Red Bluff Technical Report Abstract

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  McNabb, C.D., Borthwick, S.M., and C.R. Liston, 2000. Experimental Results from Passing Juvenile Chinook Salmon Through Archimedes Lifts and an Internal Helical Pump At Red Bluff Research Pumping Plant, Upper Sacramento River, California. Red Bluff Research Pumping Plant Report Series, Volume 9, United States Department of the Interior, Bureau of Reclamation, Red Bluff, California. 72 pp.

Experiments were conducted to assess mortality and injury to juvenile chinook salmon that passed through Archimedes lifts and an internal helical (Hidrostal) pump in the U.S. Bureau of Reclamation's Red Bluff Research Pumping Plant. Hatchery-reared chinook salmon were used in the experiments. Size classes were chosen to cover the range of sizes of juveniles that outmigrate from spawning and rearing areas on the upper Sacramento River (34-74 mm fork-length). Twenty-seven trials were conducted in an experiment to compare pump-passage effects of the two Archimedes lifts. Forty trials were conducted in an experiment to compare effects of the Archimedes lifts and the internal helical pump. Approximately 128 chinook salmon were used in each trial. The two pumps used in each experiment were run concurrently during trials. Treatment samples were inserted in the intake of each pump. Fish in treatment samples passed through the pumps, and through their outfalls. Control samples were released just downstream of pump outfalls. Fish from all samples were recovered in holding tanks located on downstream fish-bypass channels.

Results of the experiments indicated that the Archimedes lifts and internal helical pump were fish-friendly. In the experiment comparing Archimedes lifts, a statistically significant pump-passage effect (treatment effect) on mortality was not detected for either lift. Mean total mortality (direct + 96-h delayed) in treatment samples and control samples used with both lifts was very low; in a range between 1.0 percent and 1.8 percent. Subsamples of surviving post-passage fish were examined for descaling and other sub-lethal injuries. No significant pump-passage effect was observed for either lift for percent-fish descaled, or percent-fish with other injuries. There were no significant differences between the two lifts for percent-total mortality, percent-fish descaled or percent fish with other injuries. One of the two Archimedes lifts was selected randomly and run concurrently with the internal helical pump in a second experiment. A significant pump-passage effect on total mortality was not detected for the Archimedes lifts. A small, but highly significant (P=0.001), pump-passage effect on total mortality was obtained for the internal helical pump (2.5 percent). No significant pump-passage effects were observed for either type of pump for percent fish descaled, or for percent fish with other sub-lethal injuries.

Amount of descaling and types of other injuries noted on live post-passage individuals from treatment and control samples in both experiments were not debilitating; except for one juvenile salmon in the total of 267 that were examined (0.4 percent). Juveniles that died during plant-passage of treatment and control samples were also examined for descaling and other injuries. Multiple injuries were common on these fish. There were no indications that pump-passage caused any particular type of injury.

Turbulence at the head of channels that received the free-fall of discharges from the Archimedes lifts and the internal helical pump differed. Higher turbulence occurred at the outfall of the internal helical pump. A separate study was conducted to evaluate the role of the outfall in the elevated pump-passage effect on mortality that was observed with the internal helical pump. No significant difference was detected for mortality between chinook salmon in samples that were released through a port cut in the outfall structure just upstream of the pump's outfall, and samples that were released at the location downstream of the outfall that was used for control samples during the study reported here. The outfall, by itself, was not responsible for the elevated pump-passage effect on mortality that was obtained with the internal helical pump.