Appendix 1

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
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June 30, 2004

MEMORANDUM FOR: D. Robert Lohn, Regional Administrator

FROM: James D. Ruff, FCRPS Branch Chief JDR

SUBJECT: Analysis of Action Agencies' June 22, 2004, Summer Spill Proposal - Impacts on Listed Snake River Fall Chinook Salmon in Comparison to Proposed Brownlee Flow Augmentation Offset.

The purpose of this memo is to describe the analytical approach, assumptions, and results for our evaluation of both: 1) the biological effects of curtailing summer spill in 2004 at Ice Harbor and John Day Dams on August 25 and at The Dalles and Bonneville Dams on the lower Columbia River on August 1, and 2) the potential biological benefit of an additional 100 Kaf flow augmentation during July from Idaho Power Company's Brownlee Reservoir on the Snake River.

Summer Spill Analysis of Impacts on Listed Snake River (SR) Fall Chinook Salmon

Background and Methods

The first part of the analysis considers the impact of two Federal Columbia River Power System (FCRPS) summer operational scenarios: 1) the 2000 FCRPS Biological Opinion spill program, and 2) the U.S. Army Corps of Engineers' (Corps) and Bonneville Power Administration's (BPA) proposal to curtail summer fish spill at Ice Harbor and John Day Dams on August 25 and at The Dalles and Bonneville Dams on the Lower Columbia River on August 1.[1] For this analysis we needed to consider: 1) the population of listed SR fall chinook salmon that would be affected by the summer spill proposal, 2) the migration timing or distribution of those fish, and 3) the relative impact in terms of both juvenile fish survival to below Bonneville Dam and possible adult migrant impacts. The methods for determining each component of the analysis are explained below.

The analyses of both juvenile fish impacts under curtailed spill operation and the flow augmentation offset include considerable uncertainty, as it is difficult to predict a specific level of effect in either case. Estimates of differences in juvenile fish survival between alternative spill scenarios were determined using the NOAA Fisheries SIMPAS model (Appendix D, 2000 FCRPS Biological Opinion). Current operations under the 2000 FCRPS Biological Opinion include a full collection and transportation strategy for listed SR fall chinook salmon and this was also assumed in the modeling studies. Under a maximum collection and transportation

[1]Planned fish passage research on alternative spill operations at Ice Harbor Dam will occur until July 15. Planned fish passage research on alternative spill operations at Bonneville Dam will also occur during the month of July. As these are regionally planned spill studies, any effect from those studies is not included in this analysis.

modeling assumption, the vast majority of juvenile fish are transported. Thus the relative differences in resulting system survival estimates are very small, and applying these small survival differences to an assumed starting population of fish at Lower Granite Dam to obtain small differences in numbers of juvenile fish implies a precision in the passage model output that may be beyond the range of supporting empirical data. There is also considerable uncertainty about the benefit of transporting this species.[2] Nonetheless, the survival estimates below represent our best effort to inform the Federal Executives' decision about the summer spill proposal with clear and open application of the best available scientific information.

Starting Listed Fish Population

The estimated number of Endangered Species Act (ESA)-listed juvenile fish affected by this proposal is based on the Northwest Fisheries Science Center's 2003 population estimate for outmigrating listed SR fall chinook salmon arriving at the face of Lower Granite Dam (Ferguson 2003) of 1,051,615 fish.

Listed Fish Distribution

Smolt passage distribution, or run timing, is an important parameter in this analysis to enable an estimate of the number of juvenile fish affected by the Action Agencies' summer spill proposal. The overall impact of different spill operational alternatives is sensitive to outmigration distribution. Therefore, NOAA Fisheries incorporated a range of possible migration shapes based on the range of observed listed SR fall chinook salmon outmigrations. (Historical fish passage data, University of Washington's Data Access in Real Time [DART] database.) Early, middle, and late migration estimates of the percentage of listed fish passing through the lower Columbia River in each period of operation during August are listed in Table 1, below. From the available data, NOAA Fisheries staff determined that it is difficult to predict with any certainty whether the outmigration for SR fall chinook salmon will be early, middle, or late this summer. Thus all three migration conditions are included in the impact analysis, with 2003 migration data for SR fall chinook salmon representing an early migration year, 1996 data reflecting a typical migration year, and 1995 data for a late migration year.

Fish migration distributions were based on PIT-tag data at Lower Monumental Dam and an average fish travel time from that project to The Dalles Dam of 13 days. So a juvenile fish leaving Lower Monumental Dam on July 19 could be expected to arrive at The Dalles Dam in the lower Columbia River on August 1, while a fish leaving Lower Monumental Dam on August 18 would be expected to arrive at The Dalles Dam on August 31. Thus, for early, middle, and late migrations, approximately 24%, 56%, and 62% of the total summer juvenile SR fall chinook salmon migration, respectively, could be expected to be migrating through the lower Columbia River during the month of August (Table 1).

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[2]In the Northwest Fisheries Science Center's May 6, 2004, draft technical memorandum titled "Effects of the Federal Columbia River Power System on Salmon Populations," Williams et al. reviewed the available information regarding transportation of Snake River fall chinook salmon. They observed that, "for subyearling chinook salmon, transportation appears to neither greatly harm or help the fish, and thus a combination of transportation and providing good passage conditions for fish not collected and transported is consistent with a "spread-the-risk" strategy until more is known."

In the June 22, 2004, final spill proposal from the Action Agencies, summer spill would continue through August 25 at Ice Harbor and John Day Dams, while spill would be curtailed at The Dalles and Bonneville Dams after July 31, i.e., during all of August. The second row in Table 1 illustrates the estimated percentage of juvenile fish affected in the early, middle, and late fish distributions by: a) Biological Opinion spill conditions at Ice Harbor and John Day Dams through August 25, and b) a no spill condition at The Dalles and Bonneville Dams. The final row of fish distributions in Table 1 shows the estimated percentage of fish affected in the early, middle, and late migrations under a no spill condition at all of the four FCRPS dams during the August 26-31 period, since fish during this period will still be in the lower Columbia River when spill is terminated during the last six days of August. These percentages were estimated by taking the difference in migration percentages between the previous two rows.

Table 1.

Period of Operation	**Early Migration Year (2003)**	**Middle Migration Year (1996)**	**Late Migration Year (1995)**
Est'd. % SR fall chinook salmon passing during August.	24.4%	56.1%	62.1%
Est'd. % SR fall chinook salmon passing during Aug. 1-25 spill period.	22.6%	39.0%	44.9%
Est'd. % SR fall chinook salmon passing during Aug. 26-31 no spill period.	1.8%	17.1%	17.2%

Smolt Survival

Estimated smolt survival was determined using NOAA Fisheries' SIMPAS spreadsheet model. SIMPAS estimated juvenile fish survival differences* are listed below, and are based on: a) model studies for the first 25 days of August with Biological Opinion spill on at all four FCRPS dams compared to Biological Opinion spill on at Ice Harbor and John Day Dams and Biological Opinion spill off at The Dalles and Bonneville Dams, and b) a comparison of studies for the last six days of August with Biological Opinion spill on and off at all four dams. Low impact estimates represent a low end of the survival input ranges and the high impact estimates include a high end of the ranges. The low impact estimate represents the smallest difference in survival between the no spill and spill conditions.

System survival (combined in-river and transportation survival, including 0.2 assumed differential survival of transported fish [D]) differences for listed SR fall chinook salmon originating at Lower Granite are:

August 1-25 low impact difference is:	0.00037 or 0.037%
August 1-25 high impact survival difference is:	0.00091 or 0.091%
August 22-31 low impact difference is:	0.00118 or 0.118%
August 22-31 high impact difference is:	0.00275 or 0.275%

Estimated Juvenile Fish Losses

Estimated juvenile fish losses due to the operational change in spill in August was determined using the simple equation: smolt population x fish distribution x SIMPAS model survival difference.

Our evaluation of the effect of reducing spill during the month of August pursuant to the Action Agencies' June 22, 2004, final summer spill proposal compared to survival under the 2000 FCRPS Biological Opinion spill program showed that the range of effects on listed SR fall chinook salmon is estimated to be between approximately 100 and 900 juvenile fish (Table 2). The effects were estimated under a range of migration patterns (from early to late) and a range of potential impacts from low to high.[3]

Curtailed spill can also affect migrating adult salmonids at some projects by increasing the number that fall back through turbines. Scientific information relevant to this issue is extremely limited. However, upon review of available adult salmon radio-telemetry data, survival rates of upstream migrating adult steelhead, adjusted for harvest, in the years 2000, 2001, and 2002 was quite similar (87.6%, 87.7%, and 88.8%, respectively), even though 2001 had very little spill at dams compared to the other two years. Fall chinook salmon adult survival was greater than the Opinion's adult performance standard in a year with spill (2002) and a year with little spill (2001). Thus, based on limited system survival information, it appears that a curtailment of summer spill should not result in a reduction in survival of upstream migrating steelhead and chinook salmon.

[3]Ranges in certain fish passage parameters, such as pool survival and fish guidance efficiency (FGE), were included in the analysis to capture a low or high impact on juvenile fish survival.

Table 2.

Listed SR fall chinook salmon	Estimated number of smolts lost under low/high impacts and different fish distributions.[4]					
	Early Migration Year		**Middle Migration Year**		**Late Migration Year**	
	Low Impact	High Impact	Low Impact	High Impact	Low Impact	High Impact
August 1-25 impact	90	220	150	370	170	430
August 26-31 impact	20	50	210	500	210	500
Est'd. Total Fish Loss	110	270	360	870	390	930

*Some of the more important SIMPAS modeling assumptions include:

- Smolt population starts at the face of Lower Granite Dam.
- Since 2004 forecasted runoff condition is between 2003 and 2001 water conditions, pool survivals used are the mean of 2001 and 2003 pool survivals.
- August (25 kcfs in Snake, and 112 kcfs in Columbia) flows are based on an average of 2001 and 2003 flows for these periods.
- D-value of 0.20 was applied to all transported fish to obtain system survival.
- Pool survivals were reduced from 1% and 4% for the non-surface collection dams (Ice Harbor and John Day Dams) and reduced by 0.5% to 2% for those dams with surface collection for non-spill operations (The Dalles and Bonneville Dams) to account for additional migration delay and predation under a no spill condition.[5]
- A BON-II corner collector efficiency of 46% was assumed for fish entering the forebay (1999 RT data) with a survival rate of 98% with spill; and a survival rate of either 98% or 95% without spill was assumed for the low and high impact, respectively.
- For the high impact runs, August FGE estimates were lowered by a 10% relative change to allow for the reduction in FGE seen later in the season. FGE values remained at the 2000 Biological Opinion levels in the low impact runs.

[4]All fish impact estimates are rounded to the nearest 10 smolts; total fish loss estimates may not add due to rounding.

[5]From Axel et al. (2003), for radio-tagged yearling chinook salmon, residence time in the Ice Harbor forebay was longer in 2001 under a no spill condition than in 1999. Also, a 4%-5% mortality rate was measured in the immediate forebay area of Ice Harbor Dam. This data was assumed to also apply to SR fall chinook salmon juveniles in the high impact analysis.

Other Issues

Any latent route-specific mortality of in-river migrants (i.e., is 98% bypass survival the same as 98% spill survival after the fish leave the river?) is not included in this analysis because mechanisms that might account for this factor are poorly understood (Williams et al. 2004). Also, the observation that late-migrating juvenile fall chinook salmon have shown relatively higher smolt-to-adult return rates than earlier migrating fish has not been factored into this analysis.

Analysis of Estimated Biological Benefit of Additional 100 Kaf Flow Augmentation in Snake River from Brownlee Reservoir

This potential offset action was proposed in comments by the States of Oregon and Washington, and called for BPA to work with Idaho Power Company to provide an *additional 100 Kaf draft* from Brownlee Reservoir storage during July. This additional flow augmentation volume, which we assumed would be over and above the discharge that Idaho Power Company would normally release in July based on assurances from BPA and Idaho Power Company, is expected to provide an additional flow benefit for a large percentage of listed SR fall chinook salmon juveniles typically migrating in the Snake River during the month of July. In addition, based on assurances from BPA and Idaho Power Company, our evaluation of this offset proposal also assumes there would be no change in August flows in the Snake River as a result of the July Brownlee flow augmentation operation.

Corps' Flow and Temperature Modeling

The Corps used its hydrodynamic-water temperature model CE-QUAL-W2 of Lower Granite Reservoir to forecast the velocity and thermal fields in the Snake River from Lower Granite Dam to RM 144 (near Anatone gage) for several flow conditions with and without 100 Kaf of additional discharge released from Brownlee Reservoir during the July 7-28 period, based on input from BPA. In the temperature modeling, the 100 Kaf additional volume was uniformly distributed during a 22-day period in July and was added to base flow conditions in the Snake River at Anatone for three years of simulation. Three recent years were selected for simulation by the Corps - 1998, 2000, and 2001 – which represented above average, near average, and low flow water conditions, respectively, based on the total cumulative discharge during July and August as observed at the Anatone gage.

The Corps used observed daily average discharge and water temperature on the Snake River at Anatone to estimate the thermal loading to Lower Granite pool for the base conditions in each of the study years. A second scenario for each year assumed these base flows were augmented by a Brownlee flow release of 2.3 kcfs during a 22-day period from July 7 to July 28 at the observed historic temperatures. The Corps applied historic water temperatures to the proposed Brownlee-augmented flow conditions assuming that the heat exchange associated with the higher flows in the Snake River will be similar to historic conditions.

The observed daily average discharge and water temperature on the Snake River at Spalding were used by the Corps as boundary conditions for thermal loading from the Clearwater River into Lower Granite Pool. Dworshak Reservoir was drafted from elevation 1600 feet (full pool) to elevation 1520 feet by the end of August for each of the three study years. The Corps' May 19, 2004, memo (Attachment 1) includes three tables showing daily average flows and water temperatures at Lower Granite Dam under both the base condition and the simulated 100 Kaf Brownlee flow augmentation condition. These tables also summarize the potential thermal impact of the Brownlee flow releases below Lower Granite Dam for above average (1998), near average (2000), and low flow (2001) conditions. From the Corps' modeling results, introducing the additional 100 Kaf volume during the July 7-28 period could result in a slight (0.1° to 0.2° C) increase in tailrace water temperatures at Lower Granite Dam.

Analytical Approach

NOAA Fisheries staff used the changes in average daily flows and water temperatures from the Corps' CE-QUAL-W2 model (Table 3) to estimate the biological effect of the additional Brownlee discharge in July. To estimate juvenile fish survival, B. Connor's (U.S. Fish and Wildlife Service [USFWS]) peer-reviewed regression model was used, where survival = 140.82753 + 0.02648*flow (m3/sec) – 7.14437*temp (degrees C). Temperature and flow input parameters and estimated juvenile fish survival rates, with 95% prediction limits, are shown in Table 3, below.

Table 3.

July BRN Operation	**Temperature blw LWG Dam (C)**	**LWG Outflow (m3/sec)**	**Est'd. juv. fish survival, in percent**	**95% prediction limits, in %**
Base case – low flow	19.5	980.5	27.5	19.7 – 35.3
w/100 Kaf flow aug.	19.6	1045.4	28.5	20.7 – 36.3
Base case – avg flow	19.0	1134.9	35.1	28.9 – 41.4
w/100 Kaf flow aug.	19.1	1199.8	36.1	29.9 – 42.4
Base case – abv avg Q	20.06	1671.9	41.8	32.1 – 51.5
w/100 Kaf flow aug.	20.14	1736.3	42.9	32.7 – 53.2

Results

In each of the three water conditions, juvenile fish survival is estimated to change about 1% from the base case operation versus the additional 100 Kaf flow augmentation operation from Brownlee (see Table 3). B. Connor's regression model predicts this slight increase in juvenile fish survival through the Lower Granite project because the 2.3 kcfs additional flow release from Brownlee spread over a three-week period during July would increase water velocity, thereby decreasing fish travel time, in the Lower Granite Reservoir. However, the expected increase in survival as a result of the additional Brownlee discharge during July is slightly counterbalanced by an expected 0.1° to 0.2°C increase in water temperature, based on the Corps' water quality model.

SR Fall Chinook Salmon Migration Timing in Lower Granite Pool

The major components of listed SR fall chinook salmon production above Lower Granite Dam over the 1998-2002 period include fish from the mainstem Snake River (61%), the Clearwater

River (29%), the Grande Ronde River (6%), the Imnaha River (3%), and the Salmon River (1%) (USFWS et al. 2003). We separated the Clearwater Basin production (29%) from the remaining Snake River and other tributaries' production (71%) because Clearwater River fish tend to migrate later in the summer, on average, than Snake River fish. As the USFWS has implemented a marking program over the past 11 years in the mainstem Snake River above Lower Granite Reservoir, we reviewed the PIT-tag detection data from DART at Lower Granite Dam for listed SR fall chinook salmon and selected passage years 2003, 1996, and 1995 to represent early, middle, and late migration timing, respectively, for juvenile migrants from the mainstem Snake River and its tributaries above Lower Granite Reservoir (other than Clearwater River).

There are only two years of PIT-tag data for Clearwater River fish at Lower Granite Dam, 1995 and 1998. The 1998 migration timing data was used to represent an early migration year[6] and the 1995 migration timing data was selected to represent a middle, or typical, migration pattern.[7] As there is no additional passage timing data for Clearwater River fish, the 1995 migration timing data, shifted later into the summer by two weeks, was used to represent a late migration pattern at Lower Granite Dam.

Using listed SR fall chinook salmon migration PIT-tag data for timing of the Snake River populations, the estimated juvenile survival improvement was applied to the various proportions of the migration affected at Lower Granite Dam during the July 8 through July 29 Brownlee flow augmentation period for early, middle, and late migration patterns (Table 4). Similar early, middle, and late passage timing information was developed and used to estimate the survival benefit for the Clearwater River population (Table 4).

Table 4.

Flow Operation Period (July 8-29)	**Early Migration Year**	**Middle Migration Year**	**Late Migration Year**
Snake R. populations	17.5%	43.2%	41.2%
Clearwater R. populations.	39.1%	13.3%	10.0%

<u>Method</u>

NOAA Fisheries staff estimated the potential survival benefit to juveniles of the additional July draft from Brownlee Reservoir using the following calculation: (% of migration affected during

[6]1998 was picked as early migration pattern due to warmer than normal winter and spring air and water temperatures in North Fork Clearwater River below Dworshak Dam, likely resulting in an early emergence and outmigration (DART data).

[7]1995 was selected as middle migration pattern due to more mid-point winter-spring air temperatures at Dworshak Dam, and thus a more average emergence and outmigration timing (DART data).

July 8-29 period) x (number of fish at head of pool)[8] x (estimated juvenile fish survival improvement).[9] The estimated juvenile fish benefit from the additional Brownlee flow augmentation was calculated for early, middle, and late migration patterns and a low flow condition based on the Corps' water quality model output. Note that this additional water is expected to benefit only those SR fall chinook salmon juveniles migrating during the July 8-29 period.

Results

The results of the benefit analysis of the Brownlee flow offset (Attachment 2) are shown below in Table 5 and can be compared to the analysis of impacts of curtailing summer spill from Table 2. All juvenile fish numbers in Table 5 are based on system survival estimates of passage through all FCRPS projects to below Bonneville Dam.[10]

To summarize, NOAA Fisheries estimated the survival effects of the Brownlee flow augmentation under a range of migration patterns (from early to late) and a range of potential impacts from low to high, similar to the spill impact analysis. For example, in Table 5, the flow augmentation survival benefit is estimated to range between about 700 and 1100 additional juvenile fish surviving to below Bonneville Dam, and the benefit is greater than the projected survival impact in each of the study cases evaluated. Since the additional flow augmentation from Brownlee Reservoir is unlikely to reduce water temperatures in the lower Snake River, there is no expected effect on adult salmon passage.

In conclusion, based on the survival estimates in Table 5, NOAA Fisheries estimates the 100 Kaf of additional flow augmentation volume from Idaho Power Company's Brownlee Reservoir during the month of July would benefit listed juvenile SR fall chinook salmon that are present in Lower Granite Reservoir in July to a level sufficient to offset the estimated adverse effects of the reduced spill operation at four FCRPS mainstem dams during August in each scenario evaluated.

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[8]Total estimated juvenile SR fall chinook salmon run size at the head of Lower Granite pool was estimated by dividing the NWFSC's listed population estimate of just over 1 million smolts at the face of Lower Granite Dam by 0.55 Lower Granite estimated pool survival based on empirical reach survival measurement taken in below average (2003) flow conditions.

[9]The USFWS regression model was used to estimate juvenile fish survival through the Lower Granite pool to the dam.

[10]Juvenile fish survival estimates through the FCRPS to below Bonneville Dam are based on a SIMPAS system survival estimate using 2001/2003 average August flows and pool survivals under the reduced spill condition.

Table 5.

	Comparison of estimated number of smolts impacted from summer spill reduction to estimated benefit of smolts gained from additional 100 Kaf Brownlee flow augmentation, for each estimate of impact and fish distribution.					
Listed SR fall chinook salmon	**Early Migration Year**		**Middle Migration Year**		**Late Migration Year**	
	Low Impact	High Impact	Low Impact	High Impact	Low Impact	High Impact
Est'd. Total Fish Loss due to curtailment of BiOp spill	-110	-270	-360	-870	-390	-930
Est'd. Total Fish Benefit from BRN flow augment.	740	710	1070	1040	1000	970
Est'd. Fish Benefit/Loss	+630	+440	+710	+170	+610	+40

References

Axel G. et al. 2003. Passage behavior and survival of hatchery yearling chinook salmon passing Ice Harbor and McNary Dams, 2001. Report prepared by Fish Ecology Division, Northwest Fisheries Science Center, Seattle, WA.

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USFWS, Nez Perce Tribe and Idaho Power Company. 2003. Fall Chinook Salmon Spawning Ground Surveys in the Snake River Basin Upriver of Lower Granite Dam, 2002. Report prepared for USDOE-BPA; project #199801003. September 2003.

Attachment 1

from MIKE SCHNEIDER
COE-ERDC

Date: May 19, 2004

Subject: Lower Granite Pool Simulations for 100 KAF from Brownlee Reservoir, July 7-July28

Background The coupled hydrodynamic-water temperature model CE-QUAL-W2 of Lower Granite Pool was used to forecast the velocity and thermal fields in the Snake River from Lower Granite Dam to RM 144 for several flow conditions with and without 100 KACF of additional discharge released from Brownlee Reservoir during July 7-28. The 100 KACF uniformly distributed during a 21 day period in July and was added to base flow conditions in the Snake River at Anatone for three years of simulation. A one day travel time was assumed for these simulations resulting in the flow released from Brownlee Dam on July 7 arriving in the Lower Granite pool a day later on July 8. Three base years were selected for simulation; 1998, 2000, and 2001 representing a wet, average, and low flow condition based on the total cumulative discharge during July and August as observed at the Anatone gage. The flow conditions during 2000 were slightly larger that the current STP forecast for cumulative discharge as forecasted for the Snake River at Lower Granite Dam and Orofino on the Clearwater River. The forecasted STP monthly flows for the Snake River at Lower Granite Dam based on the May 10 forecast were 35 kcfs and 29 kcfs respectively for the months of July and August. The observed flow conditions for the Snake River at Lower Granite Dam during the 2000 for July and August were 38 and 25.9 kcfs, respectively.

Boundary Conditions

Snake River - The observed daily average discharge and water temperature on the Snake River at Anatone were used to estimate the thermal loading to Lower Granite pool for the base conditions in each of the study years. A second scenario for each year assumed these base flows were augmented by 2.4 kcfs during a 21 day period from July 8 – July 29 at the observed historic temperatures. The application of historic water temperatures to the proposed higher flow conditions assumes that the heat exchange associated with the higher flows in the Snake River will be similar to the historic conditions. The validity of this assumption is supported by the relatively small change in travel time and effective depth of flow in the Snake River between Brownlee Dam and the Anatone gage caused by the additional 2.4 kcfs released from Brownlee. A summary of the monthly average flows and temperatures as observed during the three years of study are listed in Table 1. The response of accelerating the drafting of Brownlee reservoir in July on base flow conditions later in the year was not captured by these simulations. It is possible that base flow conditions in the Snake River resulting from Brownlee releases could be reduced later in the year as a consequence of the 100 KACF releases scheduled in July. This could cause an impact on temperatures throughout Lower Granite pool not captured by this evaluation.

Clearwater River - The observed daily average discharge and water temperature on the Snake River at Spalding were used as boundary conditions for thermal loading from the Clearwater River to Lower Granite Pool. The Dworshak pool was drafted from 1600 to 1520 by the end of August for each of the study years. A summary of the monthly average flows and temperatures as observed during the three years of study are listed in Table 1.

Table 1. Average Monthly flow and water temperatures in the Snake and Clearwater Rivers for 1998.

Month		Snake River @ Anatone		Clearwater @ Spalding		Snake River @ Brownlee Dam		Snake River @ Lower Granite Dam	
		Flow (kcfs)	Temp (°C)	Flow (kcfs)	Temp (°C)	Flow (kcfs)	Temp (°C)	Flow (kcfs)	Temp (°C)
1998	Jun	89.4	14.7	25.4	13.8	41.4		113.7	13.2
	Jul	43.0	21.1	20.4	16.2	22.1		61.7	18.1
	Aug	21.2	23.2	12.9	15.4	13.8		33.0	18.8
	Sep	24.6	21.6	3.4	17.4	18.4		26.7	18.6
2000	Jun	40.4	16.2	20.8	13.9	14.4		63.5	15.3
	Jul	23.4	20.4	14.9	13.7	16.1		37.8	19.3
	Aug	13.4	21.8	12.8	12.5	9.7		25.9	18.3
	Sep	18.8	18.4	3.1	14.0	15.0		21.9	19.4
2001	Jun	20.8	16.2	14.7	14.2	8.3		35.8	13.4
	Jul	13.7	20.7	12.6	14.8	9.3		26.7	18.5
	Aug	12.8	22.2	11.4	12.7	10.3		23.8	17.8
	Sep	13.0	20.4	2.8	16.6	9.7		14.5	17.8

Results Discussion - The average daily release temperatures from Lower Granite Dam were determined by simulating the hydrodynamic/thermal conditions throughout Lower Granite pool from April through August for 1998, 2000, and 2001. The daily average discharges and release water temperatures from Lower Granite Dam for the base flow and augmented flow scenarios are listed in Tables 2-4. Introducing the 100 KACF during July will likely cause a small (.1 to .2 C) increase in release water temperatures from Lower Granite Dam. The timing of this impact will be several days after the arrival of these waters to the pool and the duration will slightly longer than the 3 week period of higher flows. If the base flow releases from Brownlee are reduced later in the season as a result of the accelerated drafting of Brownlee pool in July, Lower Granite release temperatures could be slightly colder than shown by these simulations later in the summer.

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Table 2. Daily Average Release Flow and Water Temperature at Lower Granite Dam , 2001 Base Condition and 100 KACF Augmentation					
	Base Condition		100 KACF Augmentation		Temperature Change (C)
Date	Discharge (cms)	Temperature (C)	Discharge (cms)	Temperature (C)	
7/1/2001	784.1	19.1	784.1	19.1	0.0
7/2/2001	785.8	19.3	785.8	19.3	0.0
7/3/2001	803.9	19.7	803.9	19.7	0.0
7/4/2001	781.4	19.9	781.4	19.9	0.0
7/5/2001	787.6	20.0	787.6	20.0	0.0
7/6/2001	923.2	20.2	923.2	20.2	0.0
7/7/2001	965.9	20.2	965.9	20.2	0.0
7/8/2001	1009.0	20.4	1043.0	20.4	0.0
7/9/2001	957.3	20.1	1025.3	20.1	0.0
7/10/2001	1150.0	19.9	1218.0	19.9	0.0
7/11/2001	1143.8	20.0	1211.8	20.1	0.1
7/12/2001	1167.3	20.2	1235.3	20.3	0.1
7/13/2001	1064.7	20.4	1132.7	20.5	0.1
7/14/2001	1057.7	20.4	1125.7	20.5	0.1
7/15/2001	1003.2	20.3	1071.2	20.4	0.1
7/16/2001	990.4	20.2	1058.4	20.3	0.1
7/17/2001	994.4	20.1	1062.4	20.1	0.1
7/18/2001	998.5	19.9	1066.5	19.9	0.1
7/19/2001	907.3	19.6	975.3	19.7	0.1
7/20/2001	953.0	19.2	1021.0	19.2	0.0
7/21/2001	987.9	18.8	1055.9	18.9	0.1
7/22/2001	1011.1	18.6	1079.1	18.7	0.1
7/23/2001	895.9	18.5	963.9	18.6	0.1
7/24/2001	858.6	18.5	926.6	18.7	0.1
7/25/2001	859.5	18.8	927.5	18.9	0.1
7/26/2001	930.0	19.0	998.0	19.1	0.2
7/27/2001	905.7	19.5	973.7	19.7	0.1
7/28/2001	901.0	19.5	969.0	19.6	0.1
7/29/2001	825.0	19.8	859.0	19.9	0.1
7/30/2001	731.6	19.9	731.6	20.0	0.1
7/31/2001	733.3	20.1	733.3	20.1	0.0
8/1/2001	750.6	19.6	750.6	19.6	0.1
8/2/2001	764.1	19.1	764.1	19.2	0.1
8/3/2001	744.3	18.4	744.3	18.4	0.1
8/4/2001	673.1	18.0	673.1	18.0	0.0
8/5/2001	661.2	18.1	661.2	18.1	0.0
8/6/2001	659.9	18.0	659.9	18.0	0.0
8/7/2001	661.0	18.1	661.0	18.1	0.0
8/8/2001	654.2	18.0	654.2	18.0	0.0
8/9/2001	639.2	18.0	639.2	17.9	0.0
8/10/2001	645.1	18.0	645.1	18.0	0.0
8/11/2001	646.2	18.3	646.2	18.3	0.0
8/12/2001	648.5	18.2	648.5	18.1	0.0
8/14/2001	648.5	18.1	648.5	18.0	0.0
8/15/2001	641.7	18.1	641.7	18.1	-0.1
8/16/2001	640.6	18.4	640.6	18.3	-0.1
8/17/2001	641.7	18.3	641.7	18.2	-0.1

8/18/2001	651.2	18.3	651.2	18.1	-0.2
8/19/2001	637.0	18.3	637.0	18.2	-0.1
8/20/2001	646.8	18.1	646.8	18.0	-0.1
8/21/2001	644.7	18.0	644.7	18.0	-0.1
8/22/2001	577.9	17.7	577.9	17.7	-0.1
8/23/2001	576.1	17.6	576.1	17.5	0.0
8/24/2001	718.9	17.5	718.9	17.5	0.0
8/25/2001	714.7	17.2	714.7	17.2	0.0
8/26/2001	713.8	16.9	713.8	16.9	0.0
8/27/2001	703.4	16.9	703.4	16.9	0.0
8/28/2001	710.3	17.0	710.3	17.0	0.0
8/29/2001	603.9	17.0	603.9	17.0	0.0
8/30/2001	521.1	17.1	521.1	17.1	0.0
8/31/2001	442.0	17.2	442.0	17.2	0.0

Table 3. Daily Average Release Flow and Water Temperature at Lower Granite Dam , 2000 Base Condition and 100 KACF Augmentation					
	Base Condition		100 KACF Augmentation		Temperature Change (C)
Date	Discharge (cms)	Temperature (C)	Discharge (cms)	Temperature (C)	
7/1/2000	989.4	18.9	989.4	18.9	0.0
7/2/2000	950.6	19.3	950.6	19.3	0.0
7/3/2000	958.7	19.3	958.7	19.3	0.0
7/4/2000	951.9	19.1	951.9	19.1	0.0
7/5/2000	1021.2	18.8	1021.2	18.8	0.0
7/6/2000	1064.5	18.5	1064.5	18.5	0.0
7/7/2000	1056.8	18.2	1056.8	18.2	0.0
7/8/2000	1113.1	17.9	1147.1	17.9	0.0
7/9/2000	1278.1	17.9	1346.1	18.0	0.0
7/10/2000	1282.7	18.2	1350.7	18.3	0.1
7/11/2000	1290.8	18.3	1358.8	18.4	0.1
7/12/2000	1262.9	18.5	1330.9	18.6	0.1
7/13/2000	1327.4	18.7	1395.4	18.8	0.1
7/14/2000	1249.4	18.7	1317.4	18.8	0.1
7/15/2000	1190.2	18.8	1258.2	18.9	0.1
7/16/2000	1183.0	19.0	1251.0	19.1	0.1
7/17/2000	1198.7	19.1	1266.7	19.2	0.1
7/18/2000	1129.6	19.2	1197.6	19.3	0.1
7/19/2000	1074.6	19.1	1142.6	19.2	0.1
7/20/2000	1122.1	19.0	1190.1	19.1	0.1
7/21/2000	1121.5	18.9	1189.5	19.0	0.1
7/22/2000	1058.0	18.9	1126.0	19.0	0.1
7/23/2000	1019.4	19.1	1087.4	19.3	0.2
7/24/2000	995.9	19.4	1063.9	19.6	0.2
7/25/2000	1060.7	19.6	1128.7	19.7	0.2
7/26/2000	1056.5	19.8	1124.5	19.9	0.1
7/27/2000	1057.3	19.5	1125.3	19.5	0.1
7/28/2000	1028.4	19.4	1096.4	19.5	0.0
7/29/2000	867.4	19.2	901.4	19.3	0.0
7/30/2000	832.6	19.5	832.6	19.5	0.0
7/31/2000	801.9	19.1	801.9	19.2	0.1
8/1/2000	792.6	19.1	792.6	19.2	0.1
8/2/2000	815.5	19.2	815.5	19.2	0.1
8/3/2000	787.3	19.0	787.3	19.1	0.1
8/4/2000	755.2	19.0	755.2	19.0	0.0
8/5/2000	788.1	18.7	788.1	18.7	0.0
8/6/2000	790.8	18.5	790.8	18.5	0.0
8/7/2000	779.4	18.4	779.4	18.4	0.0
8/8/2000	771.6	18.4	771.6	18.4	0.0
8/9/2000	732.3	18.4	732.3	18.4	0.0
8/10/2000	782.5	18.7	782.5	18.7	0.0
8/11/2000	783.6	18.6	783.6	18.6	0.0
8/12/2000	779.7	18.5	779.7	18.5	0.0
8/14/2000	794.5	18.5	794.5	18.5	0.0
8/15/2000	778.3	18.5	778.3	18.5	0.0
8/16/2000	772.6	18.3	772.6	18.3	0.0
8/17/2000	786.1	18.3	786.1	18.3	0.0

8/18/2000	793.5	18.2	793.5	18.2	0.0
8/19/2000	809.0	17.8	809.0	17.8	0.0
8/20/2000	845.5	17.6	845.5	17.6	0.0
8/21/2000	715.4	17.4	715.4	17.4	0.0
8/22/2000	762.6	17.1	762.6	17.1	0.0
8/23/2000	708.1	17.0	708.1	17.0	0.0
8/24/2000	700.5	16.8	700.5	16.8	0.0
8/25/2000	698.4	16.6	698.4	16.6	0.0
8/26/2000	700.6	16.6	700.6	16.6	0.0
8/27/2000	694.0	16.6	694.0	16.6	0.0
8/28/2000	653.7	16.7	653.7	16.7	0.0
8/29/2000	645.5	17.0	645.5	17.0	0.0
8/30/2000	579.3	17.4	579.3	17.4	0.0
8/31/2000	554.1	17.5	554.1	17.5	0.0

Table 4. Daily Average Release Flow and Water Temperature at Lower Granite Dam , 1998 Base Condition and 100 KACF Augmentation					
	Base Condition		100 KACF Augmentation		Temperature Change (C)
Date	Discharge (cms)	Temperature (C)	Discharge (cms)	Temperature (C)	
7/1/1998	2324.7	16.2	2324.7	16.2	0.0
7/2/1998	2295.2	17.1	2295.2	17.1	0.0
7/3/1998	2350.1	17.7	2350.1	17.7	0.0
7/4/1998	2477.1	18.2	2477.1	18.2	0.0
7/5/1998	2316.5	18.4	2316.5	18.4	0.0
7/6/1998	2158.6	18.4	2158.6	18.4	0.0
7/7/1998	1988.6	18.6	1988.6	18.6	0.0
7/8/1998	1866.5	19.0	1900.5	19.0	0.0
7/9/1998	1873.3	19.5	1941.3	19.5	0.0
7/10/1998	1863.4	20.1	1931.4	20.1	0.0
7/11/1998	1938.1	20.6	2006.1	20.7	0.0
7/12/1998	1883.2	21.1	1951.2	21.1	0.0
7/13/1998	1842.2	20.9	1910.2	20.8	0.0
7/14/1998	1877.1	20.3	1945.1	20.2	-0.1
7/15/1998	1741.9	19.8	1809.9	19.8	0.0
7/16/1998	1684.9	19.6	1752.9	19.6	0.0
7/17/1998	1602.8	19.6	1670.8	19.7	0.0
7/18/1998	1613.1	19.8	1681.1	19.9	0.1
7/19/1998	1615.0	20.0	1683.0	20.1	0.1
7/20/1998	1561.8	20.1	1629.8	20.2	0.1
7/21/1998	1553.6	20.4	1621.6	20.4	0.1
7/22/1998	1587.2	20.3	1655.2	20.4	0.1
7/23/1998	1602.9	19.9	1670.9	19.9	0.0
7/24/1998	1529.3	19.4	1597.3	19.5	0.1
7/25/1998	1505.7	19.5	1573.7	19.6	0.1
7/26/1998	1464.7	19.7	1532.7	19.8	0.1
7/27/1998	1567.1	19.9	1635.1	19.9	0.1
7/28/1998	1543.7	19.7	1611.7	19.9	0.1
7/29/1998	1463.8	20.0	1487.8	20.2	0.2
7/30/1998	1457.0	20.2	1457.0	20.4	0.2
7/31/1998	1485.8	20.4	1485.8	20.6	0.2
8/1/1998	1483.0	20.2	1483.0	20.4	0.1
8/2/1998	988.6	20.1	988.6	20.2	0.1
8/3/1998	1017.5	19.9	1017.5	20.0	0.0
8/4/1998	1316.4	19.7	1316.4	19.7	0.0
8/5/1998	1239.8	20.1	1239.8	20.1	0.0
8/6/1998	1228.0	21.2	1228.0	21.2	0.0
8/7/1998	1148.6	20.9	1148.6	20.9	0.0
8/8/1998	1093.0	20.9	1093.0	20.9	0.0
8/9/1998	1036.2	20.8	1036.2	20.8	0.0
8/10/1998	1108.4	20.6	1108.4	20.6	0.0
8/11/1998	1138.5	20.6	1138.5	20.6	0.0
8/12/1998	1117.3	20.2	1117.3	20.2	0.0
8/14/1998	1129.7	20.1	1129.7	20.1	0.0
8/15/1998	1155.9	20.3	1155.9	20.3	0.0
8/16/1998	1085.1	20.3	1085.1	20.3	0.0
8/17/1998	990.4	20.4	990.4	20.4	0.0

8/18/1998	909.1	20.4	909.1	20.4	0.0
8/19/1998	1025.9	20.4	1025.9	20.4	0.0
8/20/1998	1019.8	20.2	1019.8	20.2	0.0
8/21/1998	1024.7	19.9	1024.7	19.9	0.0
8/22/1998	980.3	19.3	980.3	19.3	0.0
8/23/1998	834.6	19.0	834.6	19.0	0.0
8/24/1998	776.8	18.9	776.8	18.9	0.0
8/25/1998	689.3	18.7	689.3	18.7	0.0
8/26/1998	741.4	18.7	741.4	18.7	0.0
8/27/1998	663.8	19.0	663.8	19.0	0.0
8/28/1998	636.5156	19.0	636.5156	19.0	0.0
8/29/1998	682.8323	19.2	682.8323	19.2	0.0
8/30/1998	657.8226	19.6	657.8226	19.6	0.0
8/31/1998	651.0245	20.1	651.0245	20.1	0.0

Attachment 2

Analysis of Summer Spill Flow Augmentation -- Brownlee Flow Offset

JDR
6/28/2004

Using B. Connor's (USFWS) regression model to estimate SR fall chinook survival:
Juv. SR fall chinook survival = 140.82753 + 0.02648*Flow(cms) - 7.14437*Temp(degrees C)

Estimated Juv. Fish Survival Effect of Add'l. 100 Kaf Draft from Brownlee Reservoir:

<u>Based on temp. modeling for a very low (2001) summer flow year:</u>

Base case assumptions for flow & temp: July 8-29 avg flow = 980.5 cms and avg water temp of 19.5 C

Juv. survival% = 27.5

July flow augment. assumptions: July augmented flow =1045.4 cms and avg water temp of 19.6C

Juv. survival% = 28.5

%change in surv. = **1.0**

<u>Based on temp. modeling for moderate (2000) summer flow year:</u>

Base case assumptions for flow & temp: July 8-29 avg flow = 1134.9 cms and avg water temp of 19.0 C

Juv. survival% = 35.1

July flow augment. assumptions: July augmented flow =1199.8 cms and avg water temp of 19.1C

Juv. survival% = 36.1

%change in surv. = **1.0**

<u>Based on temp. modeling for abv average (1998) summer flow year:</u>

Base case assumptions for flow & temp: July 8-29 avg flow = 1671.9 cms and avg water temp of 20.06 C

Juv. survival% = 41.8

July flow augment. assumptions: July augmented flow =1736.3 cms and avg water temp of 20.14C

Juv. survival% = 42.9

%change in surv. = **1.1**

Analysis of Summer Spill Flow Augmentation -- Brownlee Flow Offset JDR 6/28/2004

Total 2003 Population of Listed Wild Fall Chinook at Head of LWG Reservoir = 1,912,000 juveniles

Approx. 29% of total wild fall chinook prod'n.* in Snake Basin is Clearwater R. = 554,500 juveniles

Thus 71% of total wild fall chinook prod'n.* in Snake Basin is from Snake, Grande Ronde, Imnaha, and Salmon rivers = 1,357,500 juveniles.

Est'd. juvenile fish survival of BRN flow aug. = % migration affected x fish popul x survival estimate

Early Fish Migration -- Low Flow Condition

	95% Lower Prediction	Est'd. Survival	95% Upper Prediction
Clearwater R. fish:			
Base case low Q	42711	59623	76534
w/100 Kaf from BRN	44880	61791	78702
Estimated benefit		**2168**	
Snake R. fish:			
Base case low Q	46800	65330	83860
w/100 Kaf from BRN	49175	67705	86235
Estimated benefit		**2376**	
Total est'd. benefit	**at LWG Dam is:**	**4544**	
		High Impact	**Low Impact**
After adjustmt. for passage thru FCRPS:		**714**	**739**

Middle Fish Migration -- Low Flow Condition

	95% Lower Prediction	Est'd. Survival	95% Upper Prediction
Clearwater R. fish:			
Base case low Q	14528	20281	26033
w/100 Kaf from BRN	15266	21018	26771
Estimated benefit		**737**	
Snake R. fish:			
Base case low Q	115529	161271	207013
w/100 Kaf from BRN	121393	167135	212878
Estimated benefit		**5864**	
Total est'd. benefit	**at LWG Dam is:**	**6602**	
		High Impact	**Low Impact**
After adjustmt. for passage thru FCRPS:		**1038**	**1074**

Late Fish Migration -- Low Flow Condition

	95% Lower Prediction	Est'd. Survival	95% Upper Prediction
Clearwater R. fish:			
Base case low Q	10924	15249	19574
w/100 Kaf from BRN	11478	15803	20128
Estimated benefit		**554**	
Snake R. fish:			
Base case low Q	110180	153805	197429
w/100 Kaf from BRN	115773	159398	203022
Estimated benefit		**5593**	
Total est'd. benefit	**at LWG Dam is:**	**6147**	
		High Impact	**Low Impact**
After adjustmt. for passage thru FCRPS:		**967**	**1000**

* Fall Chinook production data taken from "Fall Chinook Salmon Spawning Ground Surveys in the Snake River Basin Upriver of Lower Granite Dam, 2002," by USFWS, Nez Perce Tribe and Idaho Power Company. September 2003. Report prepared for USDOE-BPA; project #199801003.

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Est'd. juvenile fish survival of BRN flow aug. = % migration affected x fish popul x survival estimate

Early Fish Migration -- Moderate Flow Condition

	95% Lower Prediction	Est'd. Survival	95% Upper Prediction
Clearwater R. fish:			
Base case low Q	62658	76100	89759
w/100 Kaf from BRN	64826	78268	91927
Estimated benefit		**2168**	
Snake R. fish:			
Base case low Q	68656	83384	98351
w/100 Kaf from BRN	71031	85760	100727
Estimated benefit		**2376**	
Total est'd. benefit at LWG Dam is:		**4544**	
		High Impact	**Low Impact**
After adjustmt. for passage thru FCRPS:		**714**	**739**

Middle Fish Migration -- Moderate Flow Condition

	95% Lower Prediction	Est'd. Survival	95% Upper Prediction
Clearwater R. fish:			
Base case low Q	21313	25886	30532
w/100 Kaf from BRN	22051	26623	31269
Estimated benefit		**737**	
Snake R. fish:			
Base case low Q	169481	205840	242786
w/100 Kaf from BRN	175346	211705	248651
Estimated benefit		**5864**	
Total est'd. benefit at LWG Dam is:		**6602**	
		High Impact	**Low Impact**
After adjustmt. for passage thru FCRPS:		**1038**	**1074**

Late Fish Migration -- Moderate Flow Condition

	95% Lower Prediction	Est'd. Survival	95% Upper Prediction
Clearwater R. fish:			
Base case low Q	16025	19463	22956
w/100 Kaf from BRN	16580	20017	23511
Estimated benefit		**555**	
Snake R. fish:			
Base case low Q	161635	196311	231546
w/100 Kaf from BRN	167228	201904	237139
Estimated benefit		**5593**	
Total est'd. benefit at LWG Dam is:		**6147**	
		High Impact	**Low Impact**
After adjustmt. for passage thru FCRPS:		**967**	**1000**

Total 2003 Population of Listed Wild Fall Chinook at Head of LWG Reservoir = 1,912,000 juveniles

Approx. 29% of total wild fall chinook prod'n.* in Snake Basin is Clearwater R. = 554,500 juveniles

Thus 71% of total wild fall chinook prod'n.* in Snake Basin is from Snake, Grande Ronde, Imnaha, and Salmon rivers = 1,357,500 juveniles.

Est'd. juvenile fish survival of BRN flow aug. = % migration affected x fish popul x survival estimate

Early Fish Migration -- Above Average Flow Condition

	95% Lower Prediction	Est'd. Survival	95% Upper Prediction
Clearwater R. fish:			
Base case low Q	69596	90626	111657
w/100 Kaf from BRN	70897	93011	115343
Estimated benefit		**2385**	
Snake R. fish:			
Base case low Q	76258	99301	122345
w/100 Kaf from BRN	77683	101914	126383
Estimated benefit		**2613**	
Total est'd. benefit	**at LWG Dam is:**	**4998**	
		High Impact	**Low Impact**
After adjustmt. for passage thru FCRPS:		**786**	**813**

Middle Fish Migration -- Above Average Flow Condition

	95% Lower Prediction	Est'd. Survival	95% Upper Prediction
Clearwater R. fish:			
Base case low Q	23673	30827	37980
w/100 Kaf from BRN	24116	31638	39234
Estimated benefit		**811**	
Snake R. fish:			
Base case low Q	188247	245132	302017
w/100 Kaf from BRN	191766	251583	311986
Estimated benefit		**6451**	
Total est'd. benefit	**at LWG Dam is:**	**7262**	
		High Impact	**Low Impact**
After adjustmt. for passage thru FCRPS:		**1142**	**1182**

Late Fish Migration -- Above Average Flow Condition

	95% Lower Prediction	Est'd. Survival	95% Upper Prediction
Clearwater R. fish:			
Base case low Q	17799	23178	28557
w/100 Kaf from BRN	18132	23788	29499
Estimated benefit		**610**	
Snake R. fish:			
Base case low Q	179532	233783	288034
w/100 Kaf from BRN	182888	239935	297542
Estimated benefit		**6152**	
Total est'd. benefit	**at LWG Dam is:**	**6762**	
		High Impact	**Low Impact**
After adjustmt. for passage thru FCRPS:		**1063**	**1100**