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Expected Effects of 2001 Water Conditions and Alternative Summer Spill Operations on Juvenile Fish Survival Through the FCRPS

National Marine Fisheries Service
Hydro Program

Summary of Analysis

The National Marine Fisheries Service (NMFS) evaluated expected survival of both ESA-listed and non-listed juvenile salmon through the Federal Columbia River Power System (FCRPS) in 2001 using the Simulated Passage (SIMPAS) spreadsheet model. This model was the basis of juvenile fish survival estimates included in the December 21, 2000, FCRPS Biological Opinion (hereafter, 2000 Biological Opinion). This analysis compared juvenile fish survival expected from full implementation of the 2000 Biological Opinion, including the NMFS spill program, given the likely 2001 summer flow conditions, with juvenile survival expected from three alternative operations as a result of reduced spill rates, as well as a no spill condition. The comparative analysis shows relative differences in in-river survival for both ESA-listed and non-listed juvenile fall chinook salmon for various alternative spill operations. NMFS also compared the results for ESA-listed fish with the multi-year average Acurrent@ juvenile survival rate described in the 2000 Biological Opinion, as well as with the average juvenile survival rate expected in 10 years as a result of full implementation of hydro actions in the reasonable and prudent alternative (RPA) to provide a long-term context.

Summary of Results

The anticipated reduced survival of this summer=s low flow and curtailed spill operation on both listed Snake River (SR) and non-listed Columbia River fall chinook salmon is expected to be significant. In-river survival rates in 2001 for summer migrating fish are estimated to be much lower than the average survival rates projected in the NMFS 2000 Biological Opinion because of the anticipated extreme low flow conditions this summer associated with low snowpack, low runoff[1] and expected warm water temperatures. Low flows prolong the migration time through the reservoirs, which increases the exposure time of juvenile salmon to predation and higher water temperatures. Elevated water temperatures increase the predation rate and susceptibility of salmon to disease.

[1] The National Weather Service-Northwest River Forecast Center=s final June runoff volume forecast for the January-July period for the Columbia River at The Dalles is only 55.5 million acre-feet (Maf), or 52% of average.

A summary of in-river survival estimates for both listed and non-listed fall chinook stocks is presented in Table 1. For SR fall chinook, this table assumes in-river survival as a percent of the total number of fish arriving at the head of Lower Granite reservoir. Assuming Biological Opinion spill levels, in-river survival rates for listed SR fall chinook are expected to be near the lower end of the range considered in the Biological Opinion. If spill operations are reduced from Biological Opinion levels, in-river survival rates will be depressed from over 1 to nearly 7% depending on the spill reduction, relative to survival under Biological Opinion spill levels. If summer spill is eliminated altogether, in-river survival will be reduced by 16% compared to the estimated survival with Biological Opinion spill.

A similar summary of in-river survival estimates for listed SR fall chinook is presented in Table 2. Note that Table 2 assumes in-river survival as a percent of the total number of fish arriving at Lower Granite Dam. Assuming Biological Opinion spill levels, the in-river survival rate from Lower Granite to Bonneville Dam for listed SR fall chinook is expected to be 17%. If spill operations are abridged from Biological Opinion levels, in-river survival rates will be reduced from over 1 to 7% relative to survival under Biological Opinion spill levels. If summer spill is eliminated, in-river survival will be reduced by about 17% compared to the estimated survival with Biological Opinion spill.

Mid-Columbia River (Hanford Reach) fall chinook is a non-listed stock of considerable importance to both commercial and tribal fisheries. It is estimated that roughly half of this stock will be transported at McNary Dam and half will remain in-river. Survival rates for those fish remaining in-river, which migrate through the four lower Columbia River dams and reservoirs, are expected to range from 1-4% lower under the various reduced spill operations, when compared to survival under Biological Opinion spill levels. The juvenile fish survival analysis indicates the effect of not providing any spill this summer for fish passage at lower Columbia River dams will decrease in-river survival for this stock by 14% relative to survival under Biological Opinion spill.

Deschutes River fall chinook is another non-listed summer migrating stock of interest. All of these fish will remain in-river to migrate through The Dalles and Bonneville projects on the lower Columbia River, e.g., none are subject to collection and transportation. In-river survival rates for this stock are expected to be about 1% lower under each of the various reduced spill operations, relative to survival under Biological Opinion spill levels. The survival analysis indicates the effect of not providing any spill this summer for fish passage at The Dalles and Bonneville dams would decrease in-river survival for this stock by 11% relative to survival under Biological Opinion spill.

A summary of total *system* survival estimates for SR fall chinook (including transported fish) is presented in Table 3. Expected system survival (transported plus in-river survival, including some delayed effects of transportation) for SR fall chinook migrating from the head of Lower Granite reservoir in 2001 is projected to be about 3.6%, which is less than 30% of the average survival level estimated in the opinion. Alternatively, expected system survival for this listed stock, based instead on the number of fish arriving at Lower Granite Dam in 2001, is projected to

be about 19.2%. Based on total system survival, it appears there is little difference among alternative spill operations. There are several explanations for this apparent result. First, a large proportion of the starting population above Lewiston, Idaho of this ocean-type chinook stock is not expected to survive through the Lower Granite project under the expected very low summer flow and water temperature conditions. In addition, most (nearly 80%) of the total number of fish surviving to Lower Granite Dam will be transported from the four collector dams, leaving about 21% to migrate in-river. Both affect the system survival estimates of different spill regimes in the lower Columbia River because both affect the number of SR fall chinook migrating in-river below McNary Dam. It is estimated that from 1.5 to 17% of non-transported SR fall chinook will survive to below McNary Dam and would benefit from summer spill in the lower Columbia River.

Moreover, there are significant uncertainties associated with this analysis which suggest that the conclusion of little reduction in total system survival for SR fall chinook should be viewed with caution. For example, because this species has not been the subject of formal transportation studies, considerable uncertainty exists regarding the differential post-Bonneville Dam survival of transported SR fall chinook salmon, relative to post-Bonneville survival of non-transported fish.[2] In the 2000 Biological Opinion (Section 6.2.3.3.1), NMFS reviewed the various alternative assumptions and methods used to estimate AD@ for this listed stock and found that the PATH estimate of D = 0.24 represents the best fall chinook D-estimate currently available. However, the uncertainty regarding the quantitative estimates of transport survival used in the survival analysis suggests those estimates should be considered with caution.

There are also significant uncertainties affecting the survival analysis for in-river migrants. The analysis does not take into account unquantifiable effects, including latent mortality associated with delays in passing FCRPS projects, increased predation rates, and added stress and mortality associated with warm water conditions that are likely to occur during the low summer flows expected this year.

Methods

A full description of the SIMPAS model and parameter assumptions is included in Appendix D of the 2000 FCRPS Biological Opinion. With the exception of the various spill operations defined below, the spreadsheet was set up essentially as it was for the 2000 Biological Opinion analysis.

This analysis compared juvenile salmon survival, given expected summer 2001 low flow conditions, under five operational scenarios. The first operation (Full BiOp Spill) included summer spill levels anticipated with full implementation of the NMFS 2000 Biological Opinion. The reduced spill operations included different spill levels based on four levels of available system storage (800, 600, 400 and 200 MW-months) under consideration as contingency spill

[2] This post-Bonneville survival ratio is referred to as AD.@

operations this summer by the FCRPS action agencies (see Table 4: Spill Summary). These contingency spill operations reduce the summer spill levels in Table 9.6-3 of the 2000 Biological Opinion in varying amounts at the non-collector dams, e.g., Bonneville, The Dalles, John Day and Ice Harbor dams. At the extreme low flow levels expected in 2001, powerhouse minimum flow requirements often limit the amount of available fish spill. The sixth operation eliminates all summer spill for fish passage, e.g., operate the hydrosystem to meet power load only.[3]

For each of these spill operations, and based on Bonneville Power Administration=s (BPA) recent hydrosystem analysis of expected flows, NMFS assumed that the average summer flow in 2001 would be 26 kcfs in the Snake and 88 kcfs in the lower Columbia River. Given that this year=s runoff in the Columbia Basin is forecasted to be the second lowest on record (only 52%), these expected flows are considerably lower than flows that were evaluated by NMFS during the 2000 Biological Opinion consultation.

[3] BPA has stated that a January-July runoff volume at The Dalles of 53.3 Maf is the threshold below which BPA cannot simultaneously maintain financial solvency, meet its firm loads, maintain spill for fish passage, keep storage reservoirs from drafting below summer draft limits and have sufficient resources to meet long-term demand.

The expected seasonal average flows described above were used to define key dam passage parameters in the SIMPAS analysis (e.g., some spill levels were limited by powerhouse minimums, as described above). However, the SIMPAS spreadsheet does not include a function for predicting reservoir survival at a given flow level. For the 2000 Biological Opinion analysis, NMFS included a range of pool survivals estimated from recent empirical studies between 1995-1999 for SR fall chinook. However, the expected flows in 2001 are considerably below the range of flows included in the survival analysis under the biological opinion.

In the case of SR fall chinook, empirical survival data were not available for the 1994 low flow year, the only below average flow condition in the last six years. NMFS has, however, observed a relationship between flow and survival from Lower Granite Dam to Lower Monumental Dam (NMFS 2000, Figure 16). This relationship was interpolated in this analysis to adjust downward the lowest observed pool survival rate included in the 2000 Biological Opinion analysis (1998 water year). Accordingly, for all mainstem Snake and Columbia river reservoirs except Lower Granite pool, fall chinook pool survival rates were set at 95% of the 1998 pool survival rates used in the opinion analysis. For the Lower Granite project, survival was based on a multi-regression model of flow, temperature and survival for wild juvenile fall chinook (Connor B. USFWS, pers. com. 3/15/01). Assuming average summer flows of 26 kcfs in the Snake River in 2001 and a seasonal water temperature of 20° C (the WA state water temperature standard for the Snake River), juvenile survival is estimated to be about 0.17 (95% C.I.=0 B 0.37) from release to the tailrace of Lower Granite Dam.

As noted above, a large proportion of SR fall chinook will be transported in 2001. For this ESU, system survival (combined in-river and transport survival to below Bonneville Dam) was estimated with SIMPAS using assumptions identical to those in the 2000 Biological Opinion. This system survival analysis included an estimated D value[4] of 0.24, as assumed in the biological opinion.

[4] AD@ refers to the post-Bonneville Dam survival of transported fish, divided by the post-Bonneville survival of non-transported fish.

Table 1. ***In-river survival*** estimates based on SIMPAS analysis (**as percent of fish arriving at head of upper pool**) for listed Snake River fall chinook, non-listed Mid-Columbia River (Hanford Reach) and Deschutes River fall chinook under expected 2001 low water conditions. The reach through which survival is estimated is indicated in AStock@ column. (n/a = not applicable and n/c = no change.)

	Multi-Year Average Survival (and Range) Est=d. in 2000 Biological Opinion under a range of water conditions			Reduced Spill Operation B 800 MW-mos		Reduced Spill Operation B 600 MW-mos		Reduced Spill Operation B 400 MW-mos		No Spill	
Stock	ACurrent@	ARPA@ (after 10 years)	Est=d. Survival with Full BiOp Spill	Est=d. Survival	% Change From BiOp Spill	Est=d. Survival	% Change From BiOp Spill	Est=d. Survival	% Change From BiOp Spill	Est=d. Survival	% Change From BiOp Spill
SR fall chin ESU (LWG-BON)	10.2 (0.5-16.4)	14.3 (1.1-22.4)	3.15	3.1	-1.3	3.0	-3.2	2.9	-6.5	2.6	-16.1
Hanford Rch fall chin (MCN-BON)	n/a	n/a	33.9	33.4	-1.3	33.4	-1.3	32.6	-3.7	29.1	-14.0
Deschutes fall CH (TDA-BON)	n/a	n/a	61.7	61.1	-0.9	61.1	-0.9	61.1	-0.9	54.7	-11.3

Table 2. ***In-river survival*** estimates based on a SIMPAS analysis (**as percent of fish arriving at Lower Granite Dam**) for listed Snake River fall chinook under expected 2001 low water conditions. The reach through which survival is estimated is indicated in AStock@ column. (n/a = not applicable and n/c = no change.)

	Multi-Year Average Survival (and Range) Est=d. in 2000 Biological Opinion under a range of water conditions			Reduced Spill Operation B 800 MW-mos		Reduced Spill Operation B 600 MW-mos		Reduced Spill Operation B 400 MW-mos		No Spill	
Stock	ACurrent@	ARPA@ (after 10 years)	Est=d. Survival with Full BiOp Spill	Est=d. Survival	% Change From BiOp Spill	Est=d. Survival	% Change From BiOp Spill	Est=d. Survival	% Change From BiOp Spill	Est=d. Survival	% Change From BiOp Spill
SR fall CH (LWG-BON)	n/a	n/a	17.0	16.8	-1.2	16.2	-4.7	15.8	-7.1	14.1	-17.1

Table 3. ***Total system survival*** estimates based on a SIMPAS analysis (combined transported and non-transported smolts) for listed Snake River fall chinook. Estimates include the differential post-Bonneville survival of transported smolts (compared to non-transported smolts), as defined in the 2000 Biological Opinion. (n/c = no change)

ESU	Multi-Year Average Survival (and Range) Est=d. in 2000 Biological Opinion under a range of water conditions		Est=d. Sur-vival with Full BiOp Spill	Reduced Spill Operation B 800 MW-mos		Reduced Spill Operation B 600 MW-mos		Reduced Spill Operation B 400 MW-mos		No Spill	
	ACurrent@	ARPA@ (after 10 years)		Est=d. Sur-vival	% Change From BiOp Spill	Est=d. Sur-vival	% Change From BiOp Spill	Est=d. Sur-vival	% Change From BiOp Spill	Est=d. Sur-vival	% Change From BiOp Spill
SR fall CH (head of LWG pool to BON)	11.7 (6.2-15.0)	12.7 (7.5-15.8)	3.56	3.56	n/c	3.55	-0.3	3.55	-0.4	3.54	-0.6
SR fall CH (LWG Dam to BON)	n/a	n/a	19.24	19.23	n/c	19.19	-0.2	19.17	-0.3	19.11	-0.6

Table 4. Summer spill levels applied in the SIMPAS analysis for fall chinook, assuming average seasonal summer flows of 26 kcfs in the Snake River and 88 kcfs in the lower Columbia River.

FCRPS Dam	BiOp Spill	800 MW-mos	600 MW-mos	400 MW-mos	200 MW-mos
Spill Period:	July 1-Aug 31	June 28-Aug 6	June 29-Aug 4	June 29-July 31	July 12-July 31
Spill Duration:	62 days	40 days	38 days	34 days	20 days
Bonneville	Day: 58 kcfs Night: 58 kcfs	Day: 50 kcfs Night: 58 kcfs	24 hr at 50 kcfs	24 hr at 50 kcfs	24 hr at 50 kcfs
The Dalles	24 hr at 40%	24 hr at 40%	24 hr at 40%	24 hr at 40%	24 hr at 30%
John Day	Day: No spill Night: 38 kcfs	Day: No spill Night: 30%	Day: No spill Night: 30%	No spill	No spill
McNary	No spill	No spill	No spill	No spill	No spill
Ice Harbor	24 hr at 17 kcfs	24 hr at 17 kcfs	No spill	No spill	No spill
Lower Monumental	No spill	No spill	No spill	No spill	No spill
Little Goose	No spill	No spill	No spill	No spill	No spill
Lower Granite	No spill	No spill	No spill	No spill	No spill

Note: Summer spill period dates and spill levels are estimates and are for planning purposes only. Actual duration of spill periods and changes in spill levels between projects should be determined in-season based on real-time flow and fish passage information by the Technical Management Team.