Red Bluff Technical Report Abstract

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S.M. Borthwick, R.R. Corwin, and C.R. Liston, 1999. Investigations of Fish Entrainment by Archimedes and Internal Helical Pumps at the Red Bluff Research Pumping Plant, Sacramento River, California: February 1997 - June 1998. Red Bluff Research Pumping Plant Report Series, Volume 7, United States Department of the Interior, Bureau of Reclamation, Red Bluff, California and Denver. Colorado. 61 pp.

The overall goal of the Red Bluff Research Pumping Plant program is to determine whether Archimedes and/or internal helical pumps can be used to deliver water to canals without harming fish inhabiting the Sacramento River. This report contains results of entrainment monitoring of fish from the Sacramento River during February 1997 through June 1998. Objectives addressed include: determining if differences exist in numbers, species, survival and injury of fish entrained into each of the two types of-pumps; and estimating the number of juvenile chinook salmon in each of the four Sacramento River salmon runs entrained annually into the pumps.

Twenty-nine species of fish, 16 native to the Sacramento River, were captured during entrainment monitoring. Juvenile chinook salmon was the most frequently entrained species followed by prickly sculpin, lamprey, Sacramento sucker, Sacramento pikeminnow, and threespine stickleback. These six species comprised 95 percent of the 17,530 fish entrained. Nearly 90 percent of the entrained chinook were fall ran. Seasonal patterns of chinook salmon entrainment followed those of chinook abundance in the river. Assessment of diel patterns of entrainment revealed that 8 1 percent of chinook were entrained at night. This has important implications for pump operations. If it becomes necessary to decrease the number of chinook entrained, a substantial reduction could be made by puinping only during the day.

Ninety-two percent of entrained fish were <1 00 mm in length. Most chinook salmon (84 percent) were less than 40 min fork length. The lowest median fork length for chinook salmon occurred September through October, and December through February reflecting the outmigration of winter and fall chinook fry, respectively.

Because the plant was operated for biological evaluations during all seasons, the number of fish entrained during this study was higher than would occur if the plant were used only for delivering water. Sixty-five percent of the chinook entrained were collected during trials conducted in December and January, months that the plant would not operate if functioning for water deliveries. The winter of 1997-1998 was wet so the peak of fall chinook outmigration occurred during the winter months and relatively few remained to be vulnerable to spring pumping. In a dry winter, however, spring entrainment rates would be expected to be relatively high since the peak outmigration of fall chinook would be delayed until spring, coinciding with high water demands and continuous pumping.

During this study, 24-hr trials were conducted simultaneously with the U. S. Fish and Wildlife Service's rotaryscrew trap sampling to determine the proportion of chinook salmon in the river entrained into the pumping plant during different seasons of the year. Preliminary data from October through December 1997 reveal that the upper estimate of the percentage of riverine chinook entrained into the plant ranged from approximately 0.05 to 0.60. This is well below the 1.5 to 5.5 percent that was predicted based upon the assumption that chinook are entrained in proportion to the amount of flow diverted into the plant. The low entrainment rate is likely due to the plant intakes being positioned near the bottom of the river whereas the majority of outinigrating chinook salmon inhabit the upper water column.

The number of fish entrained into Archimedes 2 was significantly greater than the number entrained into Archimedes I or the internal helical pump, which were not different. Survival of chinook recovered from the holding tanks was 98 percent for each of the Archimedes pumps and 94 percent for the internal helical pump. Survival of fish other than chinook was 95 percent for the Archimedes pumps and 94 percent for the helical pump. The differences in survival among pumps was not statistically significant for chinook or other species. Percent survival values should not be interpreted strictly as pump passage survival. Captured fish also passed a screening facility, traveled curved bypass channels, up a dewatering ramp, and were routed into a tank where they were held with debris and other fish for up to 14 hours. Factors besides pump passage could affect the survival of entrained fish collected from the holding tanks.

Considering all three pumps, mortality of chinook salmon entrained into the RPP was 3 percent, and the percentage with sublethal injuries was 2.1. This 5.1 percent mortality and injury is less than anticipated by the Biological Opinion (National Marine Fisheries Service 1993) for the Archimedes pumps (10 percent) or the internal helical pump (>10 percent, even as high as 90 percent). Delayed mortality of chinook was also low, less than or equal to I percent for each of the pumps.