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EFFECTS OF SPILL IN FALL ON PASSAGE OF ADULT STEELHEAD AT JOHN DAY DAM, 1997

A report for Project MPE-P-95-1

by

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Abstract

A study was conducted in 1997 to determine the effects of low levels of daytime spill during the early fall on use of the north-shore fishway by steelhead at John Day Dam. Passage of steelhead with transmitters were monitored at the dam during alternating periods with and without daytime spill at the north end of the spillway. We found no significant difference in the proportion of steelhead that first approached and first entered the north-shore entrance (NSE), or eventually passed the dam using the north-shore fishway on days with and without spill. Likewise, median passage times for steelhead to first approach, first enter, and pass the dam using the north-shore fishway were not significantly different with and without spill. Spill levels used during the study averaged 1.7 kcfs, or about 1% of river flow on days with spill, and were insufficient to counter the outflow from the powerhouse near the south shore.

Introduction

Steelhead passing John Day Dam on the Columbia River have been observed to hold up and exhibit jumping behavior in the south-shore fish ladder (Figure 1). The area of concern is the upstream section of the ladder that contains the vertical-slotted weirs. Spilling water through the north end of the spillway during the summer and early fall may be one way to attract more steelhead to pass the dam using the north-shore ladder, and so avoid the south-shore ladder. In 1997, a study was conducted at John Day Dam to evaluate the effectiveness of daytime spill at the north end of the spillway to attract steelhead to the north-shore ladder. Passage of steelhead with radio transmitters was monitored during alternating periods with and without spill at the dam.

Methods

The effects of daytime spill on use of the north-shore ladder at John Day Dam were evaluated by monitoring passage of radio-tagged steelhead from 1 September until the end of October 1997 during which daytime spill at the north end of the spillway was alternated with periods with no spill almost daily (Figure 2). All fish used for this study were collected and outfitted with radio transmitters at Bonneville Dam (Figure 1) and released 8 km downstream from Bonneville Dam as part of the lower Columbia River Adult Passage Study funded by the COE and Bonneville Power Administration (BPA). Radio transmitters and receivers used in this study were manufactured by Lotek Engineering Inc[1]., of New Market, Ontario, Canada. Transmitters used were 83 mm long x 16 mm diameter, or 43 mm x 14 mm, depending on size of fish tagged, with a 43 cm wire antenna. Transmitters emitted a digitally coded signal every 5 seconds. Transmitter signals were interpreted by radio receivers as a unique numerical code on the transmitted channel (frequency). Transmitter frequencies ranged from 149.480 (channel 9) to 149.740 MHz (channel 22) in 0.02 MHz increments. SRX-400 sequentially scanning receivers, set to scan for 6 seconds on each channel, were connected to 9-element Yagi antennas placed on each shore 1.9 km downstream from the dam to record when fish entered the tailrace. Seven SRX receivers linked with

[1] Provided for information only, does not signify endorsement.

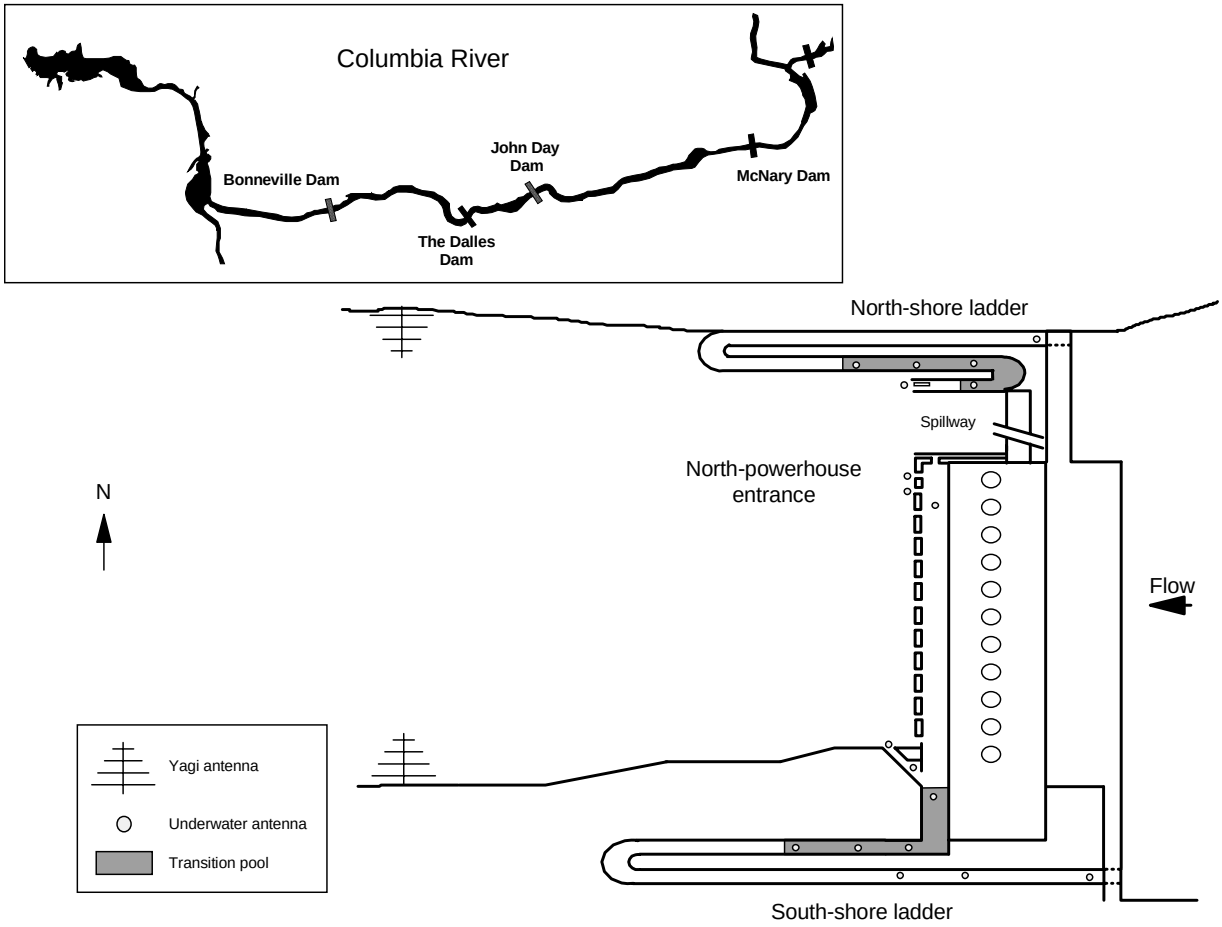

Figure 1. Placement of aerial and underwater antenna for radio receivers used at John Day Dam during 1997 and location of John Day and Bonneville dams on Columbia River (inset).

digital-spectrum processors (DSP/SRX), that scanned all channels simultaneously, were connected to underwater antenna to determine when fish approached and entered the north-shore entrance (NSE), north-powerhouse entrance (NPE), and the south-shore entrance (SSE), and when fish exited from the top of the north-shore and south-shore ladders (Figure 1). Orifice gates were not monitored at John Day Dam in 1997.

Evaluations of daytime spill at John Day Dam in 1997 focused on the proportion of all steelhead at the dam that first approached and first entered at the north-shore entrance and passed the dam using the north-shore ladder, and on times for steelhead

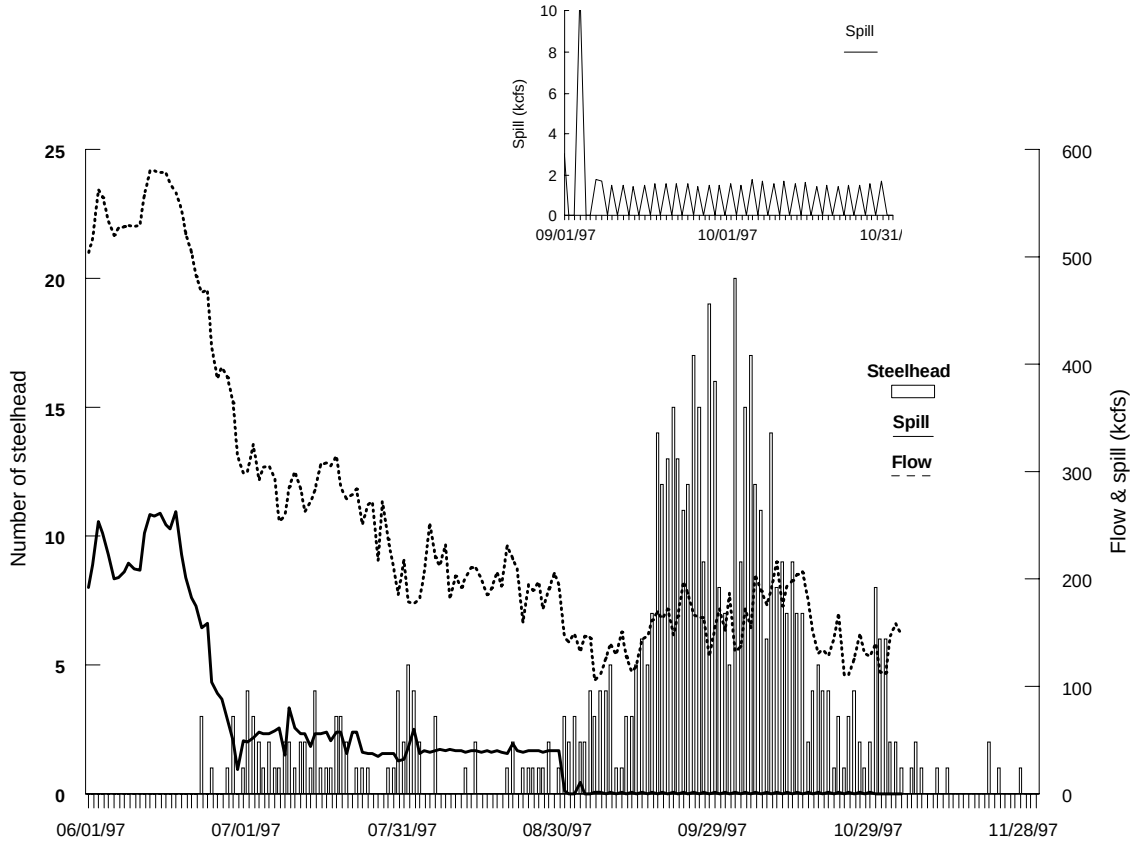

Figure 2. Number of steelhead on date they first were recorded in the tailrace, and river flow and spill levels at John Day Dam in 1997. A magnification of spill levels during study period shown at top of figure.

to first approach and first enter the north-shore entrance and to pass the dam using the north-shore ladder during periods with and without spill. Comparisons of passage times were based on spill condition (spill or no spill) at the time the steelhead first entered the tailrace of the dam. Comparisons of where steelhead first approached and first entered fishways were based on spill condition at the time first approaches and first entries were made. Comparisons of the proportion of steelhead that used the north-shore ladder to pass the dam were based on spill condition at the time the fish made their last entrance at NSE prior to passing the dam.

From 1 September to 31 October 1997, water was alternately spilled and not spilled at the north end of the spillway in 29 blocks lasting one to two days each. Daytime spill averaged 1.7 kcfs (sd = 1.7 kcfs), or about 1.1% of mean river flow during the study.

Water was generally not spilled after dark during the study. The proportion of first approaches and first entrances that occurred at NSE, and the proportion of steelhead that passed the dam using the north-shore ladder during each block with and without spill were compared using a blocked analysis of variance (ANOVA) (Proc GLM, SAS Institutes Inc. 1990). Proportions were arc sine transformed when needed to normalize data. Treatment blocks that contained five or more fish with first approaches, first entries, or that passed the dam were used in analysis the proportional use of the north-shore fishway, resulting in 17 to 18 replicate blocks of spill treatment. Median passage times for steelhead that first approached, first entered, and passed the dam using the north-shore fishway were pooled across blocks because of the low frequency of fish that used the north-shore ladder during each block. Median passage times were compared with respect to spill treatment (spill versus no spill) using the 2-sample test of medians (Proc NPAR1WAY, SAS Institutes Inc. 1990). In this procedure, individual data points were scored as a 1 if they were above the overall median, or 0 if they were below the overall median. Scores were then totaled for each treatment and compared using a normalized Z score.

Results

Locations of first approaches and entries into fishways, and passage times of steelhead at the dam were similar with and without daytime spill during the early fall at John Day Dam in 1997. During 1 September to 31 October, water was alternately spilled and not spilled a total of 29 times, during which 472 steelhead with transmitters were recorded at John Day Dam (Figure 2). There were 440 steelhead that were recorded in the tailrace prior to making their first approach at the dam, of which an mean of 43% (95% confidence interval = $\pm$ 10%) were first recorded on the north shore on days with spill and 49% ($\pm$ 11%) were first recorded on the north shore during periods of no spill (ANOVA P = 0.4440, n = 17).

Times from first record in the tailrace to first approach at NSE were analyzed for 61 steelhead (Figure 3). Median times for steelhead to first approach the dam at NSE with and without spill were 2.6 h and 2.5 h, and these values did not differ significantly based on the outcome of the test of medians (P = 0.6210). There were 464 first approaches of steelhead at the dam during the study, 212 during periods with spill and

252 when no spilled occurred. With spill, an average of 19% (± 6%) of the steelhead at the dam made their first approaches at NSE as compared to 16% (± 7%) that first approached at NSE when there was no spill (ANOVA P = 0.4414, n = 16) (Table 1).

Times from first record in the tailrace to first entrance at NSE were analyzed for 63 steelhead (Figure 3). Median times to first entrance at NSE with and without spill were 5.2 h and 3.7 h and these values did not differ significantly (P = 0.8691). There were 456 first entries by steelhead to the north-shore fishway, 205 with spill and 251 without spill. With spill, an mean of 21% (± 8%) of the steelhead at the dam first entered at NSE, as compared to 15% (± 7%) that first entered at NSE without spill (ANOVA P = 0.3023, n = 17).

Times from first record in the tailrace until the steelhead exited from the top of the north-shore ladder were analyzed for 86 steelhead. Median times to pass the dam through the north-shore ladder with and without spill were 16.2 h and 20.3 h and these values did not differ significantly (P = 0.0855). There were 424 steelhead that passed the dam during the study (including fish that fell back and passed the dam more than once), 230 with spill and 194 without spill. With spill, an average of 26% (± 8%) of the salmon passed the dam using the north-shore ladder, as compared to 17% (± 7%) that passed via the north-shore ladder without spill (ANOVA P = 0.0631, n = 17).

Conclusions

We found little evidence that spill at levels used during the 1997 study significantly improved passage for steelhead at John Day Dam. There were no significant differences in use of the NSE nor were there significant differences in median passage times for steelhead that first approached and first entered NSE and passed the dam using the north-shore ladder with and without spill. The proportion of steelhead that first approached and first entered NSE, and that eventually passed the dam using the north-shore ladder was consistently higher during spill periods than during periods without spill, but differences were not statistically significant. Nearly half the steelhead first entered the tailrace at John Day Dam along the north shore, but only 16-17% first approached the dam at the north-shore fishway. Spill levels during this study were

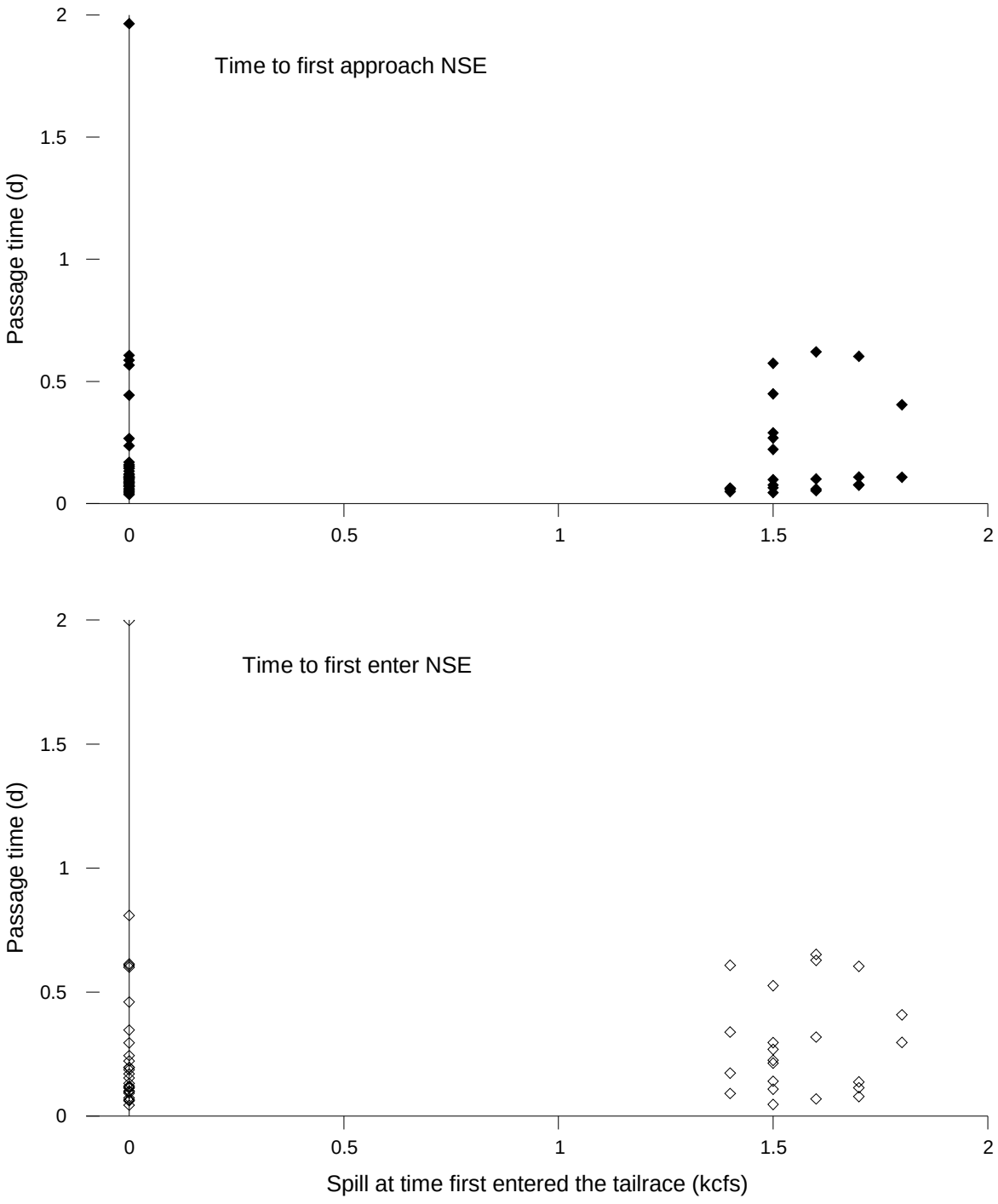

Figure 3. Passage time for steelhead to first approach and first the enter north-shore entrance (NSE) versus spill level at John Day Dam during 1 September to 31 October 1997.

Table 1. Replicate blocks used during analysis, spill level and dates of spill treatments completed during 1997, number of first approaches at dam , and proportion of fish at dam that first approached the north-shore entrance (NSE) during blocks.

Block	Spill (kcfs)	Dates	First approaches at dam	Proportion of first approaches at NSE
	3.0	1 Sept.	2	0
	0	2-3 Sept.	4	0
	11.0	4 Sept.	4	0
1	0	5-6 Sept.	6	0
1	1.8, 1.7	7-8 Sept.	8	0
	0	9 Sept.	4	0
	1.5	10 Sept.	4	0
	0	11 Sept.	3	0
	1.5	12 Sept.	0	-
	0	13 Sept.	3	0
	1.4	14 Sept.	6	0
	0	15 Sept.	4	0.250
2	1.5	16 Sept.	6	0.333
2	0	17 Sept.	7	0.429
	1.6	18 Sept.	4	0
3	0	19 Sept.	17	0
3	1.6	20 Sept.	13	0.154
4	0	21 Sept.	18	0.056
4	1.6	22 Sept.	11	0.091
5	0	23 Sept.	14	0.214
5	1.6	24 Sept.	15	0.133
6	0	25 Sept.	12	0
6	1.4	26 Sept.	14	0.214
7	0	27 Sept.	20	0
7	1.5	28 Sept.	12	0.250
8	0	29 Sept.	17	0.118
8	1.5	30 Sept.	19	0.263
9	0	1 Oct.	8	0.250
9	1.6	2 Oct.	9	0.333
	0	3 Oct.	3	0.333
10	1.5	4 Oct.	15	0.200
10	0	5 Oct.	12	0.167
11	1.8	6 Oct.	15	0.133
11	0	7 Oct.	18	0.222
12	1.7	8 Oct.	12	0.333
12	0	9 Oct.	14	0.357
13	1.6	10 Oct.	5	0
13	0	11 Oct.	16	0.188

Table 1. Continued.

Block	Spill (kcfs)	Dates	First approaches at dam	Proportion of first approaches at NSE
14	1.7	12 Oct.	8	0.250
14	0	13 Oct.	9	0.111
15	1.6	14 Oct.	8	0.125
15	0	15 Oct.	12	0.083
16	1.7	16 Oct.	5	0.200
16	0	17 Oct.	7	0.286
	1.4	18 Oct.	3	0.667
	0	19 Oct.	4	0
	1.5	20 Oct.	4	0
	0	21 Oct.	3	0
	1.5	22 Oct.	1	0
	0	23 Oct.	2	0
	1.5	24 Oct.	4	0.250
	0	25 Oct.	2	0
	1.5	26 Oct.	2	0
	0	27 Oct.	3	0
	1.6	28 Oct.	2	0
	0	29 Oct.	3	0.333
	1.7	30 Oct.	1	0
	0	31 Oct.	7	0.143
Mean	0		n = 16	0.188
	1.7		n = 16	0.155

about 1% of river flow, with the remaining flow passing through the powerhouse near the southern shore. The level of spill used during this study was insufficient to counter the attractive flow coming from the powerhouse. Columbia River flows were also above average in 1997. Effects of spill during summer and early fall on passage of steelhead at John Day Dam during low flow years may vary from that observed during this study.