ANNUAL PERFORMANCE REPORT

FEDERAL AID IN SPORT FISH RESTORATION ACT

State: California   Project Number: F-51-R-6

Project Title: Inland and Anadromous Sport Fish Management and Research

Category: Surveys and Inventories

Project No. 33: Klamath River Basin Habitat Investigations

Job No. 2: Seasonal Water Quality Monitoring in the Klamath River Estuary

Period Covered: July 1, 1993 through June 30, 1994

I. Summary: Klamath River flow through the estuary from July through September 1993 was about twice as high as we observed during the same time period in 1992. However, river flow from December 1993 through June 1994 was significantly lower than the previous year and more closely resembled the flows from the 1991 and 1992 drought years. Due to the higher river flows saltwater did not intrude as far up river as in previous years, and the seasonal impoundment of water by the formation of a sand bar did not occur until early October. Due to the low river flow in the spring of 1994 we detected saltwater in the estuary by May and the sand bar formed by late July 1994. Maximum surface water temperatures were 21-22 C, while water temperatures in the saltwedge were typically 12-16 C. The salt wedge may be an area of thermal refuge for juvenile salmonids as river water temperatures rise in summer. The sand bar does not appear to be a barrier to adult salmonid migration and in fact the impounded water may increase the productivity of the Klamath River estuary.

II. Background: The Klamath River estuary is being monitored to describe seasonal changes and ranges of water quality conditions occurring there. Declines in the number of salmonids, returning to the Klamath/Trinity River system have caused concerned among user groups, conservation groups, and the biological community alike. Causes for the declines have been attributed in part to improper land use and water diversion. Some of these activities have degraded water quality conditions to below acceptable levels for juvenile salmonids. This study will allow us to determine whether water quality conditions in the Klamath estuary are acceptable for salmonids.

III. Objectives:

1) To monitor and describe seasonal changes and ranges water quality conditions within the Klamath River estuary.

IV. Procedures: We collected water quality data at high an low tides on a monthly basis except for December when river flows were too high to safely conduct field work. We collected water temperature, dissolved oxygen, salinity, water conductivity, and depth of the saltwedge information near high slack and low ebb tide levels using a YSI Model 33 Conductivity/Salinity meter, and YSI Model 57 Oxygen/Temperature meter. When practical we attempted to sample the highest and lowest tides of the month to identify the extreme upstream range of saltwater intrusion into the estuary. We sampled transects perpendicular to the river flow every 1/4 to 1/2 mile corresponding to a permanent landmark to insure that we sampled the same location each month (Figure 1). We collected data at 3 stations (middle, right, left) along the transect at surface, mid-water, and bottom elevations. Daily river flow information was provided by the Department of Water Resources gaging station at Terwer, approximately 2 miles upstream of the estuary.

V. Findings: Klamath River flow through the estuary from July through September 1993 was about twice as high as we observed during the same time period in 1992. However, river flow from December 1993 through June 1994 was significantly lower than the previous year and more closely resembled the flows from the 1991 and 1992 drought years. Klamath River flow at Terwer ranged from a low of 2,814 cfs on June 30, 1994 to a high of 36,512 cfs on December 8, 1993. This is the lowest annual peak flow since our study was started in 1986. Another example of the low flow conditions was that the flow at the beginning of the summer of 1994 was already lower than the flow at the end of the summer of 1993.

In most years a sand berm forms at the mouth of the Klamath River as the result of sediment deposition from marine sources and decreased river flows. Due to the higher than normal river flow during the summer of 1993 the sand berm which usually forms in August or September did not form until early October. But due to the lower than normal flows in the fall of 1993 the sand bar remained and tidal fluctuation within the estuary was minimal until December. The continued less than average flows during the winter and spring has resulted in the early formation of the sand berm at the river mouth as of July 1994.

Generally a wedge of saltwater moves along the river bottom with the tide, following the channel up and down the estuary. As river flow decreases the salt wedge is able to move farther upstream. Also the wedge moves farther upstream with increased tidal height. The farthest upstream occurrence of saltwater was 2.5 miles above the river mouth. This occurred on August 20 during a 7.4 ft high tide and September 17 during a 7.7 ft high tide with salinities of 25 and 26 ppt respectively. The preceding summer we found saltwater at 28.5 ppt 3.25 miles above the mouth which has been the location of the typical upstream limit of saltwater intrusion into the estuary during the summer months (Wallace 1993). During low tides the saltwater retreated to the bottom of the deeper holes in the lower 1 or 2 miles of the river. The highest concentration of saltwater we detected was 32 ppt about 0.75 miles above the mouth in June 1994. However, saltwater concentration in the estuary were normally 24 to 28 ppt. High river flows from December through April kept salt water from the entering the estuary.

Water temperatures ranged from a low of 5 C in January 1993 to a high of 22 C in July 1993. When the salt wedge was present in the summer months its' temperature was 12 to 16 C, usually about 5 to 8 C cooler than the surface freshwater temperatures. High concentrations of juvenile chinook salmon were observed near the mouths of cooler tributary streams in the mainstem Klamath River during the summer months of 1984 and 1985 (Mills, T. J. unpublished manuscript). He hypothesized that the salmon were using these areas as cool water refugia when the mainstem river temperatures became too warm. We have also observed and captured high numbers of juvenile chinook cooler waters at the mouth of Hunter Creek. Hunter Creek enters the estuary about 1 mile above the mouth of the Klamath River and is typically 5 to 8 C cooler than the mainstem Klamath River. The wedge of cooler brackish water in the estuary may also be used for thermal refuge by juvenile salmonids during the summer months.

Dissolved oxygen concentrations ranged from 7.0 to 12.0 ppm during the summer months (May-October), with occasional readings as low 2.5 to 5.5 ppm at the bottom of deep pools or within heavily vegetated side channels. Dissolved oxygen concentrations ranged from 8.0 to 13.0 ppm for the remaining months except for one reading of 4.1 ppm in January at the bottom of a pool.

Studies of other smaller coastal lagoons have shown that after sand bar closure a lens of saltwater located at the bottom of deep pools tend to become anaerobic and reduce production in the lagoon (Smith 1987). Also, seasonal meromixus has been reported in coastal lagoons in Oregon (Lichatowich and Nicholas 1985), and California (Busby 1991). However, we found no evidence of meromixus, and only very small isolated pockets of near anaerobic conditions within the Klamath estuary. This is likely due to that unlike smaller coastal lagoons which may form sand bars that isolate the lagoon from the ocean for 3 to 6 months, the sand bar at the mouth of the Klamath rarely closes completely, and when it does it only remains closed for a few days. Measured oxygen levels within the Klamath estuary suggest that there is adequate water circulation throughout the estuary to minimize the chances of meromixus or anaerobic conditions developing. This is probably due to the relatively substantial river flow into the estuary, or to the constant partial breaching of the sand spit that naturally occurs once the water level of the estuary rises above a certain height.

The formation of a sand berm at the mouth of the Klamath River and the subsequent impoundment of water in the estuary may increase the production of the estuary by increasing its' surface area. In addition, the reduced tidal fluctuation in the estuary may create a more stable environment by decreasing the area normally dewatered during the tidal cycle. As a result the estuary may be able to support more sedentary or burrowing animals such as the Corrophium amphipod, which is an important food item for juvenile chinook salmon. Ratti (1979) hypothesized that extensive modifications (jetties) at the mouth of the Rogue River, Oregon, has prevented the historic shoaling at the mouth, which led to reduced food production in the estuary. This in turn caused juvenile chinook salmon to rear for a shorter time in the estuary.

VI. Recommendations: This job should continue through FY 1994/1995. We need to assess the response of water quality parameters to changing physical processes such as river flow and river mouth location along the spit. We should also continue to collect water quality information in conjunction with our fish collections to better describe the conditions in which they are found. The California Department of Fish and Game should closely scrutinize any requests to artificially breach or keep open the sand bar at the river mouth in the name of flood control or "fish enhancement" because there is evidence that the impoundment caused by the formation of the sand bar is beneficial to rearing juvenile chinook salmon.

VII. Estimated Fy 93-94 Job Cost: Wallace Salary 5%

Additional Costs:	Fuel	$ 360.00
	Travel	$ 100.00
	Temporary Help	$ 850.00 (1 day/mnth)

VIII. Preparer: ____

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LITERATURE CITED

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