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To: Marvin Shutters and Dave Clugston, USACE

From: George Naughton and Chris Peery, University of Idaho

Re: Lower Granite Dam transition pool weir test 2001 and 2002; Letter Report.

The following is a preliminary summary of our evaluation of a weir modification to improve passage of adult salmon and steelhead through the transition pool at Lower Granite Dam conducted in 2001 and 2002. The goal of this modification was to decrease passage times and increase the proportion of fish that passed through the transition pool area at Lower Granite Dam.

Methods

Fishway Modification

In 2000, the first five downstream weirs in the fish ladder at Lower Granite Dam were modified so a minimum head of 0.25 ft could be maintained at each weir to produce orifice velocities of approximately 4 feet per second. Slotted aluminum panels that were eight inches wide and varied from 15-19 feet long were used to restrict the flow through the overflow portion of the modified weirs. Each pair of panels added to a weir increased the head by about one-tenth of a foot. Head differences were monitored periodically with a water-level meter. In 2000, the weir panels were lowered in place for the entire migration period. While results from monitoring passage of radio-tagged adult salmon and steelhead were encouraging, they were inconclusive because inter-annual variation in river conditions made comparisons difficult. In 2001, a test was conducted in which the weir panels were raised and lowered in a randomized block paired treatment design. The test was repeated in 2002, however during that test individual weir panels were bolted together to form one large panel to facilitate treatment changes.

Passage Times and Fish Behavior

Passage times for radio-tagged adult salmon and steelhead at Lower Granite Dam were divided into five segments: (1) from the first tailrace record to first approach at the dam, (2) first approach to first fishway entry, (3) first record in transition pool to last record in transition pool, (4) last record in transition pool to first record at top-of-the-ladder site and (5) first record at the tailrace site to last record at top-of-the-ladder site.

Fish behavior was analyzed from the time a fish first entered the transition pool until it exited the transition pool upstream into the ladder. Transition pool behaviors were divided into three

categories: (1) passed straight through the transition pool on the first attempt, (2) exited the transition pool into the collection channel and (3) exited the transition pool into the tailrace.

Experimental Design

We compared paired treatments blocks to determine if passage times were significantly different between transition pool treatments. Treatments were defined as control (two panels down) and test (all 14 panels down) on each of the first two weirs. Treatments were randomly assigned to each block. All 14 weir panels in place produced about a 1 ft head differential at the two modified weirs. We queried PTAGIS or downloaded radio-telemetry receivers to determine the number of fish passing through the transition pool. Weir panels were changed at night after at least 10 fish had passed through the transition pool. Treatment periods were from 18 April to 15 October 2001. Treatment periods in 2002 were from 10 May to 20 November.

We used analysis of variance (ANOVA) at $\alpha = 0.05$ level to statistically compare passage times between the two treatment conditions, using median times for fish from each treatment block as the dependent variable. Passage times were log transformed to reduce variance heterogeneity and normalize the distributions. Paired treatments were weighted according to the block size because the number of fish passing through the transition pool varied among treatment periods. The sample size of 27 paired treatment blocks in 2001 was comprised of 646 fish (418 spring/summer chinook, 173 steelhead, and 55 fall chinook) and 635 fish (260 spring/summer Chinook, 344 steelhead, and 31 fall chinook) made up the 29 paired treatment blocks during 2002.

Results

Chinook salmon and steelhead passed through the Lower Granite Dam transition pool at a significantly ($P < 0.05$) faster rate when the weir panels were down in 2001 and 2002 (Table 1). Passage times through the transition pool were about 1.2 h in both years when weir panels were down compared to 2.6 h (2001) and 1.8 h (2002) when weir panels were up.

Table 1. Passage times for chinook salmon and steelhead through Lower Granite Dam transition pool in 2001 and 2002. Passage times are the mean of block medians.

Year	Treatment	Sample size	Mean (h)	SD	P-value
2001	Up	27	2.60	3.65	0.004
	Down	27	1.18	1.98	
2002	Up	29	1.76	4.10	0.0495
	Down	29	1.22	4.39	

Overall dam passage time (F1LT) was not significantly faster ($P = 0.114$) in 2001 when weir panels were down than when weir panels were up, based on time when fish first entered the transition pool (Table 2). We did not calculate overall passage times in 2002 because most fish were captured in the Lower Granite Dam trap before passing the dam. Passage times for the other passage segments were not significantly different in 2001. In 2002, passage time from the first tailrace record to the first approach at the dam was significantly faster ($P = 0.009$) when the

weir panels were up. Passage time from the first approach at the dam to first fishway entry was not significantly (P = 0.148) different in 2002.

Table 2. Times (h) for chinook salmon and steelhead at different passage segments at Lower Granite Dam in 2001 and 2002. Times are the mean of block medians.

		Passage Segment				
Year	Treatment	F1A1[a]	A1E1[b]	FPLP[c]	LPFT[d]	F1LT[e]
2001	Up	1.27	3.48	2.60	2.81	12.47
	Down	1.32	3.67	1.18	3.23	11.50
	P-value	0.996	0.907	0.004	0.120	0.114
2002	Up	1.46	3.78	1.76	-	-
	Down	2.07	3.82	1.22	-	-
	P-value	0.009	0.148	0.0495	-	-

[a] First tailrace record to first approach at dam.
[b] First approach at dam to first fishway entry.
[c] First record in transition pool to last record in transition pool.
[d] Last record in transition pool to first record at top-of-the-ladder site.
[e] First record at the tailrace site to last record at top-of-the-ladder site.

The proportion of chinook salmon and steelhead that passed straight through the transition pool was significantly (P <0.05) higher in both years when the weir panels were down. The proportion of fish exiting to the collection channel and to the tailrace was lower in 2001 and 2002 when the weir panels were down (Table 3), however, these differences were not significant (P > 0.05).

Table 3. Proportion of chinook salmon and steelhead passing straight through transition pool or exiting to collection channel or tailrace at Lower Granite Dam in 2001 and 2002.

			Behavior		
Year	Treatment	Sample size	Straight through	Exit to collection channel	Exit to Tailrace
2001	Up	27	0.25	0.41	0.34
	Down	27	0.39	0.33	0.28
		P-value	0.019	0.157	0.164
2002	Up	29	0.31	0.54	0.15
	Down	29	0.44	0.45	0.11
		P-value	0.003	0.051	0.110

Discussion

Weir modifications appeared effective in reducing the travel time through the transition pool at Lower Granite Dam in 2001 and 2002. Chinook salmon and steelhead passage times were more than one hour faster when weirs were down than when up in 2001, and more than a half an hour faster in 2002. Although differences were not significant, total dam passage time was faster

when weir panels were down in the transition pool in 2001. This difference is probably related to faster passage through the transition pool because passage times between other segments were not significantly different. In 2002, passage time from the first tailrace record to the first approach at the dam was significantly faster when the weir panels were up. Passage between these segments is not affected by treatments in the transition pool. Differences in paterns observed between years may have been related to discharge at Lower Granite Dam. Snake River disharge in 2001 was one of the lowest on record, whereas discharge in 2002 was near average. Differences may also be related to the compostion of samples between the two years. Steelhead composed greater than 50% (n=344) of the sampled fish in 2002 compared to about 25% (n=173) in 2001.

Weir modifications also appeared effective in increasing the number of fish that passed straight through the transition pool in 2001 and 2002. The number of exits to the collection channel and tailrace was also reduced in both years when the weir panels were down. Those differences were not statistically different, however we believe this represents a significant biological effect.

Future work

We will use data collected from radio data storage tags in 2001 to further analyze fish behavior in the transition pool of Lower Granite Dam.