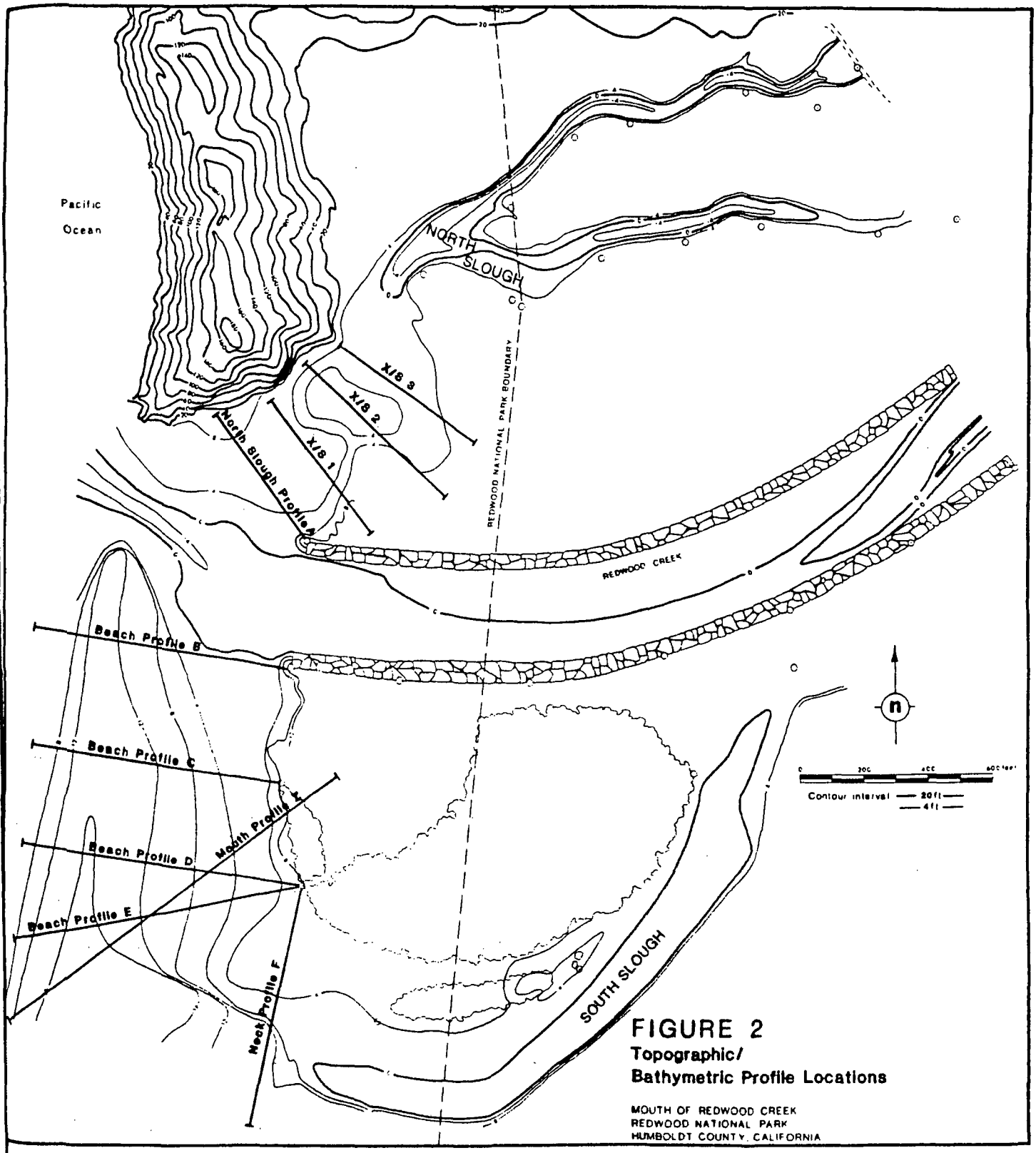


FIGURE 2

Topographic/
Bathymetric Profile Locations

MOUTH OF REDWOOD CREEK
REDWOOD NATIONAL PARK
HUMBOLDT COUNTY, CALIFORNIA

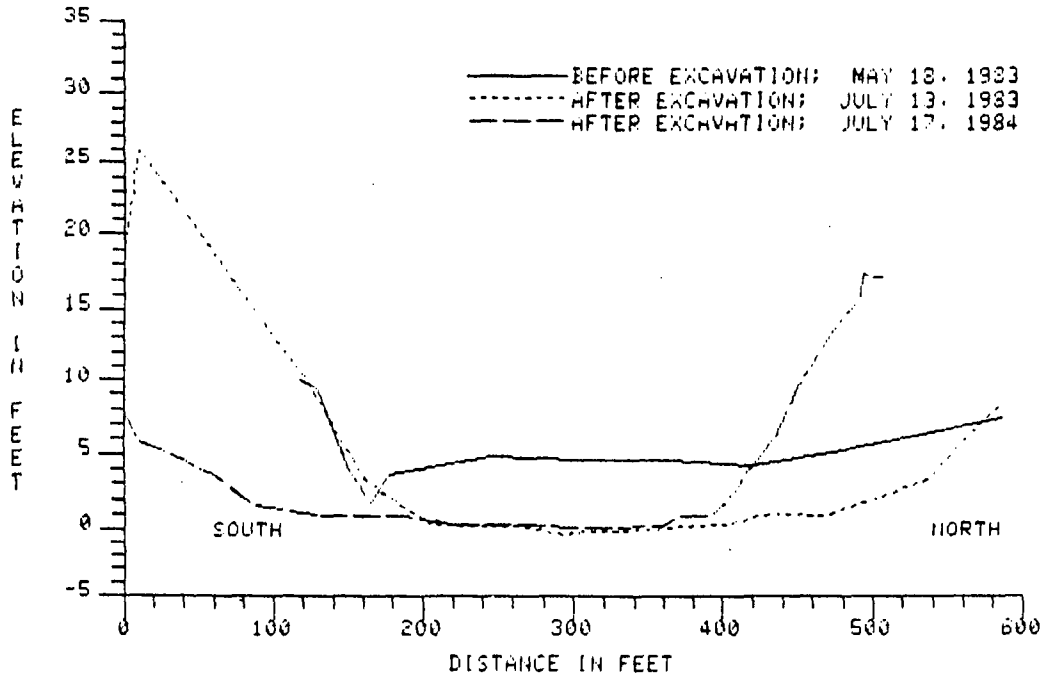


FIGURE 3: NECK PROFILE F

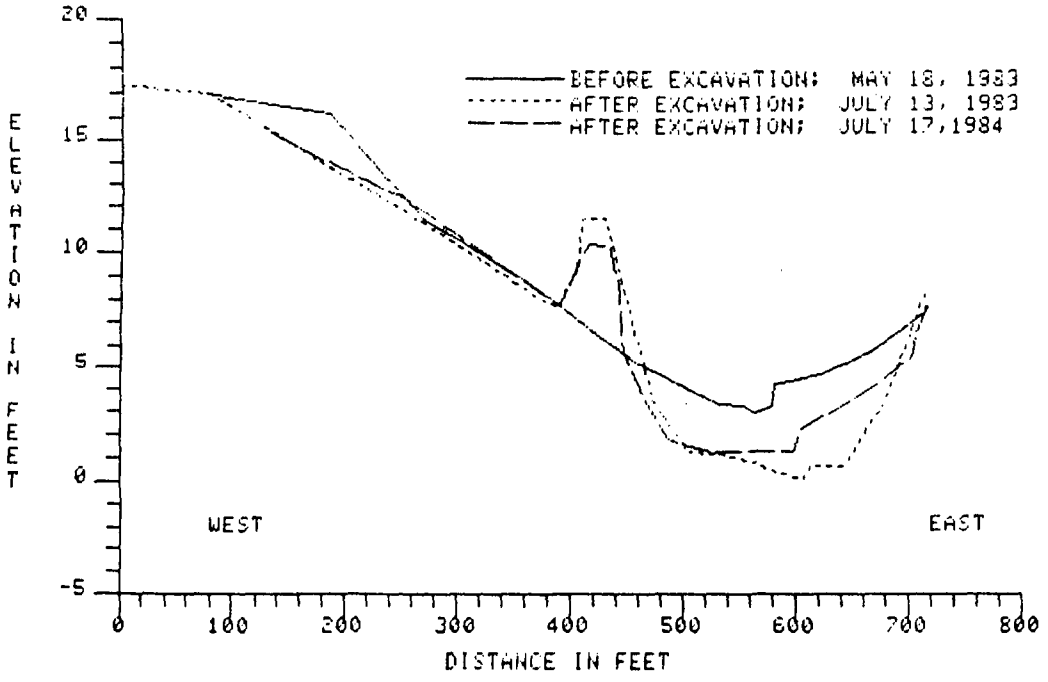


FIGURE 4: BEACH PROFILE E

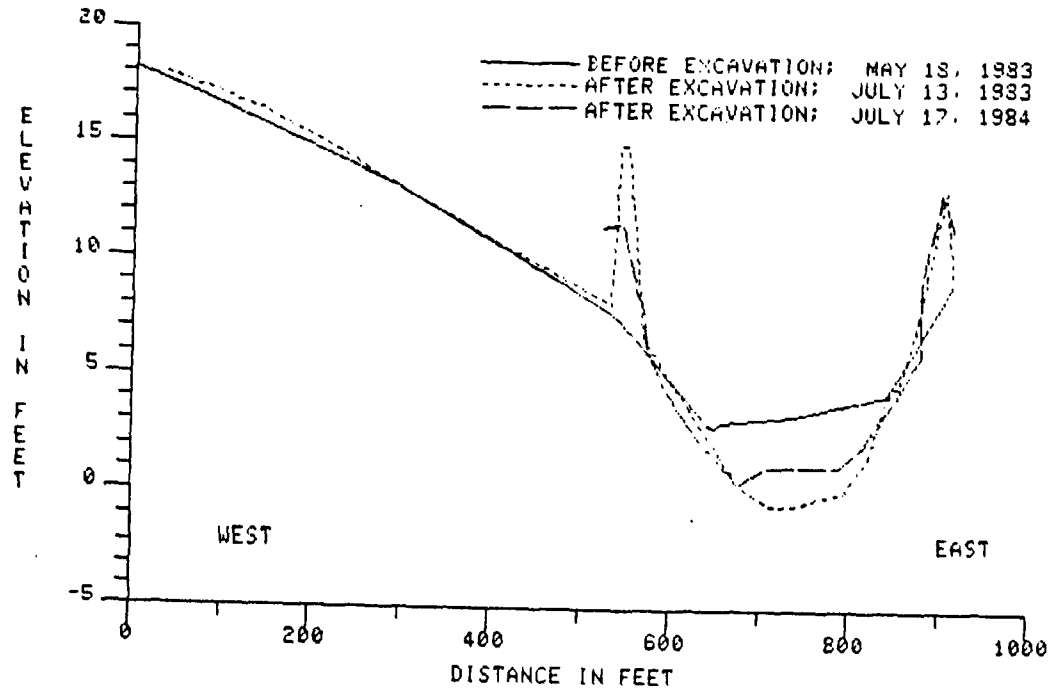


FIGURE 5: MOUTH PROFILE Z

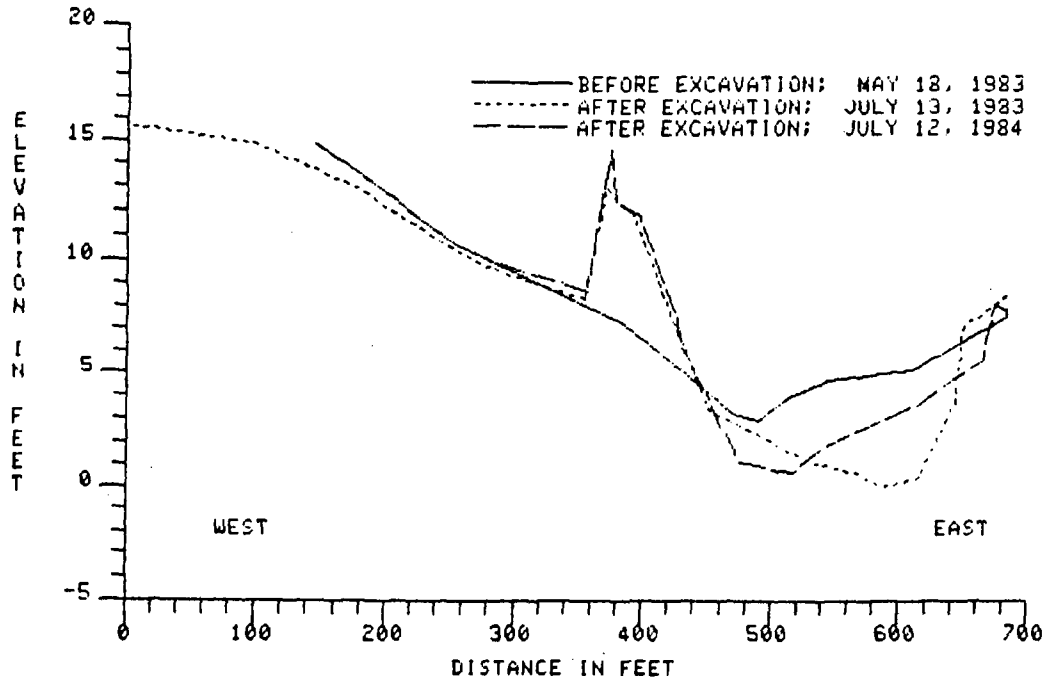


FIGURE 6: BEACH PROFILE D

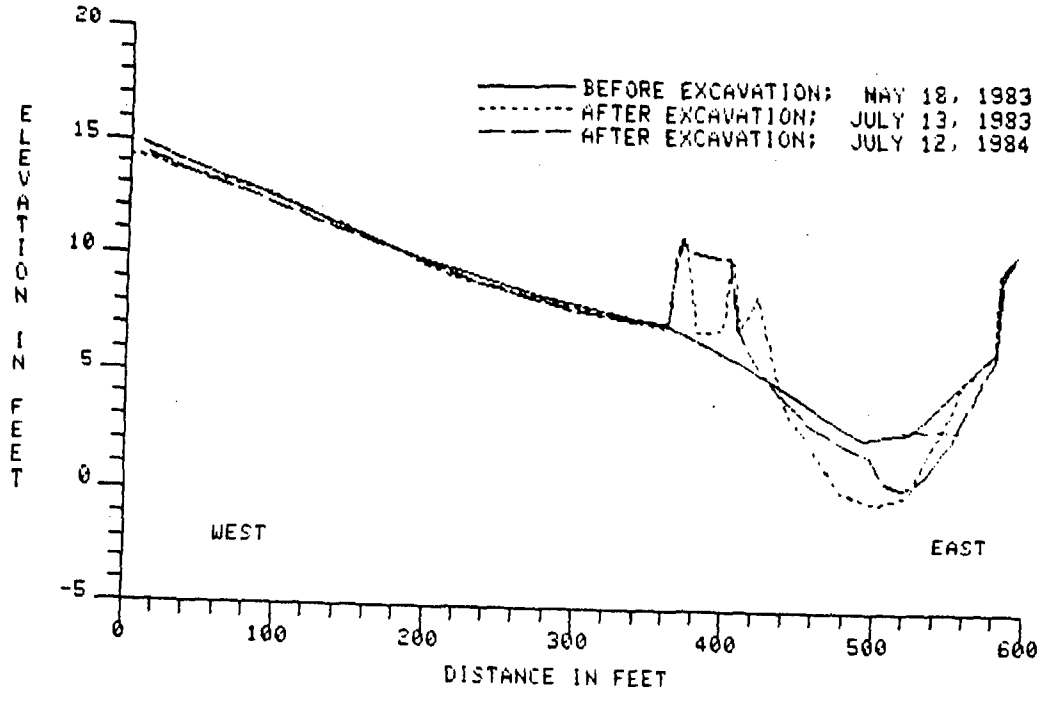


FIGURE 7: BEACH PROFILE C

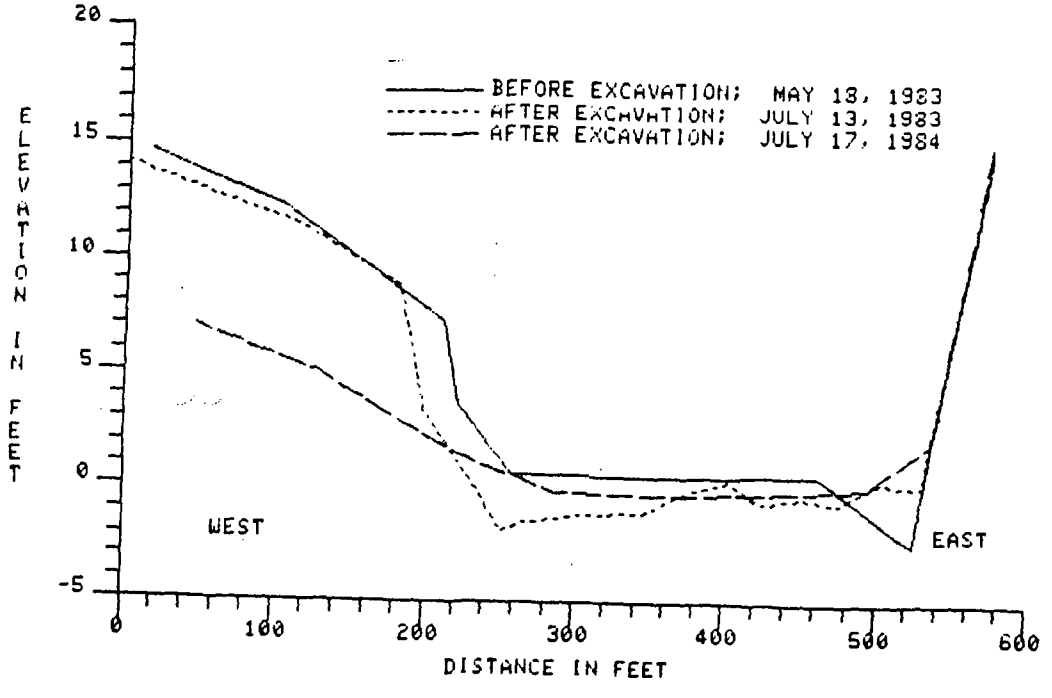


FIGURE 8: BEACH PROFILE B

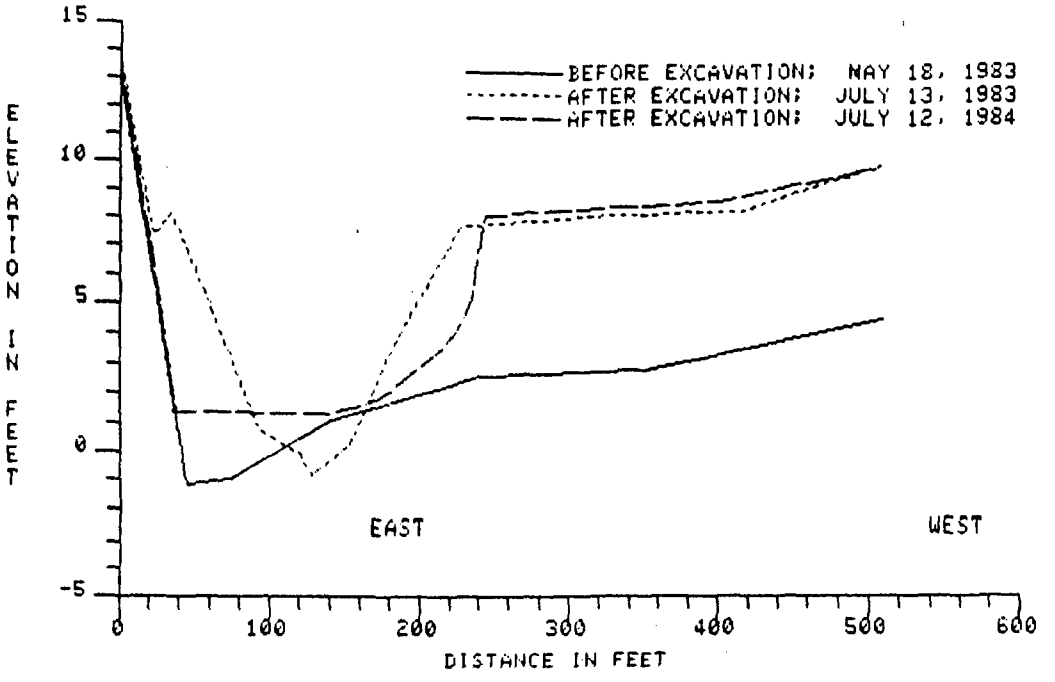


FIGURE 9: NORTH SLOUGH PROFILE A

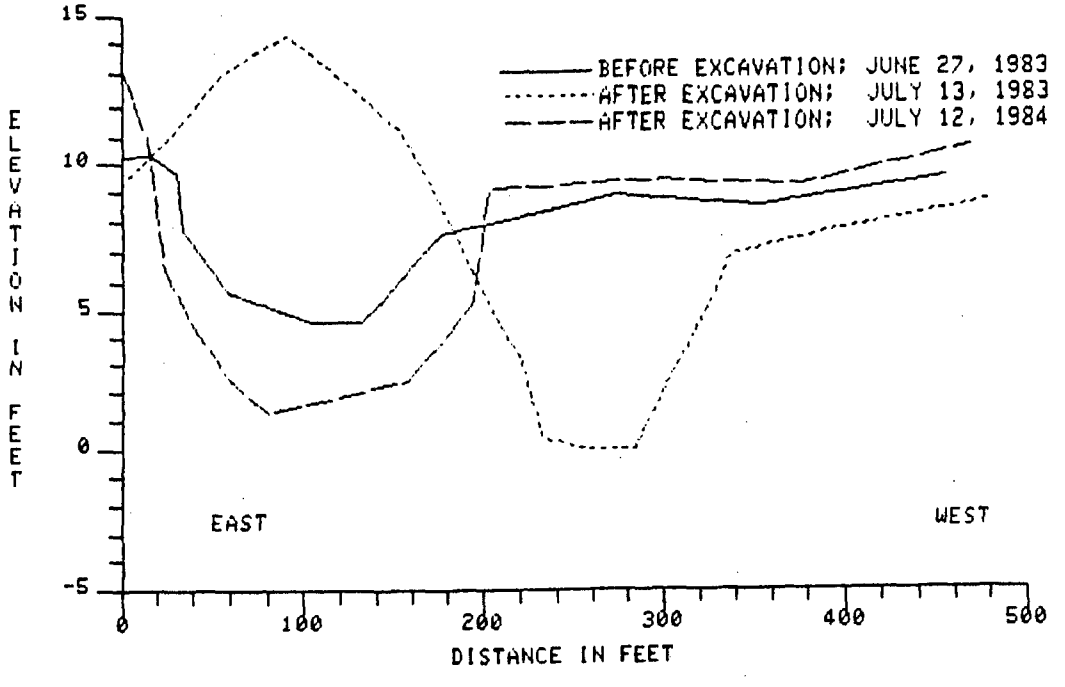


FIGURE 10: X/S 1

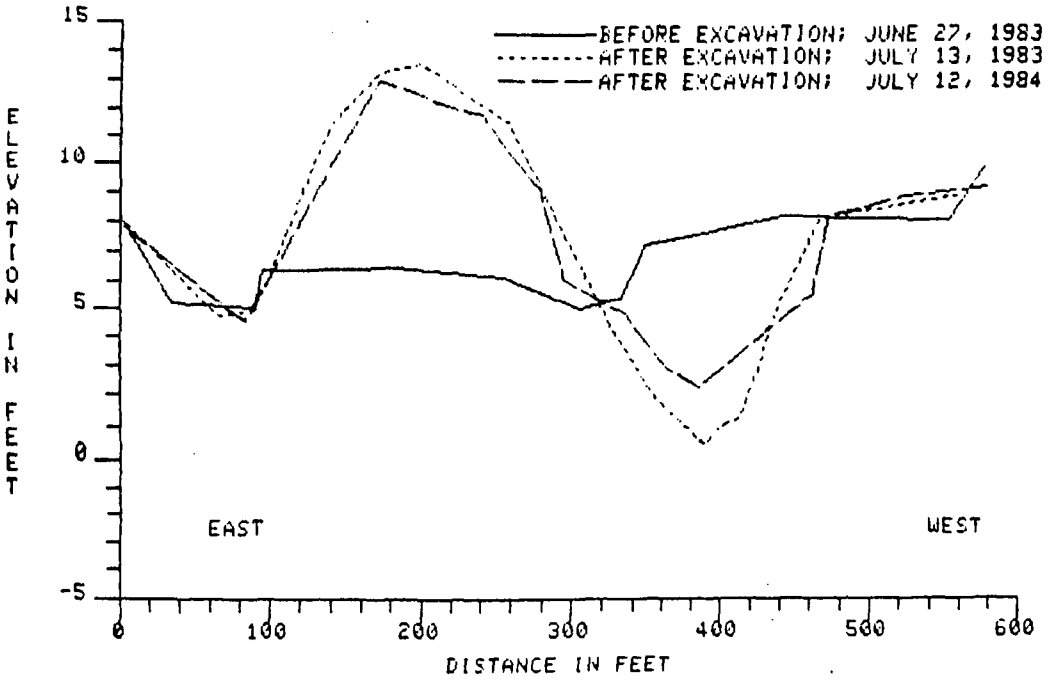


FIGURE 11: X/S 2

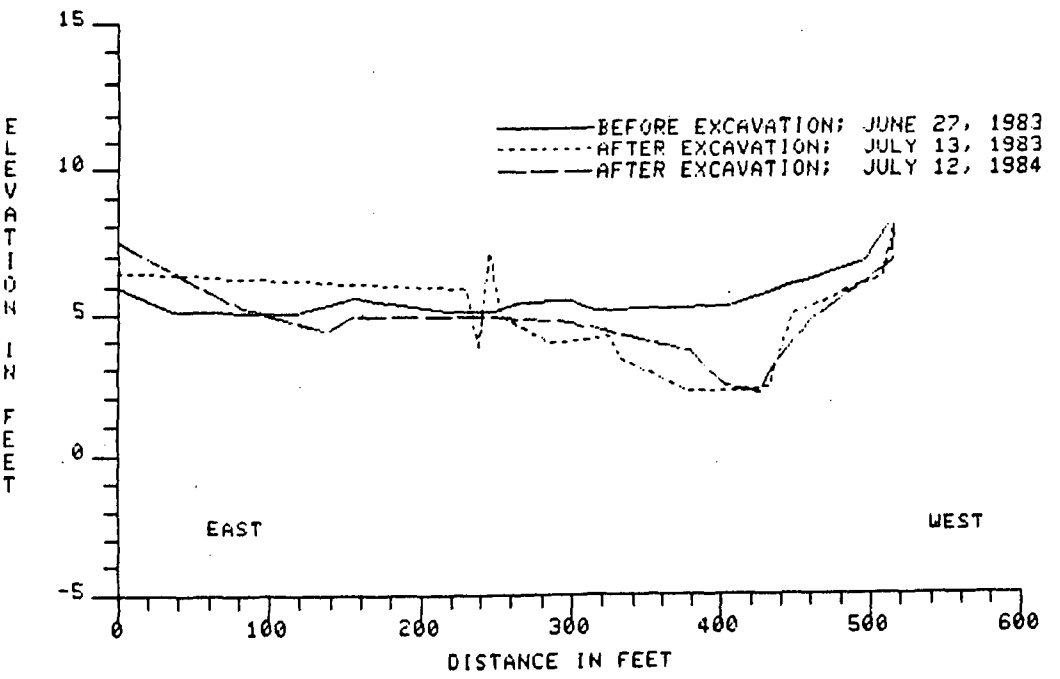


FIGURE 12: X/S 3

water levels, outflow configuration, wind and sea conditions, time spent, and other comments. A total of 301 observations were recorded from June 1 to November 15.

Water Quality Studies

Monitoring was conducted to determine if and when estuarine (embayment and sloughs) water quality was limiting for juvenile salmonids. Twelve monitoring sites were established in the north and south sloughs and the embayment. Parameters measured included conductivity, temperature, salinity, and dissolved oxygen. A vertical profile from surface to bottom was determined for each parameter, at each station, 9 different times from June 6 through October 25. Poorest water quality was observed in the sloughs, where temperatures and dissolved oxygen reached levels that were limiting to salmonids. In the embayment, water temperature occasionally increased to undesirable levels, but was never limiting. These elevated temperatures usually accompanied low embayment water levels. Dissolved oxygen was consistently adequate in the embayment.

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 on the embayment bottom, but its depth varied with tide, ocean conditions, and mouth configuration.

Aquatic Invertebrate Sampling

Aquatic invertebrates were sampled to determine abundance and areas of greatest density. Sampling methods included the use of small artificial substrate baskets and plastic bottom samplers. Suspended artificial substrate baskets were used to sample the slough areas while plastic bottom samplers were used in the neck of the south slough and the embayment. A total of 27 samples were collected from June 27 to October 12.

These samples have not been analyzed. However, visual inspection of samples suggests greatest invertebrate density in the north and south sloughs. Samples collected in 1983 were analyzed in spring 1984 and confirmed estimates of greatest invertebrate density in the sloughs for summer 1983.

Fish Migration and Estuary Utilization

This program was directed at identifying the timing and extent of juvenile salmonid downstream migration, and numbers and growth of juvenile salmonids utilizing the embayment.

Trapping of downstream migrating fish began on May 7 and continued through August 1. Trapping was conducted from approximately 5:00 p.m. to 9:00 a.m. one night each week on both Prairie Creek and Redwood Creek. Trapped fish were identified, counted, measured, and scale samples were collected. 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 estimates were made from June 18 to September 11. Growth was monitored 11 times by seining and measuring each fish captured from May 21 to October 18. On each of these sampling days approximately 20 fish (10 steelhead and 10 salmon) were

sacrificed for stomach analyses and for determination of food habits. Scales were collected from 30 individuals of each species.

Downstream migration of juvenile chinook salmon peaked in late June. Chinook migration ended by July 16. Peak down migration of juvenile steelhead and cutthroat trout occurred in late June and mid-May respectively. Downstream migrant trapping was terminated after chinook downmigration ceased. It is assumed that a low level of steelhead migration continued past this date.

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 Figures 13 and 14. These figures show downstream migrating salmonids found favorable habitat in the estuary as soon as an embayment began to form. A decline in chinook through July (Figure 13) was probably the result of inadequate habitat associated with frequent water level fluctuations and low embayment water levels.

Unlike 1982 and 1983, the majority of chinook had entered the ocean by early September. The shortened 1984 rearing period may have been influenced by an influx of small steelhead trout (Figure 14) and resultant displacement of chinook.

Juvenile salmon growth in the estuary during the summer was significant (see Figure 13). Fork length averaged 63.8 mm on May 21 and 123 mm on October 18.

Patterns of estuarine use by juvenile steelhead trout (Figure 14) were similar to that of salmon. That is, when habitat was available, steelhead spent an extended period in the estuary. Unlike salmon, downmigration of juvenile steelhead continued throughout the summer. On August 14, the steelhead population increased dramatically, but average size decreased, indicating an influx of smaller fish. As numbers declined, average size again increased probably indicating loss of the smaller fish from the embayment.

1984 Cost Summary

Management Activities

Log Boom Repair	$ 225
Water Level Control and Monitoring	11,418
Total	$11,643

Research and Monitoring

Resurvey of Excavated Areas	$ 520
Water Quality Monitoring	1,288
Aquatic Invertebrate Monitoring/Analysis	4,400
Fish Trapping, Population and Growth Monitoring	7,668
Total	$13,876

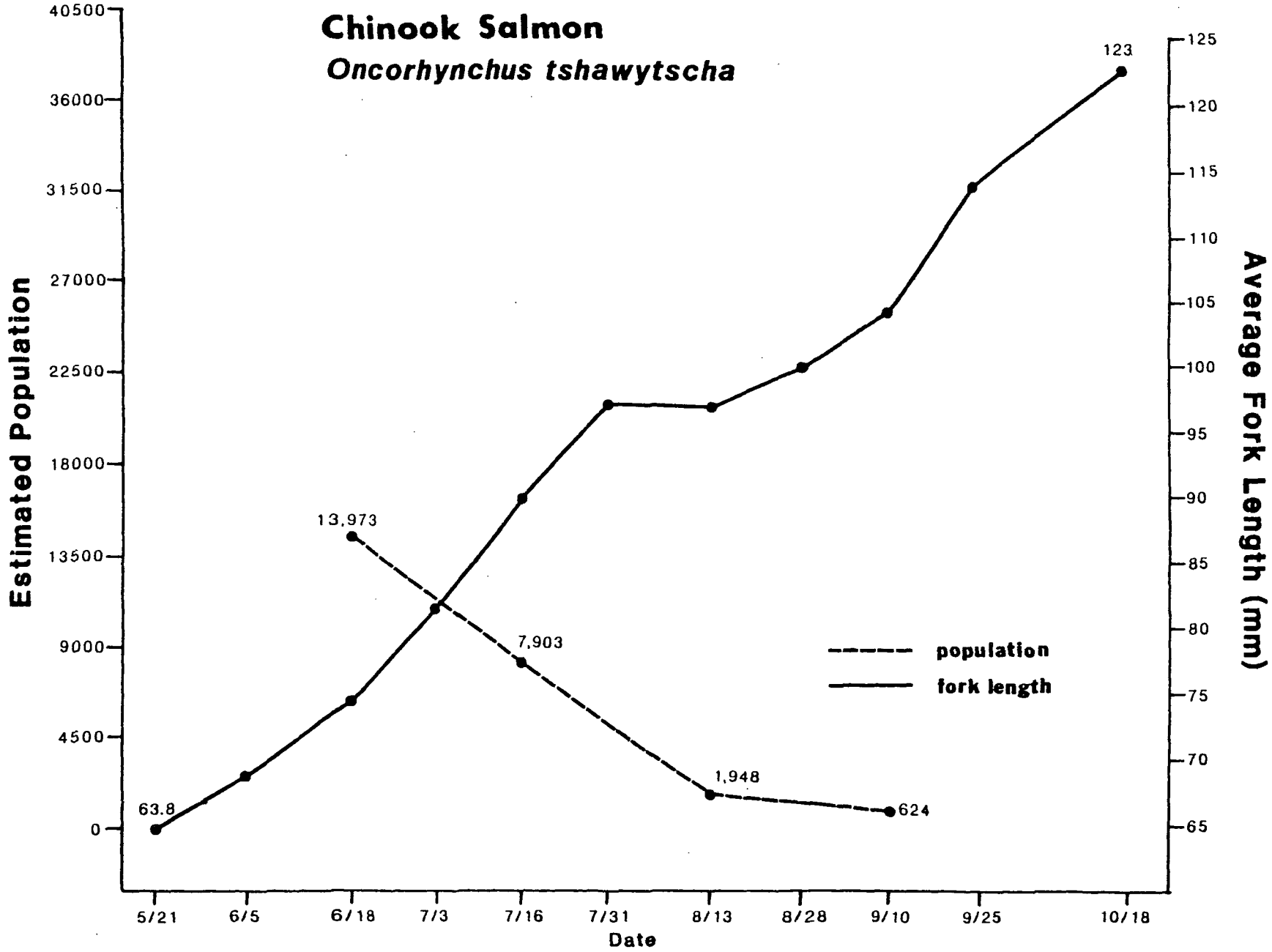


Figure 13: Population estimates and growth of chinook salmon, summer 1984

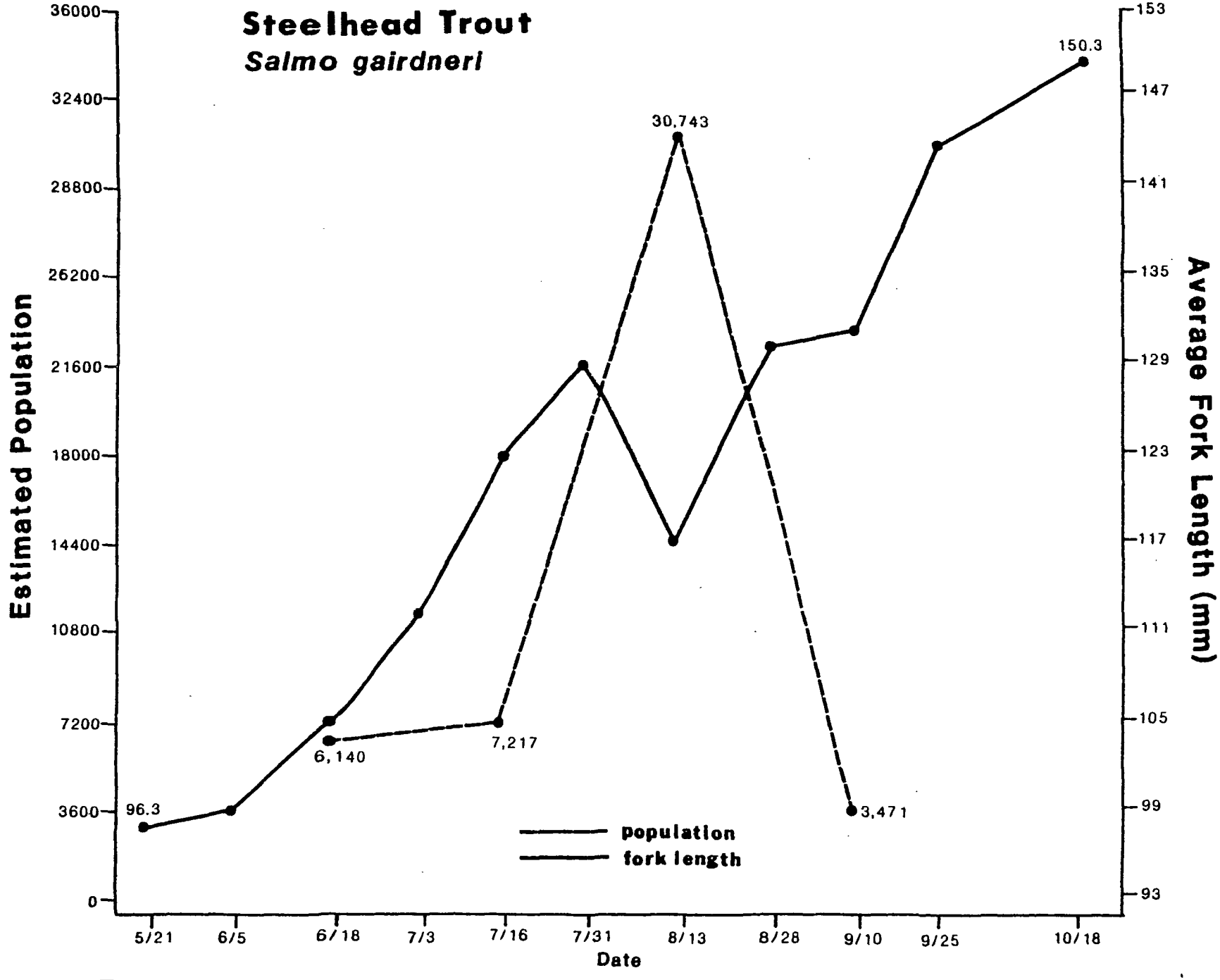


Figure 14: Population estimates and growth of steelhead trout, summer 1984