

To: Derek Fryer, USACE Walla Walla District

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RE: Evaluation of Radio-tagged Adult Chinook Salmon Behavior in Response to Nighttime Flow Reductions at McNary Dam - 2009

Date: 24 November 2009

Introduction

This summary was prompted by a USACE request to evaluate whether nighttime flow reductions at the main south-shore fishway opening of McNary Dam may impede adult Chinook salmon passage. The nighttime flow reduction treatment was applied in 2009 in an effort to improve adult lamprey passage. Before repeating the trial in 2010, managers are interested in determining if there is any evidence that the treatment adversely affected salmon passage in 2009.

Methods

Beginning on 1 July 2009, the nighttime flow reduction treatment was applied at McNary Dam using a randomized block design. Blocks consisted of two-day intervals. During the experimental treatment, the sliding gates of the main fishway opening on the south shore were lowered approximately 4-5 feet from ~2100 hrs to ~0400 hrs the ensuing day. These manipulations likely resulted in a 0.2-0.4 foot decrease in head and a velocity reduction of approximately 3-4 feet per second at the fishway opening. We are currently reviewing water elevation data in collaboration with USACE staff to refine elevation and velocity estimates. Reductions in flow were also observed (based on depth sensor data) at the main North Powerhouse fishway opening during treatment periods. The sliding gates were not manipulated during the control treatment. Operational constraints and tailwater conditions prevented application of the treatment condition on all scheduled nights and the results are currently under review as part of an effort to improve the operational modification in 2010.

From 26 April through 30 June 2009, 599 Chinook salmon were collected and intra-gastrically radio-tagged at the Adult Fish Facility of Bonneville Dam. All radio-tagged salmon were released approximately nine kilometers downstream from the dam. The movements of radio-tagged salmon were monitored at Bonneville Dam and upstream Columbia River dams (i.e., McNary Dam) as part of continuing research on adult salmon passage, delay, and fallback. 2009 adult salmon evaluations focused on spring and early summer Chinook passage at Bonneville Dam's newly modified Cascade Island entrance. Consequently, the majority of radio-tagged adult salmon passed McNary Dam prior to the lamprey run and entrance velocity manipulation.

We compared approach efficiencies of radio-tagged salmon recorded at McNary Dam during the flow reduction treatment with those recorded during the control treatment (no flow reduction). We additionally evaluated Chinook salmon, steelhead, and sockeye salmon count data for any gross alterations in passage abundance through 2 September 2009. Specifically, we compared the total dam count to the experimental treatment applied on the preceding night (assumes salmonids passed McNary Dam in about one day on average) and statistically evaluated any effects of the reduced flows on count data using a paired T-test (Zar 1999). We evaluated the count data from the Oregon-shore ladder only.

Results

Of the 599 radio-tagged salmon released downstream from Bonneville Dam, 51 were recorded at McNary Dam after the flow reduction trial began. Of the 51 tagged salmon recorded at McNary Dam during the trial, 45 (88%) successfully ascended it. Consistent with observations in prior years, most passage occurred during the daytime when velocities were not manipulated—only 9 of 51 adults were recorded near an entrance during experimental periods. Five unique salmon were recorded making a total of nine fishway approaches during control periods, with only one fishway approach resulted in a fishway entry (Table 1). Similarly, only one fishway approach resulted in a fishway entry after eight fishway approaches were made by four unique salmon during reduced flow periods.

Table 1. Site-specific fishway approaches and entries made by radio-tagged Chinook salmon during Control and Reduced Flow Treatments at McNary Dam in 2009. Also included are the total number of fishway approaches and entries made by the number of unique salmon.

Approach						Total Approaches	Total Entries	No. Unique Fish
Fish ID	Date	Time	Treatment	Site	Approach result in entry?			
15/152	3 July	00:20:07	Control	S. shore	No	9	1	5
15/152	3 July	01:23:45	Control	North PH	No			
18/20	11 July	01:31:07	Control	S. shore	No			
18/20	19 July	03:14:33	Control	S. shore	No			
18/29	11 July	00:56:27	Control	S. shore	No			
22/157	5 July	01:53:39	Control	S. shore	Yes			
22/157	5 July	02:30:02	Control	North PH	No			
22/174	5 July	22:39:23	Control	S. shore	No			
22/174	6 July	02:01:36	Control	S. shore	No			
15/169	3 July	23:53:34	Treatment	S. shore	Yes			
15/182	8 July	21:56:03	Treatment	S. shore	No			
15/182	8 July	22:03:13	Treatment	North PH	No			
18/13	4 July	03:49:04	Treatment	S. shore	No			
18/23	9 July	21:18:34	Treatment	S. shore	No			
18/23	9 July	22:58:02	Treatment	S. shore	No			
18/23	10 July	03:22:36	Treatment	S. shore	No			
18/23	10 July	03:37:38	Treatment	North PH	No			

Evaluations of total dam count data resulted in no significant differences between treatments for Chinook salmon, steelhead, or sockeye salmon (Table 2 and Figure 1).

Table 2. T-test comparison of total dam counts of Chinook salmon, steelhead, and sockeye salmon with one day lag of control and treatment conditions at McNary Dam, 2 July through 2 September 2009.

Species	Condition	Mean	Standard deviation	t	<i>P-value</i>
Chinook salmon	Control	667.2	833.5	-0.240	0.811
	Treatment	712.2	651.1		
Steelhead	Control	1817.2	2427.1	-0.024	0.981
	Treatment	1831.2	2130.2		
Sockeye salmon	Control	1200.8	2179.3	0.323	0.748
	Treatment	1005.8	1996.8		

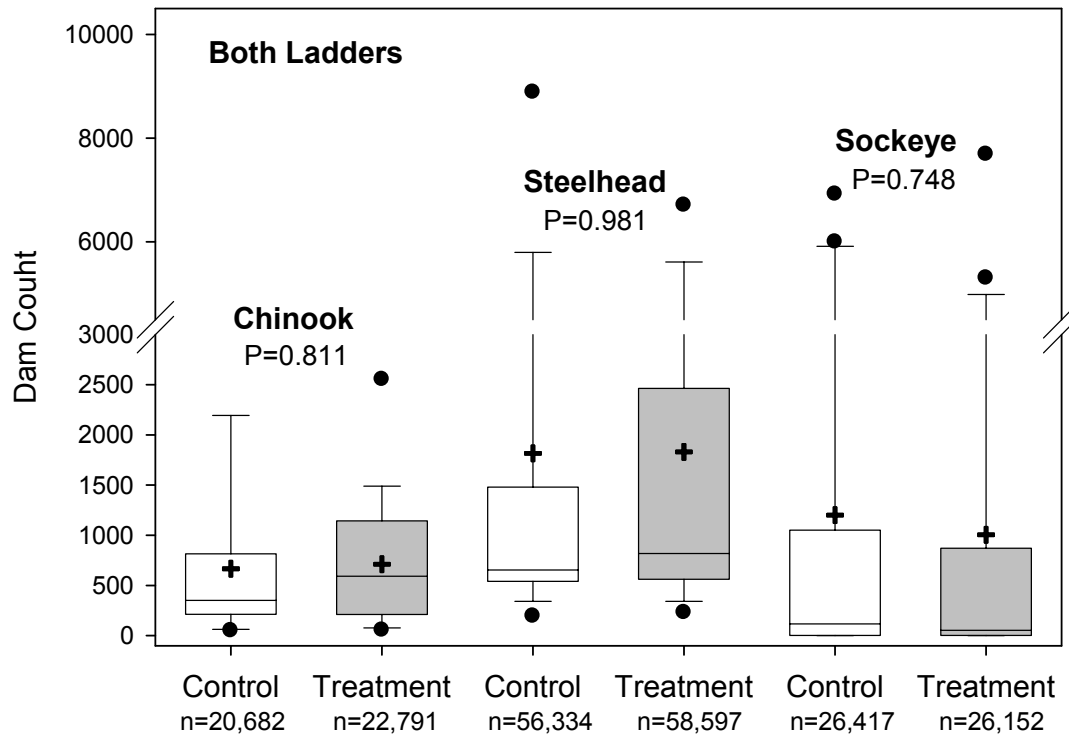


Figure 1. Total dam counts of Chinook salmon, steelhead, and sockeye salmon on days of control and treatment conditions at McNary Dam, 2 July through 2 September 2009. Solid lines within boxes are medians and the plus signs are means.

Evaluations of Oregon shore count data resulted in no significant differences between treatments for Chinook salmon, steelhead, or sockeye salmon (Table 3 and Figure 2).

Table 3. T-test comparison of Oregon shore counts of Chinook salmon, steelhead, and sockeye salmon with one day lag of control and treatment conditions at McNary Dam, 2 July through 2 September 2009.

Species	Condition	Mean	Standard deviation	t	P-value
Chinook salmon	Control	234.1	422.1	0.157	0.876
	Treatment	220.3	258.1		
Steelhead	Control	1321.7	1804.1	0.051	0.960
	Treatment	1300.4	1523.2		
Sockeye salmon	Control	344.9	694.7	-0.254	0.800
	Treatment	394.2	836.5		

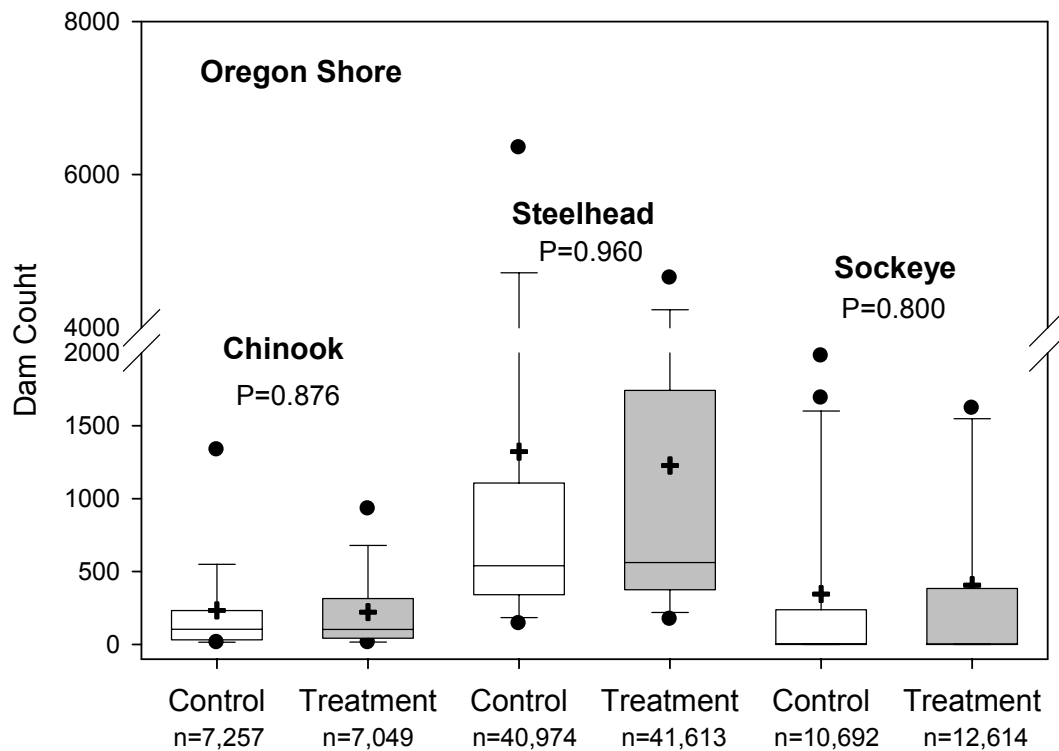


Figure 2. Oregon shore dam counts of Chinook salmon, steelhead, and sockeye salmon during control and treatment conditions at McNary Dam, 2 July through 2 September 2009. Solid lines within boxes are medians and the plus signs are means.

Discussion

This *ad hoc* evaluation found no evidence to suggest that upstream passage of adult salmon was impeded by nighttime flow reductions at McNary Dam in 2009. Relatively few radio-tagged salmon were recorded making fishway approaches at McNary Dam between 2100 hrs and 0400 hrs and the proportions of fishway approaches made by tagged salmon that resulted in entries were roughly equivalent among treatments. However, very low sample size precludes any rigorous conclusion based on the telemetry data. The few fishway approaches observed at McNary Dam during nighttime hours is consistent with extensive radio-telemetry studies conducted by the UI and NMFS (e.g., Keefer et al. 2003, 2007, 2008a, 2008b; 2008c; Burke et al. 2005; Stuehrenberg et al. 2005; Caudill et al. 2007), which have shown that the majority of adult salmonid activity in fishways occurs during daylight hours (Keefer and Caudill 2008).

The evaluation of dam count data also provided no evidence of a velocity treatment effect on adult salmon passage rate. Specifically, there were no significant differences in mean daily dam count between treatments. This result suggests that nighttime flow reductions at McNary Dam in 2009 did not adversely affect salmonid passage. The use of dam counts to make inferences about subtle treatment effects can be problematic, however, due to substantial mismatch between

the application of treatment at the entrances and observation of fish counts near the tops of ladders. For instance, many salmonids counted at the dam likely never made approaches at affected fishway openings during the treatment application intervals, while others may have experienced more than one treatment. Nonetheless, there was no evidence of slowed passage on the days following the application of the treatment and it seems implausible that there was a very large treatment effect (e.g., altered passage rates of 100s of adults per day) related to the lowered nighttime entrance velocities.

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