Effects of a removable spillway weir on the behavior, passage, and survival of juvenile salmonids.

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We evaluated the behavior, passage, and survival of juvenile salmonids during tests of surface flow structures at Bonneville, McNary, and Lower Granite dams on the Snake and Columbia rivers. This presentation will focus on the results from the tests conducted at Lower Granite Dam. These results will be compared to results from tests of other bypass structures at Bonneville, McNary, and Ice Harbor dams. Because juvenile steelhead migrate closer to the surface of the water than Chinook salmon, the performance of surface bypass structures when evaluated with juvenile steelhead is high. A conservative way to evaluate the performance of these structures is to measure their performance with Chinook salmon. At Lower Granite Dam, survival of fish passing through the Removable Spillway Weir (RSW) was high and was not statistically different from survival of fish passing through the spillway. For example, in 2003, 2005, and 2006, survival of yearling Chinook salmon passing through the RSW was 98%($\pm$2.3), 98%($\pm$3.1), and 99%($\pm$1.7), respectively. Survival of yearling Chinook salmon passing through the spillway during the same years was 93% ($\pm$6.0), 93%($\pm$9.2), and 98%($\pm$2.5), respectively. The RSW increased the percentage of the fish passing through the spillway. In 2002 and 2003, the percent of yearling Chinook salmon that passed through the RSW and other spillways was 78% and 66%, respectively. During these same years when the RSW was turned off, the percent of yearling Chinook salmon that passed the spillway was 62% and 52%, respectively. The effectiveness of the RSW was high. Effectiveness is the percent of the fish passing through the RSW relative to the percent of the water passing through the RSW. In 2002 and 2003 the effectiveness of the RSW for yearling Chinook salmon was 6.5:1 and 8.2:1, respectively. The effectiveness of the spillway without the RSW was 1.4:1 and 1.6:1, respectively. However, the RSW is always operated with some amount of flow through the spillway to improve tailrace egress conditions. This is often known as “training spill”. When the “training spill” is taken into account, the effectiveness of the RSW declines to 2.6:1 in 2002 and 2.1:1 in 2003. The RSW reduced forebay delay, especially when total river discharge was below 80 kcfs. Surface bypass structures tested at other mainstem dams showed similar results. In all cases, the effectiveness of the surface bypass structure was higher than the spillway effectiveness, survival through the surface bypass structure was equal to or higher than survival through the spillway, and forebay delay was reduced when a surface bypass structure was operating.

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Behavior and Survival for Juvenile Salmonids Passing Ice Harbor Dam during Two Spill Treatments, 2006-2007

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In 2006 and 2007, we evaluated behavior, passage distributions, and survival of yearling Chinook salmon, juvenile steelhead, and subyearling Chinook salmon at Ice Harbor Dam on the Snake River to ascertain effects of the recently installed removable spillway weir (RSW). Fish were collected, PIT tagged, and surgically tagged with a radio transmitter at Lower Monumental Dam. Project operations at Ice Harbor Dam consisted of 2-d random blocks alternating between a reduced spill treatment (~30%) and a BiOp spill utilizing 45 kcfs during the day and gas cap at night. During 2006, we encountered a high flow year with every day of the study measuring greater than the 10-year flow average in the Snake River. In 2007, we observed a low flow year with every day of the study measuring below the 10-year flow average.

Median forebay residence time for yearling Chinook salmon during the high flows of 2006 was 1.8 and 1.1 h for the reduced and BiOp spill treatments, respectively. During 2007 we observed median forebay delays of 2.0 and 1.5 h, respectively. For steelhead, 2006 results were similar to yearling Chinook salmon with reduced spill at 1.9 h and BiOp spill at 1.1 h. The percentage of first detections at the RSW in 2006 was approximately 51% for yearling Chinook salmon under both treatments while measuring near 61% for steelhead. The proportion of total river flow through the RSW increased from 7% in 2006 to 11% in 2007, although discharge remained the same during both years at 8 kcfs. In addition, fish approach distributions at the RSW increased dramatically in 2007 for both yearling Chinook salmon (>80% first seen at the RSW) and juvenile steelhead (>86%) during this low flow year. Passage through the RSW for both species also increased in 2007 as a result of more fish being drawn toward the surface passage route. However, in both years the proportion of fish that passed through the RSW was less than the proportion that first approached the structure and was within 5 meters of the opening. Overall, passage distribution for 2006 through non-turbine routes was greater than 95% for yearling Chinook salmon and 98% for steelhead. In 2007, non-turbine passage routes accounted for greater than 92% of the yearling Chinook salmon and 98% of the steelhead.

Subyearling Chinook salmon data from 2006 follow the same trend with an even higher percentage of total river flow (14%) passing through the RSW, along with an extremely high passage distribution for a life-history strategy this is known for its relatively low fish guidance efficiency. More than 98% of subyearling Chinook salmon passed through non-turbine routes, including 68% that passed through RSW that year. Median forebay residence was 2.0 h for subyearling Chinook salmon during the high flow year of 2006. The 2007 dataset is currently being processed for comparison between years and will be presented at the workshop if available.

Overall, there was no difference in survival among species, project operation treatments, or flow years. Point estimate of yearling Chinook salmon survival were not different between the spill treatments tested, in fact, estimates of dam passage survival which include forebay loss were slightly higher during reduced spill treatments in 2007 than we observed in 2006. Steelhead and subyearling Chinook salmon survival was high in 2006 for both the RSW and spillway as a whole. Steelhead survival remained high in 2007 and was similar to levels observed during 2006.

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