Decision Document on the Use of Spill at John Day Dam as a Means of Improving Survival of Juvenile Salmon Migrants

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Background

From 1999-2003, spill was evaluated at John Day Dam as a way to improve the survival of juvenile salmonids that pass the project. Each year, an alternative spill treatment was compared to a status quo spill operation called for in the Federal Columbia River Power System Biological Opinion (BIOP). The BIOP spill operation consists of no spill during the daytime and spilling 60% of the total river discharge or spill to the total dissolved gas cap for 12 hours at night. The total dissolved gas (TDG) cap is 120% TDG saturation as measured in the tailrace of John Day Dam, and 115% TDG saturation as measured at the forebay of the next downstream dam (The Dalles). Fish passage metrics that were used to compare treatments included survival, fish passage efficiency (FPE), forebay retention time, and tailrace egress. Fish passage efficiency is the proportion of fish that pass the dam via non-turbine routes. Forebay retention time is the time that elapses between first forebay detection of radio-tagged fish, and passage. Tailrace egress is a description of fish travel paths in the immediate dam tailrace, and travel times from passage to downstream exit stations. Radio telemetry methods were used to evaluate the operational changes and are described in Beeman et al. (2001), Counihan et al. (2000, In review [A], In review [B]), and Leidtke et al. (2001). Test treatments and species evaluated for each year are presented in Table 1.

Table 1. Test treatments, species tested, and metrics measured for John Day Dam spill evaluations from 1999-2000. For most years 60% night spill was superseded by the TDG cap. CH-1 = yearling Chinook, CH-0 = sub-yearling Chinook, HST = hatchery steelhead, WST = wild steelhead.

Year	Season	Spill Treatment (Day%/Night%)	Species	Metrics
1999	Spring	30/45 vs. 0/45 (BIOP)	CH-1, HST	FPE, egress, forebay retention time, survival feasibility
2000	Spring	30/53 vs. 0/53 (BIOP)	CH-1, HST	Survival, FPE, forebay retention, egress.
	Summer	30/53 vs. 0/53 (BIOP)	CH-0	FPE, forebay retention, egress
2001	Spring	No treatments	CH-1, HST	Survival (JBS only)
	Summer	No treatments	CH-0	Survival (JBS only)
2002	Spring	30/30 vs. 0/54 (BIOP)	CH-1, WST	Survival, FPE, forebay retention, egress
	Summer	30/30 vs. 0/54 (BIOP)	CH-0	Survival, FPE, forebay retention, egress
2003	Spring	0/45 vs. 0/60 (BIOP)	CH-1	Survival, FPE, forebay retention, egress
	Summer	30/30 vs. 0/60 (BIOP)	CH-0	Survival, FPE, forebay retention, egress

In developing these studies, the regional salmon managers agreed that the primary measure of success for alternative spill operations would be improved juvenile salmonid dam passage survival. In addition, there was agreement that at least two years of evaluations that indicated a survival benefit were needed to select an alternative operation to the BIOP operation. As seen from Table 1, there are three years of survival studies that compare alternative operations with the BIOP spill for yearling Chinook salmon (2002 and 2003), and two years of survival studies that compare 12 h (BIOP spill) with 24h spill for summer migrants (2002 and 2003). .

Study Results

Survival Estimates

Survival estimates for all routes and all three years are presented in Table 2. For yearling Chinook salmon and steelhead, no positive significant differences were detected between the treatments evaluated, suggesting that deviating from the recommended BIOP spill operations would not result in a dam survival benefit for these species. For sub-yearling Chinook significant differences between the treatments were documented and suggest that the estimated dam passage survival during the 24-hour spill treatment was greater than for the 12-hour spill operation in 2002 and 2003 (4-6% improvement).

Table 2. Radio telemetry-based survival estimates for juvenile salmonids passing John Day Dam, 2000 – 2003. RSS = route specific survival model estimates (Skalski et al. 2002); PR = paired release survival model estimates ((Burnham et al. 1987). Survival estimates are from Counihan et al. (2002; In Review [A]; In Review [B]; In Review [C])

YEAR	SPECIES	ROUTE (model)	% SPILL (day/night)	SURVIVAL *(95% CI)*
2000	Yearling Chinook	Dam (PR)	0/53	97.6% *(90.9 - 104.3)*
			30/53	93.5% *(87.8 - 99.2)*
		Spillway (PR)	0/53	98.6% *(92.5 - 104.7)*
			30/53	93.7% *(87.6 - 99.8)*
	Steelhead	Dam (PR)	0/53	95.7% *(91.6 - 99.8)*
			30/53	90.4% *(83.7 - 97.1)*
		Spillway (PR)	0/53	98.8% *(96.1 - 101.5)*
			30/53	90.5% *(84.0 - 97.0)*
2001	Yearling Chinook	JBS (PR)	0/30	93.2% *(89.0 - 97.4)*
	Steelhead	JBS (PR)	0/30	91.7% *(87.7 - 95.7)*
	Subyearling Chinook	JBS (PR)	0/0	86.8% *(78.4 - 95.2)*
2002	Yearling Chinook	Dam (RSS)	0/54	92.9% *(89.5 - 96.3)*
			30/30	96.3% *(93.0 - 99.6)*
		Spillway (RSS)	0/54	99.3% *(95.8 - 103)*
			30/30	100.0% *(96.5 - 104)*
		JBS (RSS)	0/54	91.1% *(85.7 - 95.9)*
			30/30	99.1% *(94.0 - 103)*
		Turbine (RSS)	0/54	77.8% *(67.3 - 87.0)*
			30/30	83.2% *(74.4 - 90.9)*
	Steelhead (unclipped)	Dam (RSS)	0/54	94.0% *(88.7 - 99.3)*
			30/30	91.5% *(86.2 - 96.8)*
		Spillway (RSS)	0/54	95.8% *(89.9 - 100)*
			30/30	93.2% *(85.7 - 98.8)*
		JBS (PR)	54 (night)	88.2% *(82.2 - 94.2)*
			30 (night)	92.6% *(85.9 – 99.3)*
		Powerhouse (RSS)	0/54	93.0% *(84.7 -99.5)*
			30/30	89.9% *(80.7 – 96.7)*
	Subyearling Chinook	Dam (RSS)	0/54	92.8% *(88.5 - 97.1)*
			30/30	99.2% *(94.1 - 104.3)*
		Spillway (RSS)	0/54	98.5% *(93.4 - 102.3)*
			30/30	100.3% *(98.3 - 107.8)*
		Powerhouse (RSS)	0/54	86.6% *(79.5 - 92.8)*
			30/30	96.6% *(88.5 - 103.1)*
2003	Yearling Chinook	Dam (RSS)	0/45	92.2% *(87.5 - 96.9)*
			0/60	94.0% *(89.9 - 98.1)*
		Spillway (RSS)	0/45	93.9% *(90.3 - 96.7)*
			0/60	93.4% *(90.0 - 96.3)*
		JBS (RSS)	0/45	98.8% *(95.9 - 100.8)*
			0/60	101.9% *(99.6 - 103.6)*
		JBS (PR)	45 (night)	84.8% *(79.2 - 90.4)*
			60 (night)	76.4% *(71.3 - 81.5)*
		Turbine (PR)	0 (day)	89.1% *(82.9 - 95.3)*
			45 (night)	80.7% *(77.2 - 84.2)*
	Subyearling Chinook	Dam (RSS)	0/60	84.5% *(81.4 - 87.6)*
			30/30	88.6% *(85.6 - 91.6)*
		Spillway (RSS)	0/60	90.1% *(87.7 – 92.2)*
			30/30	95.5% *(93.8 – 97.0)*
		JBS (RSS)	0/60	89.2% *(85.5 – 92.4)*
			30/30	92.1% *(87.7 – 95.5)*
		Turbines (RSS)	0/60	71.9% *(67.1 – 76.4)*
			30/30	72.2% *(67.3 – 76.7)*

Fish Passage Efficiency

Fish passage efficiency (FPE) is the proportion of fish that pass the dam via non-turbine routes (e.g. spillway and bypass system). The FPE results from 1999 – 2003 are presented in Table 3. For spring migrants, 24-hour spill had no significant effect on FPE in all years tested for all species. For sub-yearling chinook, however, there was a significant increase in FPE under the 24-hour spill treatment in 2000. The effect of 24-hour spill on passage distribution for most of the tests was to redistribute passage between the bypass system and spillway, with more fish passing the spillway under 24-hour spill and more passing the bypass system under 12-hour spill.

Table 3. Estimated percent fish passage efficiency (FPE) during studies of spill at John Day Dam from 1999 to 2003. The 95% likelihood ratio confidence intervals are in parentheses following the point estimates. Bolded estimates for 2000 subyearling Chinook are significantly different.

Treatment (day%/night%)	Year	Yearling Chinook	Juvenile Steelhead	Subyearling Chinook
12-h (0/45)	1999	82.5 (75.5, 88.1)	94.2 (88.9, 97.5)	na
24-h (30/45)	1999	87.5 (81.4, 92.2)	90.4 (84.6, 94.5)	na
12-h (0/53)	2000	84.6 (74.8, 91.8)	93.0 (89.0, 96.0)	**78.7 (71.5, 84.9)**
24-h (30/53)	2000	91.3 (83.7, 96.2)	91.3 (87.2, 94.5)	**91.1 (86.0, 94.9)**
12-h (0/54)	2002	84.1 (79.8, 87.9)	85.2 (77.8, 90.9)	71.8 (67.8, 75.6)
24-h (30/30)	2002	79.9 (75.3, 84.1)	89.9 (82.2, 95.2)	70.4 (66.6, 74.0)
12-h (0/60)	2003	85.7 (83.0, 88.2)	na	na
12-h (0/45)	2003	83.6 (80.6, 86.4)	na	na
12-h (0/60)	2003	na	na	70.7 (64.7, 76.4)
24-h (30/30)	2003	na	na	74.8 (69.5, 79.7)

Forebay Behavior

Forebay retention time, which is the amount of time that elapses between first forebay detection and passage, was estimated as part of the FPE and survival studies. Yearling Chinook and steelhead spent significantly more time in the forebay in 1999 and 2000 under the 12-hour spill condition but did not show a difference in 2002. Analysis of 2000 survival data did not show a relationship between survival (from Rock Creek to John Day Dam) and forbay retention time (Counihan 2002). 24-hour spill reduced sub-yearling Chinook forebay residence times in 2000 and 2003, but had no measurable effect in 2002.

Tailrace Egress

Time to exit the immediate tailrace area, and the paths that radio-tagged fish took in the tailrace were evaluated for fish that exited the juvenile bypass system. Yearling Chinook salmon, steelhead trout, and sub-yearling Chinook released through the juvenile bypass system had median travel times to an exit station, located 1.9 km downstream, that were about twice as long under 60% spill, than during 30 or 45% spill. Travel paths of fish exiting the bypass system during 60% spill were predominantly northward across the river toward the spillway. Many of these fish spent time in a large eddy that forms between the spillway and the powerhouse. At the same time, the estimated survival for yearling and sub-yearling Chinook that passed through the juvenile bypass system was lower under the 60% spill than during 30% spill, suggesting that the delay or different route subjected these fish to increased predation opportunities. Most fish exiting the bypass system under 30 and 45% spill traveled directly downstream. Figure 1 shows typical travel routes and times for fish exiting the juvenile bypass system during 60% and 45% spill treatments.

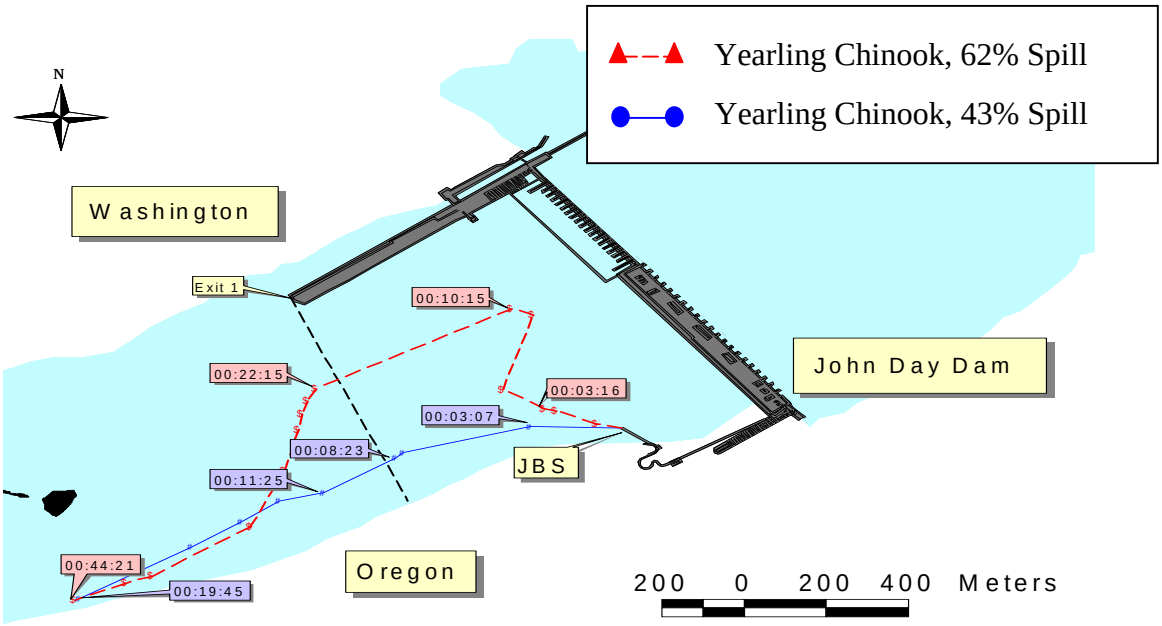

Figure 1. Travel routes of two hatchery yearling Chinook salmon released through the juvenile bypass system at John Day Dam, spring 2003. The travel route displayed with solid lines and circles represents a fish released during a total flow of 244 kcfs and a total spill of 105 kcfs (43%). The travel route shown with dashed lines and triangles represents a fish released during a total flow of 228 kcfs and a total spill of 141 kcfs (62%). Time stamps are the elapsed time from release to the point indicated. Each point represents a fish location collected via boat tracking.

Turbine Survival

Survival estimates for radio-tagged fish passing the John Day Dam turbines are among the lowest observed within the Federal Columbia River Power System. Turbine survival estimates (Route Specific Survival Model) for yearling and subyearling Chinook salmon ranged from 71.9% to 83.2% in 2002 and 2003. Turbine survival estimates for Columbia and Snake River dams more commonly fall within the 85% to 95% range (USACE 2003).

Effects on Adult Passage

Adult salmon and steelhead were tagged with radio transmitters downstream from John Day Dam and monitored as they passed the dam during the spill tests. The purpose of this was to determine whether changing spill operations increased the proportion of adult migrants falling back over the dam. The proportion of adult salmon and steelhead that fell back in 2000 and 2002 was 2% higher under 24-hour spill treatments than under BIOP Spill. The difference was not statistically significant. Most fish fell back in April through June (C. Peery, University of Idaho, pers. comm.).

Conclusions

- Three years' of spill evaluations have not found a spill operation that increases yearling chinook and steelhead dam passage survival rates beyond that provided by BIOP spill. The one significant difference found was for steelhead spillway survival in 2002: dam survival under 24-hour spill was significantly less than survival under BIOP spill.
- For subyearling Chinook, two years' of evaluations comparing BIOP to 24-hour spill have shown a significant dam passage survival (~4-6%) increase for 24-hour spill.
- Spilling for 24-hours per day does not reduce the proportion of turbine entrained yearling Chinook and steelhead. The effect of increasing spill duration on spring fish distribution is to reduce the proportion of fish passing the juvenile bypass system and increase the proportion of fish passing the spillway.
- Higher spill percentages affect fish egress at the bypass system outfall. This coincided with lower survival rates for fish released into the bypass in 2002.
- Turbine survival is much lower than at other Snake and Columbia River dams.
- Spilling for 24-hours per day did show a trend toward increasing adult salmon and steelhead fallback rates by about 2%, however the increase was not statistically significant and most fallbacks occurred during the spring.

Recommendations

Based on results from the recent spill passage research by USGS, the Corps has adopted a 24-hour spill operation at John Day Dam for summer-migrating subyearling Chinook salmon. In the springtime, the BIOP spill operation will remain the status quo. Survival estimates of fish passing through turbine units and under some operations the juvenile bypass system suggest that there is good potential for additional survival improvements. The Corps has explored a number of alternatives to reduce the proportion of fish passing through turbine units, including extended-length turbine intake screens, surface flow bypass systems, and surface spill options. These alternatives, along with new alternatives to improve tailrace and turbine passage conditions need to be analyzed in the context of the most recent passage research. From this analysis, a plan to fill existing information gaps and proceed with future survival improvements should be developed.

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