NORTHWEST POWER PLANNING COUNCIL
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December 2, 2002

MEMORANDUM

TO: Council Members

FROM: Bruce Suzumoto

SUBJECT: Mainstem juvenile survival: CRiSP modeling results

Chris Van Holmes of the University of Washington's Columbia Basin Research group will present juvenile survival results using the CRiSP mainstem passage model. The Council requested the University of Washington to analyze the possible effects of the 2002 Draft Mainstem Amendments on various populations of migrating juvenile salmon and steelhead. Council staff provided the University of Washington with average river flows for a high, medium and low flow year based on the Council's proposed reservoir operations.

Attached is a brief summary of the CRiSP analysis and results. For comparison purposes also attached is the November 6, 2002 memo outlining the results of the staff's SIMPAS survival analysis. The SIMPAS analysis alternative that should be compared to the CRiSP results is found in Tables 1 through 6 labeled "MT OPS NO FILL" (Montana proposed reservoir operations; no April fill; and Biological Opinion spills).

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Comparison of the NPPC and BIOP flow programs using the CRiSP smolt passage model

Prepared by C. Van Holmes and J. Anderson, Columbia Basin Research, University of Washington
Data: December 2, 2002

Flows provided by NPPC: medium = 1960, high = 1974, low = 1977.

The CRiSP survival depends on travel time, temperature, and predator density in the river reaches. Dam passage survival depends on hourly spill fractions and survivals through the various passage routes at the dams. The model was calibrated with survival and travel time estimates derived from PIT tag data over the years 1993 through 2000. Survival of fish transported is set at 98%.

Survivals are from the release sites to Bonneville tailrace. Release distributions represent the observed passage distributions of the different stocks at the release sites. In-river survival represents the fish that pass in-river and total survival represents the combined survivals of transported and in-river passing fish.

The final result is the BIOP and NPPC flow scenarios are essentially identical. Averaging over all stocks the NPPC hydro operation survival is -0.032% less than the BIOP survival and 0.141% fewer fish are transported in the NPPC program than in the BIOP program. The in-river survivals between the two programs are virtually identical differing by no more than 0.13% with an average difference of 0.01%.

Release Site	Stock (release start day)	Flow Volume	Hydro Operation	In-river Survival	Total Survival	Percent Transport	D in-river S NPPC - BIOP	D total S NPPC - BIOP
McNary Forebay	Hanford Reach Fall Chinook (161)	Medium	NPPC	12.20%	34.71%	42.69%	-0.068%	0.534%
			BIOP	12.26%	34.18%	41.76%		
		High	NPPC	12.68%	25.55%	26.47%	0.035%	-0.233%
			BIOP	12.64%	25.78%	26.89%		
		Low	NPPC	11.16%	39.10%	50.29%	-0.083%	-0.212%
			BIOP	11.24%	39.31%	50.64%		
Rock Island Tailrace	Upper Columbia Steelhead (91)	Medium	NPPC	54.21%	61.38%	40.78%	0.002%	0.008%
			BIOP	54.20%	61.37%	40.75%		
		High	NPPC	54.87%	57.37%	25.39%	0.004%	-0.001%
			BIOP	54.86%	57.37%	25.40%		
		Low	NPPC	54.87%	61.10%	38.93%	0.083%	-0.435%
			BIOP	54.78%	61.54%	40.61%		
Snake River Trap	Snake River Steelhead (81)	Medium	NPPC	34.10%	69.02%	68.60%	0.001%	0.001%
			BIOP	34.10%	69.02%	68.60%		
		High	NPPC	34.57%	71.88%	71.49%	0.001%	0.000%
			BIOP	34.57%	71.88%	71.49%		
		Low	NPPC	30.93%	84.05%	88.19%	0.028%	-0.032%
			BIOP	30.90%	84.09%	88.19%		
	Snake River Subyearling Chinook (137)	Medium	NPPC	14.19%	43.36%	48.33%	-0.050%	0.020%
			BIOP	14.24%	43.34%	48.27%		
		High	NPPC	14.07%	41.42%	45.20%	0.021%	-0.002%
			BIOP	14.05%	41.42%	45.21%		
		Low	NPPC	14.66%	46.22%	52.56%	-0.049%	-0.009%
			BIOP	14.71%	46.23%	52.58%		
Rock Island Tailrace	Upper Columbia Yearling Chinook (91)	Medium	NPPC	45.13%	50.81%	30.60%	-0.005%	0.010%
			BIOP	45.14%	50.80%	30.55%		
		High	NPPC	46.73%	48.82%	18.47%	0.004%	0.001%
			BIOP	46.72%	48.81%	18.47%		
		Low	NPPC	45.99%	50.72%	28.58%	0.112%	-0.201%
			BIOP	45.88%	50.93%	29.65%		
Snake River Trap	Snake River Yearling Chinook (75)	Medium	NPPC	37.75%	70.51%	67.85%	0.001%	0.000%
			BIOP	37.75%	70.51%	67.85%		
		High	NPPC	37.53%	72.07%	69.02%	0.001%	0.000%
			BIOP	37.53%	72.07%	69.02%		
		Low	NPPC	32.55%	84.03%	87.28%	0.135%	-0.017%
			BIOP	32.41%	84.05%	87.32%		
				Average Survival difference NPPC - BIOP			0.010%	-0.032%

Wed Nov 27 10:45:02 PST 2002

Runs performed @ Columbia Basin Research by Chris Van Holmes (cvh@u.washington.edu).

Hydro Proposal	CRiSP Rel_Site	Stock	Flow Volume	In-river Survival	Total Survival	Percent Transported
BIOP	McNary Forebay	Hanford Reach Fall Chinook	Medium Flows	12.26%	34.18%	41.76%
BIOP	McNary Forebay	Hanford Reach Fall Chinook	High Flows	12.64%	25.78%	26.89%
BIOP	McNary Forebay	Hanford Reach Fall Chinook	Low Flows	11.24%	39.31%	50.64%
BIOP	Rock Island Tailrace	Steelhead	Medium Flows	54.20%	61.37%	40.75%
BIOP	Rock Island Tailrace	Steelhead	High Flows	54.86%	57.37%	25.40%
BIOP	Rock Island Tailrace	Steelhead	Low Flows	54.78%	61.54%	40.61%
BIOP	Snake River Trap	Steelhead	Medium Flows	34.10%	69.02%	68.60%
BIOP	Snake River Trap	Steelhead	High Flows	34.57%	71.88%	71.49%
BIOP	Snake River Trap	Steelhead	Low Flows	30.90%	84.09%	88.19%
BIOP	Snake River Trap	Subyearling Chinook	Medium Flows	14.24%	43.34%	48.27%
BIOP	Snake River Trap	Subyearling Chinook	High Flows	14.05%	41.42%	45.21%
BIOP	Snake River Trap	Subyearling Chinook	Low Flows	14.71%	46.23%	52.58%
BIOP	Rock Island Tailrace	Yearling Chinook	Medium Flows	45.14%	50.80%	30.55%
BIOP	Rock Island Tailrace	Yearling Chinook	High Flows	46.72%	48.81%	18.47%
BIOP	Rock Island Tailrace	Yearling Chinook	Low Flows	45.88%	50.93%	29.65%
BIOP	Snake River Trap	Yearling Chinook	Medium Flows	37.75%	70.51%	67.85%
BIOP	Snake River Trap	Yearling Chinook	High Flows	37.53%	72.07%	69.02%
BIOP	Snake River Trap	Yearling Chinook	Low Flows	32.41%	84.05%	87.32%

Hydro Proposal	CRiSP Rel_Site	Stock	Flow Volume	In-river Survival	Total Survival	Percent Transported	Δ inriver S from BiOp	Δ total S from BiOp
Council	McNary Forebay	Hanford Reach Fall Chinook	Medium Flows	12.20%	34.71%	42.69%	-0.07%	0.53%
Council	McNary Forebay	Hanford Reach Fall Chinook	High Flows	12.68%	25.55%	26.47%	0.04%	-0.23%
Council	McNary Forebay	Hanford Reach Fall Chinook	Low Flows	11.16%	39.10%	50.29%	-0.08%	-0.21%
Council	Rock Island Tailrace	Steelhead	Medium Flows	54.21%	61.38%	40.78%	0.00%	0.01%
Council	Rock Island Tailrace	Steelhead	High Flows	54.87%	57.37%	25.39%	0.00%	0.00%
Council	Rock Island Tailrace	Steelhead	Low Flows	54.87%	61.10%	38.93%	0.08%	-0.43%
Council	Snake River Trap	Steelhead	Medium Flows	34.10%	69.02%	68.60%	0.00%	0.00%
Council	Snake River Trap	Steelhead	High Flows	34.57%	71.88%	71.49%	0.00%	0.00%
Council	Snake River Trap	Steelhead	Low Flows	30.93%	84.05%	88.19%	0.03%	-0.03%
Council	Snake River Trap	Subyearling Chinook	Medium Flows	14.19%	43.36%	48.33%	-0.05%	0.02%
Council	Snake River Trap	Subyearling Chinook	High Flows	14.07%	41.42%	45.20%	0.02%	0.00%
Council	Snake River Trap	Subyearling Chinook	Low Flows	14.66%	46.22%	52.56%	-0.05%	-0.01%
Council	Rock Island Tailrace	Yearling Chinook	Medium Flows	45.13%	50.81%	30.60%	0.00%	0.01%
Council	Rock Island Tailrace	Yearling Chinook	High Flows	46.73%	48.82%	18.47%	0.00%	0.00%
Council	Rock Island Tailrace	Yearling Chinook	Low Flows	45.99%	50.72%	28.58%	0.11%	-0.20%
Council	Snake River Trap	Yearling Chinook	Medium Flows	37.75%	70.51%	67.85%	0.00%	0.00%
Council	Snake River Trap	Yearling Chinook	High Flows	37.53%	72.07%	69.02%	0.00%	0.00%
Council	Snake River Trap	Yearling Chinook	Low Flows	32.55%	84.03%	87.28%	0.14%	-0.02%
						Average change	0.010%	-0.032%

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November 6, 2002

MEMORANDUM

TO: Council Members

FROM: Bruce Suzumoto

SUBJECT: SIMPAS analysis of state proposals

Note: This memo summarizes the presentation made at the Council meeting on October 16, 2002 in Spokane, Washington.

Background

Council staff used the SIMPAS1 version 9 model to analyze the relative effects of various spill and flow alternatives on fish survival. SIMPAS is a spreadsheet model developed by NOAA Fisheries that uses empirical fish passage data to estimate relative juvenile survival through the hydrosystem for various alternatives. The model was used by the Federal Biological Effects Team to help develop the 2000 Biological Opinion and is currently used to analyze the relative consequences of hydropower operational changes on the survival of listed stocks.

Caveats

Changes in river flow can affect the routes juveniles take to move past dams (i.e. via spillways, turbines, bypass systems etc.). When flows are modified, SIMPAS estimates the change in juvenile survival resulting from the different routes fish take. SIMPAS does not incorporate an explicit flow-survival function when estimating juvenile survival. The model instead uses a reservoir survival function (based on empirical studies) to capture sources of mortality that are not accounted for in the estimates of dam related mortality. Because of this, SIMPAS may not be the best model to use when specifically analyzing the effects of flow changes on juvenile survival. One of the other regionally developed juvenile passage models may be better suited to analyze flow effects.

Confidence limits are not reflected in the results. Juvenile survival rates and input parameters used by SIMPAS are point estimates and so variability estimates are not calculated.

Alternatives considered

The 2000 Biological Opinion reservoir operations and spill levels (base case) were compared to six different proposed state alternatives. The alternatives considered were:

1. Montana proposed reservoir operations; April 10 fill; and Biological Opinion spills
2. Montana proposed reservoir operations; no April fill; and Biological Opinion spills
3. Oregon proposed reservoir operations and Biological Opinion spills
4. Montana proposed reservoir operations; April 10 fill; and 115% gas cap spills
5. Montana proposed reservoir operations; no April fill; and 115% gas cap spills
6. Oregon proposed reservoir operations and spills

50 year regulated monthly flows were modeled for each of the alternatives. In order to obtain a range of flow conditions, mean flows were calculated by averaging the highest 20% of yearly flows, the middle 20% of yearly flows and the lowest 20% of yearly flows for both spring and summer. Spring is considered to be April 16 to June 30 and summer is July through August. Estimates of 115% gas cap spill amounts for each project were obtained from the Bonneville Power Administration.

Populations

Eleven populations of listed and unlisted chinook and steelhead were examined. The populations used for the analysis were:

ESA Listed	Not Listed
Snake River Spring/Summer Chinook	John Day Spring Chinook
Snake River Steelhead	Deschutes Spring Chinook
Snake River Fall Chinook	Hanford Reach Fall Chinook
Upper Columbia Spring Chinook	
Upper Columbia Steelhead	
Middle Columbia Steelhead	
Lower Columbia Chinook	
Lower Columbia Steelhead	

Results

A. Survival differences resulting from flow changes only.

The percentages in Tables 1 through 6 indicate the difference in juvenile total system survival between 2000 Biological Opinion operations and state proposed reservoir operations. The alternatives maintain 2000 Biological Opinion spill levels and use flows derived from state proposed operations. Positive percentages indicate there is a net increase in survival and negative percentages indicate there is a net decrease in survival. For example, +1.4% indicates that starting with 1000 fish, 14 more fish survive to below Bonneville Dam under the state proposed operation than under the Biological Opinion operations. Similarly, -0.2% means that out of 1000 fish, 2 less fish survive to below Bonneville Dam under the state proposed operation than under Biological Opinion operations.

Table 1. High spring flow years: state proposed flows and Biological Opinion spill levels

POPULATION	MT OPS APRIL FILL	MT OPS NO FILL	OR OPS
Snake River Spr/Sum Chinook	0.00%	0.00%	0.00%
Snake River Steelhead	0.00%	0.00%	0.00%
Upper Columbia Spring Chinook	0.00%	0.00%	0.00%
Upper Columbia Steelhead	0.00%	0.00%	0.00%
Middle Columbia Steelhead	0.00%	0.00%	0.00%
Lower Columbia Steelhead	0.00%	0.00%	0.00%
John Day Spring Chinook	0.00%	0.00%	0.00%
Deschutes Spring Chinook	0.00%	0.00%	0.00%

Table 2. Medium spring flow years: state proposed flows and Biological Opinion spill levels

POPULATION	MT OPS APRIL FILL	MT OPS NO FILL	OR OPS
Snake River Spr/Sum Chinook	0.00%	0.0% to -0.2%	0.2% to 0.4%
Snake River Steelhead	0.2% to 0%	0.2% to 0%	0.00%
Upper Columbia Spring Chinook	0.00%	-0.20%	0.00%
Upper Columbia Steelhead	0.00%	0.00%	0.00%
Middle Columbia Steelhead	0.00%	0.00%	0.00%
Lower Columbia Steelhead	0.00%	0.00%	-0.10%
John Day Spring Chinook	0.00%	-0.20%	0.00%
Deschutes Spring Chinook	0.00%	-0.30%	0.00%

Table 3. Low spring flow years: state proposed flows and Biological Opinion spill levels

POPULATION	MT OPS APRIL FILL	MT OPS NO FILL	OR OPS
Snake River Spr/Sum Chinook	0.00%	0.00%	0.00%
Snake River Steelhead	0.00%	0.00%	0.00%
Upper Columbia Spring Chinook	0.00%	0.00%	0.00%
Upper Columbia Steelhead	0.00%	0.10%	0.00%
Middle Columbia Steelhead	-0.10%	0.10%	-0.10%
Lower Columbia Steelhead	0.00%	0.20%	0.00%
John Day Spring Chinook	0.00%	0.20%	0.00%
Deschutes Spring Chinook	0.00%	0.10%	0.00%

Table 4. High summer flow years: state proposed flows and Biological Opinion spill levels

POPULATION	MT OPS APRIL FILL	MT OPS NO FILL	OR OPS
Snake River Fall Chinook	0.00%	0.00%	0.70%
Lower Columbia Chinook	0.30%	0.30%	-0.30%
Hanford Reach Fall Chinook	0.20%	0.20%	0.00%

Table 5. Medium summer flow years: state proposed flows and Biological Opinion spill levels

POPULATION	MT OPS APRIL FILL	MT OPS NO FILL	OR OPS
Snake River Fall Chinook	-0.70%	-0.70%	1.40%
Lower Columbia Chinook	0.50%	0.50%	-1.00%
Hanford Reach Fall Chinook	0.00%	0.00%	-0.70%

Table 6. Low summer flow years: state proposed flows and Biological Opinion spill levels

POPULATION	MT OPS APRIL FILL	MT OPS NO FILL	OR OPS
Snake River Fall Chinook	0.00%	0.00%	0.00%
Lower Columbia Chinook	0.20%	0.20%	-0.50%
Hanford Reach Fall Chinook	0.20%	-0.50%	-1.20%

B. Survival differences resulting from flow and spill changes.

The percentages in Tables 7 through 12 indicate the difference in juvenile total system survival between 2000 Biological Opinion operations and state proposed reservoir and spill operations. The alternatives use spills and flows derived from state proposed operations. Positive percentages indicate there is a net increase in survival and negative percentages indicate there is a net decrease in survival. For example, +2.1% indicates that starting with 1000 fish, 21 more fish survive to below Bonneville Dam under the state proposed operation than under Biological Opinion operations. Similarly, -0.6% means that out of 1000 fish, 6 less fish survive to below Bonneville Dam under the state proposed operation than under Biological Opinion operations.

Table 7. High spring flow years: state proposed flow and spill

POPULATION	MT OPS APRIL FILL	MT OPS NO FILL	OR OPS
Snake River Spr/Sum Chinook	1.2% to 2.1%	1.2% to 2.1%	-0.6% to -0.9%
Snake River Steelhead	-1.1% to -0.4%	-1.1% to -0.4%	-0.4% to -0.6%
Upper Columbia Spring Chinook	-5.30%	-5.30%	0.70%
Upper Columbia Steelhead	-7.70%	-7.70%	-1.40%
Middle Columbia Steelhead	-7.80%	-7.80%	-1.40%
Lower Columbia Steelhead	0.00%	0.00%	0.00%
John Day Spring Chinook	-5.20%	-5.20%	0.60%
Deschutes Spring Chinook	-4.70%	-4.70%	0.80%

Table 8. Medium spring flow years: state proposed flow and spill

POPULATION	MT OPS APRIL FILL	MT OPS NO FILL	OR OPS
Snake River Spr/Sum Chinook	3.2% to 5.0%	3.2% to 5.0%	-3.0% to -4.1%
Snake River Steelhead	-1.5% to 0.2%	-1.5% to 0.2%	-0.8% to -1.5%
Upper Columbia Spring Chinook	-3.30%	-3.30%	0.70%
Upper Columbia Steelhead	-5.70%	-5.70%	-1.40%
Middle Columbia Steelhead	-5.70%	-5.70%	-1.50%
Lower Columbia Steelhead	-0.30%	-0.30%	-0.30%

John Day Spring Chinook	-3.10%	-3.10%	0.60%
Deschutes Spring Chinook	-2.60%	-2.60%	0.70%

Table 9. Low spring flow years: state proposed flow and spill

POPULATION	MT OPS APRIL FILL	MT OPS NO FILL	OR OPS
Snake River Spr/Sum Chinook	-0.20%	0.0% to -0.2%	0.00%
Snake River Steelhead	0.00%	0.00%	0.00%
Upper Columbia Spring Chinook	-2.40%	-1.80%	1.00%
Upper Columbia Steelhead	-2.50%	-1.80%	-1.20%
Middle Columbia Steelhead	-2.50%	-1.70%	-1.50%
Lower Columbia Steelhead	-0.20%	-0.10%	-0.20%
John Day Spring Chinook	-2.10%	-1.40%	0.80%
Deschutes Spring Chinook	-1.70%	-1.20%	0.60%

Table 10. High summer flow years: state proposed flow and spill

POPULATION	MT OPS APRIL FILL	MT OPS NO FILL	OR OPS
Snake River Fall Chinook	0.00%	0.00%	0.70%
Lower Columbia Chinook	-0.40%	-0.40%	-0.30%
Hanford Reach Fall Chinook	-2.20%	-2.20%	0.50%

Table 11. Medium summer flow years and state proposed flow and spill

POPULATION	MT OPS APRIL FILL	MT OPS NO FILL	OR OPS
Snake River Fall Chinook	-0.70%	-0.70%	1.40%
Lower Columbia Chinook	-0.20%	-0.20%	-1.00%
Hanford Reach Fall Chinook	-1.70%	-1.70%	-0.20%

Table 12. Low summer flow years: state proposed flow and spill

POPULATION	MT OPS APRIL FILL	MT OPS NO FILL	OR OPS
Snake River Fall Chinook	0.00%	0.00%	0.00%
Lower Columbia Chinook	0.20%	0.20%	-0.50%
Hanford Reach Fall Chinook	0.00%	-0.50%	-0.70%

Comments on the results

- SIMPAS modeling indicates little change in survival resulting from changes in spring and summer flows. Spring migrants exhibit almost no change (range: –0.3% to 0.4%) and summer migrants very little change in survival (range: -1.2% to 1.4%). As stated previously, SIMPAS is not highly sensitive to changes in flows. Another regional passage model might be better able to estimate the effect of flow changes on total system survival.
- In the spring, Snake River and Columbia River fish populations are affected differently when the spill cap is reduced to115% (Montana proposal):
    - In the Snake River, spring chinook survival generally increases (range: -0.2% to +5.0%) and steelhead survival remains fairly neutral (range: -1.5% to 0.2%). This is because more fish are transported from collector dams when spill is decreased and SIMPAS calculates a survival improvement.

    - Upper and lower Columbia River spring chinook and steelhead survivals decrease as a result of spill reductions. Spring chinook survivals decrease from –1.8% to –5.2% and steelhead from 0.0% to –7.8%. Spring migrant survivals decrease because when spill is reduced, more fish pass dams thru higher mortality routes such as turbines.
- In the summer, listed Snake River fall chinook (-0.7% to 0.0%) and listed Lower Columbia chinook (-0.4% to 0.2%) show almost no change in survival as a result of decreasing spill. Hanford Reach fall chinook show a fairly low change in survival (0.0% to -2.2%).
- It appears that if spill reductions were to occur, they would be the most beneficial or cause the least mortality if, 1) they occurred later in the summer or 2) at the Lower Snake River projects during the spring.
- During the summer, very few listed Snake River fall chinook remain in the river because under Biological Opinion operations almost all surviving fish are transported. Therefore Snake River fall chinook mortality does not increase with spill reductions. Lower Columbia chinook only pass Bonneville Dam and are not greatly affected by spill reductions. Hanford Reach fall chinook are only transported at McNary and exhibit some mortality with reduced spills.
- In the spring, spill reductions at Lower Snake dams would cause greater numbers of listed spring chinook and steelhead to be transported possibly enhancing overall survivals.