ANADROMOUS SALMONID NURSERY HABITAT IN THE REDWOOD CREEK WATERSHED

1983

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ABSTRACT

The extent and quality of anadromous salmonid nursery habitat in the Redwood Creek watershed, one-third of which is in Redwood National Park, were surveyed in 1980 during the months of lowest stream discharge (August, September). In 1981, 12 sites representative of stream habitats throughout the watershed were sampled with regard to aquatic organisms and habitat characteristics. Habitat quality has been extensively degraded as a result of logging and related activities, but nursery habitat was essentially limited by stream gradient and "natural" barriers. Juvenile salmonids were widespread with most found in the tributaries. Steelhead trout *Salmo gairdneri* was the predominant species. Coho salmon *Oncorhynchus kisutch* and coastal cutthroat trout *S. clarki* were limited in numbers and distribution. Chinook salmon *O. tshawytscha* occur as well but spend little time in their natal stream and migrated prior to sampling. The results of this study will assist development of Park rehabilitation schemes and evaluation of their effects on salmonid populations.

INTRODUCTION

Anadromous salmonids are an important commercial and recreational resource in northern California. Before they smolt and migrate to sea, a part of their lives are spent as juveniles in nursery areas of rivers and tributaries. Steelhead trout remain in a stream for 1 to 4 yrs before smolting and coho salmon remain 1 yr before migrating to the stream estuary and then to the ocean (Shapovalov and Taft 1954). Chinook salmon (fall) migrate to the stream estuary soon after emerging and then, after a short delay, to the sea (Riemers 1973). Coho and steelhead survival is therefore dependent upon favorable stream conditions throughout the year, while chinook survival is dependent upon spring stream and summer estuarine conditions. Conditions, physical and biological, together with the amount of nursery area available to the fish, determine the stream's production of juvenile fish, assuming a constant spawning stock.

A physical condition such as low summer flow limits nursery habitat. Burns (1971) correlated biomass of juvenile salmonids in northern California streams to stream surface area. With low flows, the amount of living space is decreased as is the stream's carrying capacity for juvenile salmonids.

Barriers and log jams stop fish migration and prevent the utilization of suitable nursery areas (Chapman 1962). Water temperatures also limit the numbers and species of fish surviving. Brett (1952) measured the temperature tolerance of young Pacific salmon and reported 25° C and 25.1° C as the upper lethal temperatures of coho and chinook juveniles, respectively. The upper lethal temperature for steelhead is 24.1° C, but the temperature preference for all three species is 7.3° C to 14.6° C (Reiser and Bjornn 1979).

Another physical factor affecting amount of nursery area available is streambed sedimentation and aggradation. Rocky areas are most productive of benthic invertebrates, a food source of fish, while a substrate covered by sediment decreases productivity (Cordone and Kelly 1961). Equally important is the filling-in of spaces between the rocks and of deep pools which decreases the amount of shelter and cover available to fish. McCrimmon (1954) reported stocked juvenile Atlantic salmon *Salmo salar* had decreased survival and distribution when sedimentation rates were increased. With protective cover gone, fish suffered higher mortality from predators. Redwood Creek, like other northern coastal

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streams, produces large amounts of sediment as a result of its erosion-prone slopes and land use activities (e.g., timber harvesting) that take place in the watershed (Bradford and Iwatsubo 1978). A stream damage survey of Redwood Creek and some of its tributaries by the California Department of Fish and Game in 1966 found that of 84 mi surveyed, 64 mi (76%) were severely damaged (Fisk et al. 1966). Severely damaged was characterized as 75% to 100% of the stream bottom silt covered, an elimination of streamside canopy and pools, and a total loss of shelter for fish. Deposited sediment raised and widened the streambed so that low flows combined with a lack of vegetation made Redwood Creek unsuitable as a nursery area.

Historically, Redwood Creek was known as a producer of many large salmon. The adult salmon and steelhead population of Redwood Creek was last estimated in 1960 at 5,000 chinook, 2,000 coho, and 10,000 steelhead (USDI 1960). At that time, the population was declining in numbers.

There is no available information about the amount of nursery area available in the entire basin, particularly in the tributaries. This study determined the amount of nursery area available and limiting factors affecting fish distribution in the Redwood Creek basin. Redwood National Park and its extensive watershed rehabilitation program encompasses the lower third of the basin. The results of this study provide an indication of the condition of fishery resources of Redwood Creek that can be used to measure the benefit of the rehabilitation effort and recovery of the fishery.

METHODS

Study Area

Redwood Creek, a 88.5 km long north-northwest flowing coastal stream, and its tributaries drain a 72,550 ha watershed in Humboldt County, California. The lower one-third of the watershed is in Redwood National Park. The watershed has a mean annual precipitation of 203 cm. Severe winter flooding occurs periodically. Vegetation consists of coast redwood *Sequoia sempervirens* and Douglas-fir *Pseudotsuga menziesii* forests, their associated flora and ridgetop prairies. The watershed is steep sided and narrow with unstable eroding slopes. Hillslope gradients range from 31% to 34% in the basin. Elevations range from sea level to 1,500 m. Timber harvesting is the dominant land use in the basin; 90% of its forests having been harvested.

Salmonid species common in the streams are steelhead trout *Salmo gairdneri,* coastal cutthroat trout *S. clarki,* coho salmon *Oncorhynchus kisutch,* and chinook salmon *O. tshawytscha.* Other fish occurring in the streams are Humboldt suckers *Catostomus occidentalis humboldtianus,* sculpin *Cottus* sp., threespine stickleback *Gasterosteus aculeatus,* and Pacific lamprey ammocetes *Lampetra tridentatus.* A more detailed description of the watershed is provided by Iwatsubo et al. (1976).

Methods

In 1980 and 1981, during the months of lowest flow, August and September, Redwood Creek and its tributaries were surveyed. Physical parameters of flow, air and water temperature (° C), dissolved oxygen (ppm), and conductivity (μmhos) were measured. Using a backpack shocker, the presence and extent of fish was determined, as well as potential barriers to migration in each tributary. Representative fish were measured and scales sampled. The fish were aged from micro-projection of their scales.

In August and September of 1981, 12 streams representative of the Redwood Creek watershed were sampled with regard to habitat characteristics and aquatic organisms (Fig. 1). In addition to measuring the previously mentioned parameters, the cover available to juvenile fish was determined. A two-pass removal method (Seber and LeCren 1967) was used with an electro-shocker on representative 50 m stream sections to estimate fish populations. Captured fish were anesthetized with MS-222 and identified. Fork lengths and volumes were measured for all fish caught and scale samples were obtained from representative fish. To sample the benthic invertebrates, six Surber samples, three each from pools and riffles, were taken at each site in addition to a 24-hr drift sample. The invertebrates will be identified and enumerated.

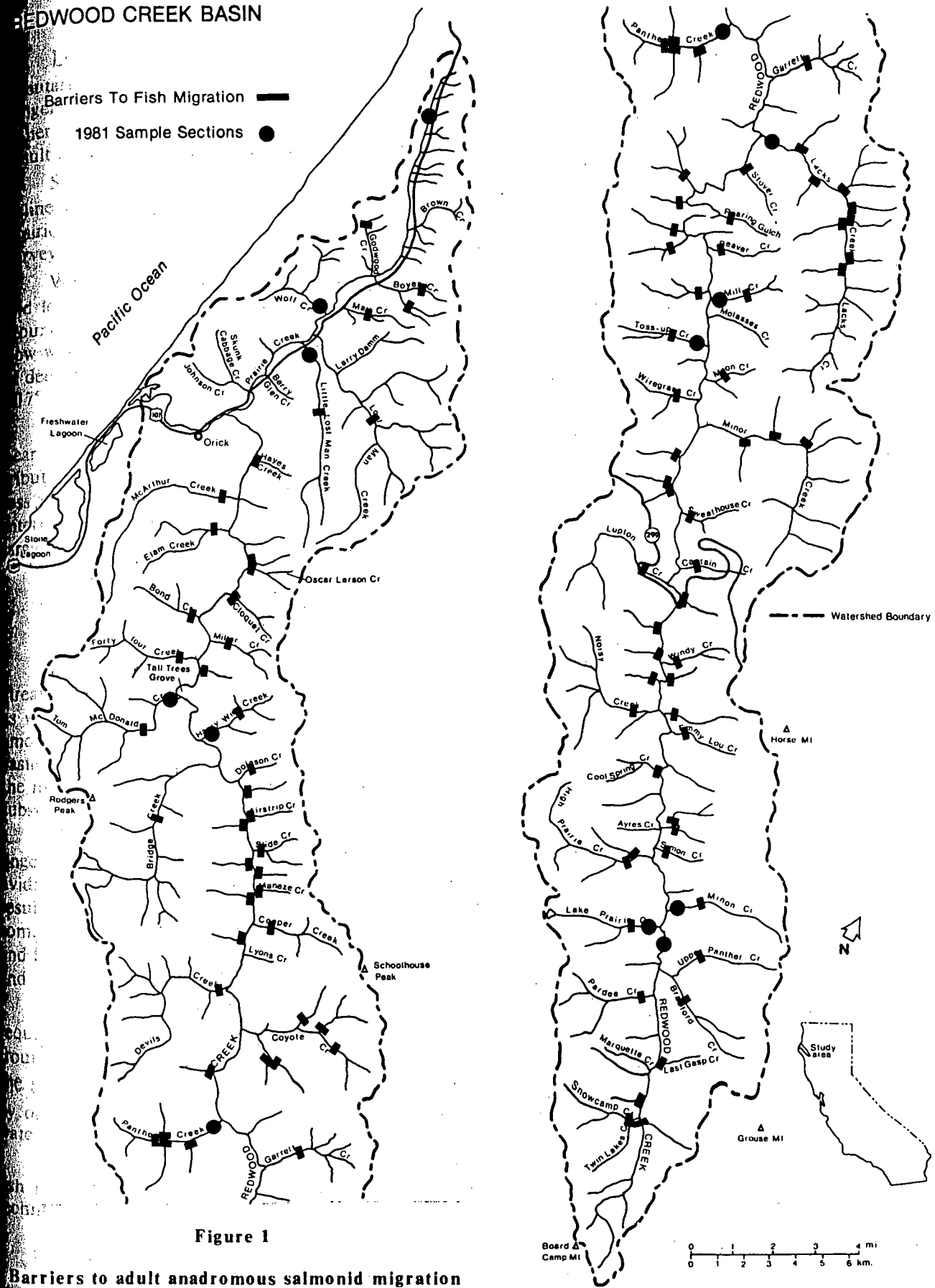

Figure 1

Barriers to adult anadromous salmonid migration in the Redwood Creek watershed and stream location of 1981 sample sections.

RESULTS

Locations of suspected barriers to adult salmonid migration are indicated in Fig. 1. In some tributaries no barrier was encountered. High winter flows may act to make some suspected barriers no longer impassible. Stream gradient was most often considered the main impediment to migration. Other structures, such as log jams or waterfalls, often occurred in conjunction with and probably as a result of increasing gradient.

Steelhead trout was the predominant anadromous salmonid in the watershed utilizing the area delineated by barriers. Coastal cutthroat trout and coho salmon juveniles were primarily limited to Prairie Creek and its tributaries. Chinook salmon (fall run) juveniles were not encountered during our survey.

Water temperatures generally reached maxima of less than 20° C in tributaries with open canopies and less than 15° C in tributaries with closed canopies. Night time temperatures usually dropped to around 11° C - 12° C. Temperatures as high as 26° C were recorded in the mainstem in areas where flow was mostly sub-gravel, the creek shallow, and spread over broad gravel bars. Water temperatures in deeper sections seldom exceeded 24° C however, and nighttime temperatures dropped into the 15° C - 17° C range.

Dissolved oxygen concentrations were seldom less than 8 ppm in the mainstem and constantly near 10 ppm in the tributaries. Specific conductivity never exceeded 300 μmhos in the mainstem or tributaries. Stream discharge was not measured in the mainstem but flow in the tributaries ranged from less than 0.03 m^3/second to 0.23 m^3/second. In many areas Redwood Creek and its tributaries become intermittent in late summer, most notably in the upper reaches of streams, at log jams (behind which large amounts of sediment are stored), and at the confluence of tributaries with Redwood Creek.

Data collected from the 12 sample sites in 1981 is currently being analyzed.

DISCUSSION AND CONCLUSIONS

Our survey of the watershed indicates the amount of nursery habitat is essentially limited by stream gradient, natural barriers, and low or subsurface flow. Steep gradients and natural barriers such as waterfalls and log jams prevent upstream migration of spawning adult fish, therefore restricting the amount of potential rearing area available. Some streams, especially those further inland and on the eastern side of the basin where summer conditions are more xeric, are intermittent. Juvenile fish in the intermittent tributaries are confined to isolated pools, vulnerable to predators, and dependent upon subsurface flow to maintain the drying pools.

Most barriers found were considered natural and not the result of past land usage; however, the lingering effects of clearcut logging combined with erosion-prone slopes and large flood events were evident. The loss of riparian vegetation in conjunction with extreme aggradation in the mainstem have resulted in water temperatures which exceed those considered optimum for rearing salmonids and in some cases approach lethal temperatures for the species encountered. With few exceptions (see Keller and Hofstra 1983) much of the mainstem of Redwood Creek could still be considered severely damaged and unsuitable as rearing habitat.

The success of steelhead trout in the watershed seems to indicate it has more liberal habitat requirements relative to the other salmonid species. In contrast, the distribution of coastal cutthroat trout and coho salmon would appear to be the result of more rigid requirements. This is exemplified by the apparent restriction of these species to the Prairie Creek drainage, a low gradient system bounded by old-growth redwood forest which has sustained far less logging activity than the remainder of the watershed.

The data gathered during 1981 should be suitable for comparing the habitat and corresponding fish populations of the Redwood Creek watershed with other coastal streams. We plan to publish a technical report encompassing the final results and conclusions of our study.

MANAGEMENT RECOMMENDATIONS

Stream rehabilitation for salmonids in the Pacific Northwest has to date concentrated on the use of in-stream structures aimed at increasing fish production. In contrast, the watershed rehabilitation effort at Redwood National Park has focused on stabilizing damaged upper-slope areas. Using this study as a reference, periodic monitoring of the aquatic community should continue in order to evaluate the success and potential of the program for rehabilitation of salmonid populations.

It has also become common practice to remove barriers to migration in order to increase the habitat available for spawning and rearing of anadromous salmonids. Removal of natural barriers in the Redwood Creek watershed would, in most instances, not significantly increase spawning and nursery areas and should not be considered.

ACKNOWLEDGEMENTS

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ANDERSON'S HEIMLICH, 1983

Redwood Creek, Humboldt County
(Field Note)

Tributary to: Pacific Ocean

Date of Survey: October 13, 1983

Location: T11N, R1E, Sec.37; north slough of Redwood Creek estuary.

Method of Survey: Gill netting and water quality methods

Equipment Used: One standard sampling gill net and water quality sampling equipment.

Surveyors: Steve Heimlich; Dave Anderson (Redwood National Park)

Observations: On October 13 at 1600 hrs. a gill net was set in the north slough of Redwood Creek estuary. It was checked periodically to insure that no large salmon were caught. At 2200 hrs. the net was pulled and 20 steelhead, Salmo gairdnerii gairdnerii, were caught. Scale samples were taken and age was determined to be 1+. Below is a list of fork lengths, along with the water quality data.

Fork Lengths in mm

153	168(2)	173	179	260
161	170(2)	174(2)	180	
164	171	175	182	
165	172	178	186	

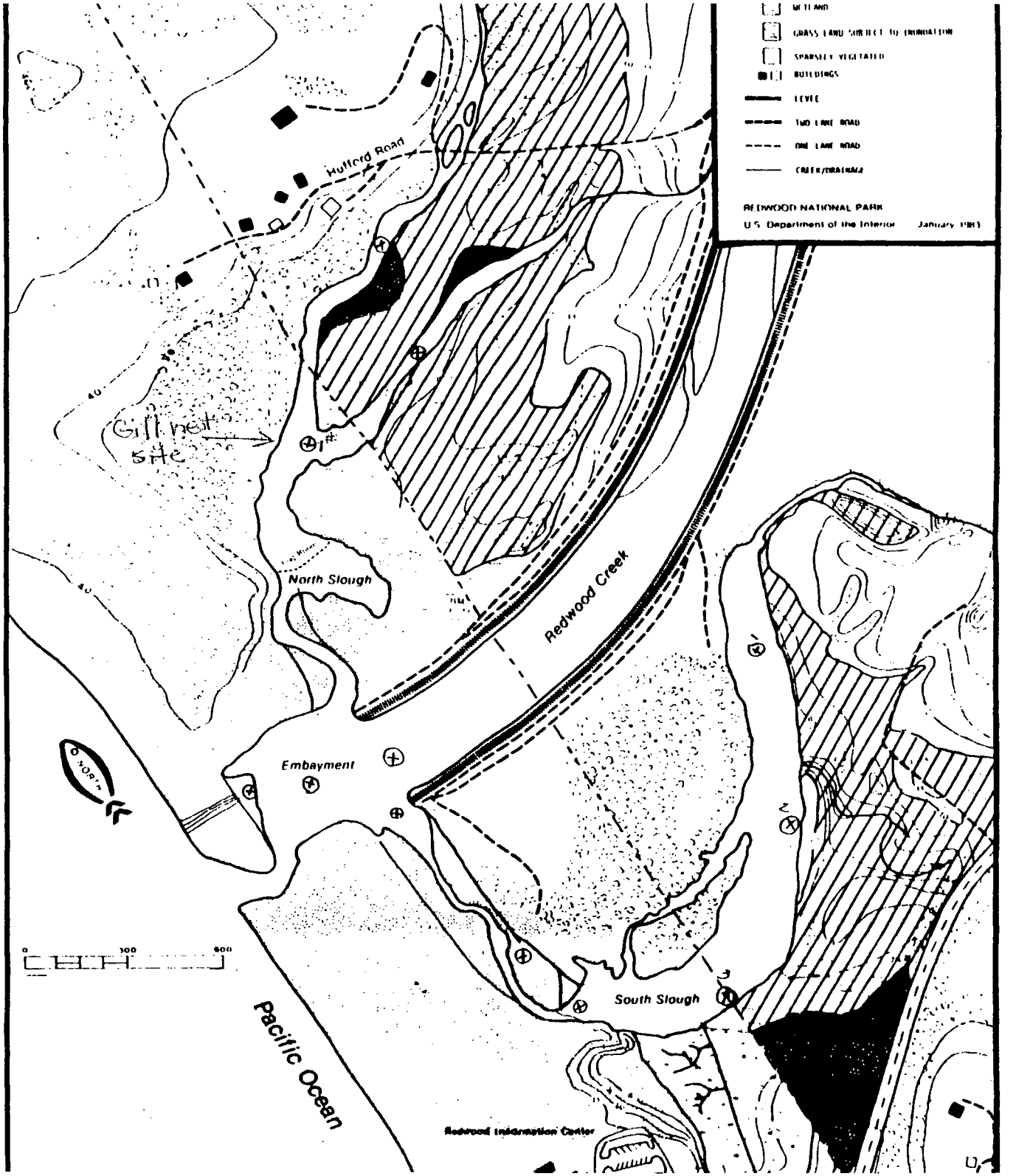
Water quality data from the gill net site which is at the confluence of two forks of the north slough (see attached map):

1) Depth in Feet	2) Conductivity	3) Salinity	4) Temperature	5) Oxygen
0	19000	15.5	12.5	7.3
1.0	26500	21.0	13.5	4.0
2.0	30500	23.0	14.0	7.2
2.5	30500	23.0	13.5	7.6
3.0	30500	22.5	13.5	7.6
4.0	30500	23.5	13.0	5.4
5.0	31000	23.5	12.5	4.4

1) Depth in feet from surface
2) Conductivity in μmhos/cm
3) Salinity °/oo
4) Temperature in centigrade
5) Dissolved oxygen in ppm

Written by: Steve Heimlich
Seasonal Aid

cc: Bailey


WETLAND
GRASS LAND SUBJECT TO INUNDATION
SPARSELY VEGETATED
BUILDINGS
LEVEE
TWO LANE ROAD
ONE LANE ROAD
CREEK/DRAINAGE
REDWOOD NATIONAL PARK
U.S. Department of the Interior
January 1981
Hufford Road
Gill net site
North Slough
Redwood Creek
Embayment
South Slough
Pacific Ocean
Redwood Information Center
NORTH
0
300
600

Redwood Creek, Humboldt Co.

(Field Note)

Tributary to: Pacific Ocean

Date of Survey: November 29, 1983

Location: R1E, T10N, Sec. 32 (Redwood Creek Estuary - south slough)

Purpose of Survey: Water quality measurements, sample fish population.

Equipment Used: YSI Model 57 oxygen meter. YSI Model 33 meter for measuring conductivity, salinity and temperature. Two standard 125' floating gill nets.

Surveyors: Steve Heimlich (DFG) and Dave Anderson (RNP).

Observations: Two gill nets were set at 1530 hrs. on 11/29/83 and were pulled at 0730 hrs. on 11/30/83. Four species of fish were caught; steelhead, suckers, sculpin and sticklebacks.

At 1400 hrs. on 11/29/83, the temperature was 62°F, oxygen content was 8 ppm, conductivity measured 110 µmhos and salinity was 0 °/oo.

The water depth varied with the tidal influence. One net was set in a channel that was 5' deep, the other net was set in a 2' deep area. Below is a list of fishes caught.

Steelhead (Salmo gairdnerii gairdnerii)

Fork length	Total length
180 mm	194 mm
159	172
167	187
170	182
175	188
207	222
121	130
126	137
147	157
171	183
203	217
112	122
183	192
146	159

Threespine stickleback (Gasterosteus aculeatus)

62 mm

Pacific staghorn sculpin (Leptocottus armatus)

127 mm
100
104

Humboldt Sucker (Catostomus humboldtianus)

Fork length	Total length
219 mm	230 mm
175	185
203	213
190	198
166	174
196	206
169	179
195	206
235	246

Written by: Steve Heimlich
Seasonal Aid

cc: Baldwin