APPENDIX A

Additional Information on the Updated Impacts Analysis For the Proposed Summer Spill Reductions

We have made several refinements to the impacts analysis in response to comments received. Those refinements include:

1. Updating the hatchery release estimates based on actual 2003 releases.
2. Correcting some of hatchery releases numbers that had been double-counted.
3. Removing yearlings from the analysis, which are released in the springtime and should be unaffected by the proposed summer spill change.
4. Analyzing the specific operation that is proposed.
5. Correcting an erroneous equation within the Simpas model.

Taking all of these comments into account, our updated estimated impacts are shown in Table 1. The numbers in Table 1 are in terms of fish surviving to below Bonneville, including transport and in-river migrants. For instance, the proposed operation will result in approximately 177,000 less Hanford Reach juveniles surviving below Bonneville Dam compared to the BiOp operation. These 177,000 fish are about 1.7 percent of the number of Hanford Reach juvenile that would otherwise survive to below Bonneville under the full BiOp spill operation.

Table 1. Estimated Impact of the Proposed Operation (Estimated Differences Between Proposed Operation and July-August BiOp spill).

FALL CHINOOK	Action Agency Impact Estimate	
Upriver Bright		
Priest Rapids & Ringold Hatcheries	72,000	1.7%
Hanford Reach Natural	177,000	1.7%
Yakima River & Marion Drain	5,000	1.6%
Snake River Bright		
Listed Wild Snake River	900	0.5%
Lyons Ferry Hatchery*	1,000	0.5%
Nez Perce Hatchery and Hatchery Releases at Hells Canyon	1,000	0.5%
Mid-Columbia Bright		
Deschutes River	10,000	2.2%
Klickitat River	13,000	1.0%
Umatilla River	5,000	4.5%
Little White Salmon River	7,000	1.0%
SUMMER CHINOOK		
Upper-Columbia	18,000	1.7%
TOTAL LISTED Juveniles	900	0.5%
converted to adults with 0.5 to 4% SAR	5 to 36	0.5%

TOTAL Juveniles	309,000	1.6%
converted to adults with 0.5 to 4% SAR	1,545 to 12,360	1.6%

*part of the Snake River fall chinook ESU but not part of the listing

A number of other comments were also received but resulted in no change to the analysis after careful consideration as described below. These comments include:

1. **Comment: Inappropriate use of the Simpas model, particularly when extrapolating to adult returns.** Response: The Simpas model is widely used within the Regional Forum for management decisions on the hydro system. NOAA Fisheries developed the Simpas model for use in development of the 2000 BiOp, and the Corps used the model in its December 2002 "Bonneville Decision Document: Juvenile Fish Passage Recommendation" to evaluate the relative benefits of operational and structural modifications. NOAA also used the model to evaluate effects of the difficult operations in 2001 in response to drought conditions and power shortages. The Council used SIMPAS for its own 2003 summer spill analysis. The Simpas model has been criticized for not being able to predict survival with great certainty. Unfortunately, all of the survival models available rely on assumptions on passage parameters that are not always known. For purposes of relative comparisons, Simpas is sufficient to partition the fish into the different passage routes of differing expected survivals to determine potential relative differences in overall survival. Certainly, use of more complex life cycle models is also problematic, as they project into an uncertain future using assumptions from the past.

NOAA Fisheries now accepts that in a comparative analysis applying Simpas results to the estimated number of juvenile migrants along with a range of adult return rates is a reasonable means of estimating relative effects of operational alternatives on adult returns, especially when using a range of adult return rates that is wide enough to encompass the uncertainties that are not addressed by Simpas, and so long as the uncertainties are explained to and understood by the end-user of the analysis (personal communication with Gary Fredericks). Our executives, who have considered this analysis in making a decision about summer spill, are fully aware of the issues of uncertainty. There are other models that can estimate relative survival and adult return rates, but every model is going to have uncertainties so long as the data continues to show uncertainties. There will likely always be uncertainty in the passage survival rates, rates of delayed mortality after transportation, rates of delayed mortality after bypass system passage, effects of operations on pool or reach survival, etc. due to the costly and time-consuming nature of the studies and, more importantly, natural variability may preclude ever coming to resolution on these issues. Simpas is a relatively simple spreadsheet of numerous tedious calculations that can be used for relative survival analyses based on the best available data. The model itself does not include a risk or uncertainty analysis feature. However, the user can address risk and uncertainty in the model input or by applying the results in a risk-averse manner. In the summer spill impacts analysis, the Simpas results were applied to a range of adult return rates including a high but unlikely potential adult return rate. By overestimating the adult return rates, the analysis overestimated the expected adult impacts in order to mitigate for some of the risk and uncertainty associated with the operations under consideration. Smolt-to-adult return rates (SAR) represent "cradle to grave" performance of salmonids. The broad SAR range therefore captures potential actual uncertainty even if ranges for individual parameters are not explicitly addressed. Risk and uncertainty can be mitigated further by erring on the side of fish in the offset calculations and in the extent of biological offsets that are implemented. For instance, implementing offsets that are estimated to increase survival by 10,000 adult returns can alleviate the risk and uncertainty of implementing an operation that is estimated to decrease survival by 5,000 adult returns.

Nevertheless, being mindful of the criticism surrounding the use of Simpas in this analysis, we requested that the University of Washington's Columbia Basin Research Center perform a comparison of fall chinook stock survivals under the Bi-Op and two alternative summer spill programs using the Columbia River Salmon Passage Model (CRiSP). The two summer spill programs consisted of: first, BiOp spill in July with no August spill and, second, Bi-Op operations without July and August spill. CRiSP models salmonid passage and survival through the Columbia River, its tributaries, and estuary. The CRiSP analysis found very similar results to the Simpas-based analysis. Attachment A includes the results of the analysis and brief description of the CRiSP model.

2. **Comment: Delayed transportation mortality "D" was not taken into account.** Response: We used a D value of 24% for Snake River fall chinook, as this is the value used in the NMFS 2000 BiOp. We did not use a D value for Columbia River stocks since no estimate of D for these stocks is available. Additionally, and perhaps more importantly, the analysis is not sensitive to D since the proposed operation does not significantly affect the number of fish being transported. The reason that transported fish are largely unaffected by the proposed operation is that the proposal does not change operations at transportation projects. See attachment A for further discussion on D relative to the impacts analysis.

3. **Comment: Analysis is inadequate, flawed, and significantly underestimates the impacts.** Response: We disagree that the analysis is inadequate, flawed, and does not provide an adequate basis for a decision. We used a wide range of SAR's (smolt-to-adult return rates) of up to 4% to ensure that our estimated impacts are conservatively high in terms of adult returns. Additionally, in an attempt to put some sideboards on the impacts analysis, we performed alternative analyses to crosscheck our main impacts analysis and ensure that our results are reasonable. We performed the following alternative analyses: 1) an adult-return-based analysis, 2) a comparison of estimated returns to actual returns, and 3) a Columbia River Salmon Passage Model (CRiSP) analysis. These alternative analyses all confirm that our analysis is within reason, as described in attachment A.

4. **Comment: Spill is the safest fish passage route.** Response: While we agree that spill is generally the safest passage route, survival through the other passage routes is nearly as high in most cases. For instance, as shown in our impacts analysis, spill survival at Bonneville Dam is estimated at 98 percent, bypass survival is estimated at 95 to 98 percent, and turbine survival is estimated at 90 to 94 percent. There are definitely some lower survival routes of concern, like the 72 percent turbine survival estimate at John Day, the 82 percent turbine survival estimate at McNary, and the 84 percent turbine survival estimate at The Dalles. However, those low survival estimates were accounted for in the impacts analysis, directly within the Simpas survival input parameters, and the associated impacts were taken into account when deciding upon the proposed spill reduction. Based on the fairly detailed impacts analysis, we believe the impacts of the proposed spill reductions can be offset with other more cost effective actions.

5. **Comment: Analysis should have evaluated increased spill, particularly on the Snake River.** Response: Since our objective was to evaluate less costly ways of improving survival, we did not evaluate a costly spill increase.

6. **Comment: Analysis should have included delayed hydrosystem mortality, extra mortality, and/or multiple bypass mortality.** Response: We did not include extra mortality or delayed multiple bypass mortality or delayed hydrosystem mortality in the impacts analysis because there is no estimate available and we are not convinced that it exists. Most analyses that conclude that these delayed mortalities exist are based on comparing detected fish to undetected fish. We disagree with these analyses because of the extremely small sample sizes. Additionally, the undetected fish can be explained by any number of possibilities including: 1) fish that are actually transported and not detected for various reasons; 2) fish that migrate after the juvenile fish facility closes in the fall and before the spring; 3) fish that pass through turbines; 4) fish that pass through spillways; and 5) fish that pass downstream through other routes such as fish ladders and navigation locks. Given the small sample sizes and uncertainty surrounding undetected fish, we are not convinced that these hypothesized delayed mortalities exist.

7. **Comment: Analysis should have evaluated full range of uncertainty, particularly with run timing.** We initially chose to reflect uncertainty primarily within the high range of SAR's. After further consideration, we evaluated the uncertainty of run timing in a couple of different ways. First, we estimated impacts as if 100 percent of the migration occurred within July and August. Second, we estimated impacts based on selecting from post-1995 data, the migration timing with the most fish migrating in August. Based on these analyses, we concluded that our estimates are still within reason. A summary of these analyses is included in Attachment A.

8. **Comment: Analysis does not correspond with historic data.** Response: The impacts analysis considers dam and reservoir survival estimates such that even if the Simpas dam survival estimates are low, the system survival estimates appear to be reasonable since they take reservoir survival into account. As evidence, we crosschecked survival estimates from the impacts analysis with empirical data. More specifically, we compared results from our BiOp operations survival evaluation for Snake River populations to the subyearling chinook reach survival empirical data in Appendix D of the NMFS 2000 BiOp, Tables D-13 through D-17. In making this comparison, we conclude that the Simpas Survival estimate appears to be reasonable, within the range of past in-river survival estimates based on empirical data. This comparison is included in Attachment A. Additionally, our estimated adult returns for the BiOp operation compare favorably to the estimated actual returns. This analysis is also included in Attachment A and described under comment 11 below.

9. **Comment: Analysis does not account for forebay delay and increased predation due to spill reductions.** Response: The analysis does account for increase forebay delay and predation with spill reductions. As described in the "Comments on Simpas Input" tab of the Impacts Analysis posted for public review, we reduced the pool survival input parameters to Simpas by 0.5 to 1 percent for Bonneville, The Dalles, John Day, and Ice Harbor whenever evaluating an operation with reduced spill. Some have suggested that a 4 percent increase in pool mortality is more appropriate based on a comparison of 2001 and 2003 Ice Harbor pool survival data, which we have not seen. We question the appropriateness of comparing across years, particularly in the case of 2001, which was a very unusual year. We also question the appropriateness of attributing the full difference in survival to spill operations, as other factors may have attributed to the survival difference between those years,

such as river flows, water temperatures, and predator abundance. We will review the data analysis when it becomes available and provide comments as appropriate.

10. **Comment: Adult return rates are over-estimated.** We agree that the upper end of our 0.5 to 4 percent SAR range is high for most stocks. In fact the lower end of this SAR range is high for many stocks. This was done intentionally in order to over-estimate our impacts. We used the SAR to encompass the risk and uncertainty in the adult return impacts estimate rather than addressing that risk and uncertainty within the juvenile impacts estimate.

11. **Comment: Adult return rates are under-estimated.** We crosschecked our analysis by comparing the range of estimated returning adults for the BiOp operation to the estimated actual returns. This comparison is shown in Attachment A. The comparison shows that the estimated survival is within reason, and the actual returns tend to fall toward the lower end of the SAR range. We also considered using a higher range of SAR's, but found that to result in unreasonably high returns. For example, starting with 50 million smolts, applying a 50 percent average system survival, and then applying a 10 percent SAR, results in 2.5 million estimated adults (50million x 50% x 10% = 2.5 million) returning to Bonneville. In reality, only 200,000 to 500,000 adult typically return to Bonneville, which is more in line with a 1 to 2% SAR.

12. **Comment: Analysis did not account for increased mortality associated with adult fallback.** Response: The adult passage data for comparing spill versus no spill operations is extremely limited. However, our analysis of the limited available data showed no difference in the system-wide escapement of steelhead. Our analysis compared 2000, 2001, and 2002 adult escapement, which included hundreds of fish, and no real difference in the system-wide escapements was detected. Based on this data, at this time we have no evidence to support that the proposed no-spill operation in August would affect system-wide escapement of steelhead, the most appropriate method for measurement. Details of our analysis are included in Attachment B.

Attachment A
Alternative Analyses Corroborating the Simpas-base Impact Estimates

We performed the following alternative analyses: 1) an adult-return-based analysis, 2) a comparison of estimated returns to actual returns, 3) a similar analysis using the Columbia River Salmon Passage Model (CRiSP), 4) an analysis of different delayed mortality D values, 5) a comparison of modeled and empirical in-river reach survival, and 6) analyses of different migration timing assumptions. These alternative analyses all confirm that our analysis is within reason. We also evaluated potential additional impacts to adults associated with fallback. These analyses are all described below.

<u>Adult Return Based Analysis</u>

The adult-return-based analysis takes the assumptions of juvenile production and SARs out of the equation. Instead, we applied estimated survival changes to actual returns to ensure that our main impacts analysis was reasonable, primarily in response to comments of concern that our juvenile production estimates should have included a range and that our range of SARs is too low. More specifically, we did the following:

1. We assumed that all (100%) of the fall chinook will migrate in July and August and be subjected to the survival reduction associated with the proposed spill reductions. NOTE: This is not, in fact, true and overstates the impacts of the spill reduction. The main analysis assumed that 65% of the overall migration occurs in July and August based on average fish passage timing data. The assumption of 100% migration in July and August is only made in order to evaluate worst case migration timing.
2. We identified the lowest system survival of the various operational scenarios that were evaluated, which is the operation with no spill in July and August, and we estimated the maximum survival impact compared to BiOp operations. NOTE: The proposed operation provides spill in July and provides higher survival than the no-spill operation. The low-survival estimate of the no-summer-spill operation is only used her to evaluate a worst-case survival rate.
3. We compiled data on past adult escapements from a variety of sources for the affected stocks. See Tables 1 and 2 for data and sources of escapement numbers. We estimated escapement impacts to the actual average and maximum escapement estimates for each stock using the lowest-survival spill scenario with the 100% July-August migration timing. This impact was estimated by multiplying the highest survival impact (which is for the no-summer-spill alternative) by the average and maximum escapement estimates.

The results of this analysis are shown in Table 1. The analysis shows that the estimated total impact on average adult escapement for these stocks is about 5,000 adults, and the estimated impact on maximum adult escapement for these stocks is about 12,000 adults. This represents an overall impact of about 5% on adult escapement, but this varies widely among stocks. For example, for Priest Rapids hatchery fish, average escapement (1990-2000) was 13,638 adults, while the maximum escapement was 26,450. The impact is quantified by using the estimated worst-case survival divided by BiOp spill survival, which is 0.949 for the Priest Rapids hatchery fish. So the impact on average escapement would be 696 adults [i.e., 13,638 - (13,638 X 0.949) = 696], while the impact on maximum escapement would be 1349 [i.e., 26,450 - (26,450 X 0.949) = 696],. Total impacts are shown in the last line of the table. Unfortunately we were not able to find escapement data for all of the stocks potentially affected by summer operations, so the total impacts estimated in this table should not be compared to the total estimated impacts in the impacts analysis without taking that into account. Individual stock estimates can be compared, as these are based on the best available data.

This analysis helps bound the more detailed Action Agency analysis. It does not require estimates of the numbers of juvenile migrants or their migration timing or smolt-to-adult return rates, like the earlier analysis. However, it does reinforce the earlier results in estimating that, for most fall chinook stocks, impacts are modest and are especially low for listed Snake River fall chinook. For instance, the main analysis estimates that 1,000 to 6,000 Priest Rapids Hatchery adults would be impacted in an average water year by the no-summer-spill operation, while this adult-return-based analysis estimates 696 to 1349 adults would be impacted. Additionally, the main analysis estimates that 10 to 80 listed adult Snake River fall chinook would be impacted, while this adult-based analysis estimates 10 to 53. This is one alternative analysis method we used to ensure that our estimated impacts are not unreasonably low. On the other hand, we were unable to locate data on recent (2000-2003) returns for many stocks. In cases where recent adult returns are higher than previous years, our maximum adult impacts based on this method would increase, although the percentage changes would remain the same. Nevertheless, this alternative analysis provides some evidence based on best available data that the more detailed impacts analysis seems to be within reason and may over-estimate the impacts.

Table 1. Estimated Impacts to Adult Escapement Based on Lowest System Survival (No Spill Operation) and Worst-case Migration Timing Compared to BiOp Spill Operations.

Stock	Average Escapement	Maximum Escapement	Juvenile Survival Impact*	Average Impact to Adult Escapement	Maximum Impact to Adult Escapement
Priest Rapids Hatchery	13,638	26,450	0.949	696	1349
Hanford Natural	35,764	48,295	0.949	1824	2463
Yakima River fall Chinook	1,828	6,146	0.949	93	313
Marion Drain fall Chinook	no data found	no data found			
Ringold Springs Hatchery	no data found	no data found			
Wild Snake River Fall Chinook	1,040	5,163	0.990	10	53
Lyons Ferry Hatchery	2,493	7,831	0.990	25	78
Nez Perce Tribal Hatchery	no data found	no data found			
Deschutes River fall Chinook	8,337	20,811	0.916	700	1748
Klickitat River fall Chinook	4,404	11,845	0.971	128	344
Umatilla River fall Chinook	547	1,146	0.808	105	220
Little White Salmon fall Chinook	4,641	7,699	0.971	135	223
Upper-Columbia summer Chinook	23,486	99,527	0.949	1198	5076
Totals	95,327	228,084	-	4,905	11,798

* No-Spill System Survival Estimate divided by BiOp System Survival Estimate.

Table 2. Escapement Data and Sources. Blank cells in the table show where no data was available.

Stock & Data Source	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Upriver Bright													
Priest Rapids Hatchery -PR Hatchery & Wild Adult Returns	5,148	4,046			16,330	13,625	16,616	14,200	15,808	26,450	10,515		
Hanford Natural Spawning Population	39,170	30,505	28,766	30,557	48,295	38,381	37,548	37,685	29,682	27,720	36,027	44,827	
Yakima River fall Chinook -Prosser Natural & Hatchery Adult Count	1,505	865	1,500	1,056	1,357	827	1,179	1,031	1,064	1,705	1,864	3,665	6,146
Snake River Bright													
Wild Snake River Fall Chinook- PSC Chinook TAC	78	318	549	742	406	350	639	797	306	905	1,148	5,163	2,116
Snake Wild est. @ LGR													
Lyons Ferry Hatchery-StreamNet	1,662	1,366	1,331	996	798	2,934	1,442	1,190	2,976	3,416	1,393	5,070	7,831
Mid-Columbia Bright													
Deschutes River fall Chinook- PSC Chinook TAC Terminal Run Est.	3,194	3,832	2,814	8,246	5,524	7,617	8,837	20,811	11,428	4,370	3,637	11,391	16,681
Klickitat River fall Chinook- Streamnet "Natural Adult"	2,957	1,823	2,357	1,196	2,493	1,608	5,337	5,699	7,538	11,845	5,895	4,098	
Umatilla River fall Chinook- Streamnet Threemile Dam Count	333	522	239	370	688	603	646	354	286	737	643	1,146	
Little White Salmon fall Chinook- StreamNet							7,493	7,699	3,968	2,977	2,818	3,625	3,907
Upper-Columbia summer Chinook													
Upper-Columbia summer Chinook- PSC Chinook TAC Terminal Run Est.	16,827	12,343	9,588	13,887	14,155	11,247	10,289	13,092	12,735	19,963	22,585	49,078	99,527

Comparison of Estimated Returns to Actual Returns

We also crosschecked our main impacts analysis by comparing our estimated returns to actual returns. We converted the estimated number of surviving juveniles under the BiOp operation to adults using a SAR range of 0.5 to 4.0 percent. We then compared this range of estimated returning adults to the estimated actual returns shown in Tables 1 and 2. This comparison is shown in Table 3. The comparison shows that the estimated survival is within reason, and the actual returns tend to fall toward the lower end of the SAR range. For instance, the average returns to Hanford Reach have been 35,764 adults with a maximum of 48,295, and the impacts analysis estimates 77,648 with a 0.5% SAR to over 600,000 returns with a 4% SAR. This tends to discredit some claims that the SARs used in the analysis are too low. Another stock of great interest is the listed wild Snake River fall Chinook. For this stock, the estimated escapement is 1,068 to 8,544, and the average and maximum actual returns have been 1,040 and 5,163 respectively. Again, the numbers from the analysis appear to be reasonable and not significantly low. If anything, one would conclude from this table that the range of SARs used in the analysis is generally high. The use of a SAR range the encompasses the high 4% return rate was used intentionally in order to conservatively over-estimate the impacts when converting survival impacts to adult return impact.

Table 3. Comparing Estimated Adult Escapement from the Impacts Analysis to Actual Returns.

Stock	Actual Average Escapement	Actual Maximum Escapement	Estimated Escapement from Summer Spill Impacts Analysis			
			0.5% SAR	1% SAR	2% SAR	4% SAR
Priest Rapids Hatchery	13,638	26,450	20,810	41,619	83,238	166,477
Hanford Natural	35,764	48,295	77,648	155,295	310,590	621,181
Yakima River fall Chinook	1,828	6,146	3,137	6,274	12,548	25,096
Wild Snake River Fall Chinook	1,040	5,163	1,068	2,136	4,272	8,544
Lyons Ferry Hatchery	2,493	7,831	1,322	2,644	5,289	10,579
Deschutes River fall Chinook	8,337	20,811	5,200	10,400	20,800	41,600
Klickitat River fall Chinook	4,404	11,845	16,672	33,344	66,688	133,375
Umatilla River fall Chinook	547	1,146	1,675	3,350	6,700	13,399
Little White Salmon fall Chinook	4,641	7,699	8,336	16,672	33,344	66,688
Upper-Columbia summer Chinook	23,486	99,527	7,994	15,988	31,976	63,953

<u>CRiSP Analysis</u>

Being mindful of the criticism surrounding the use of Simpas in this analysis, we requested that the University of Washington's Columbia Basin Research Center perform a comparison of fall chinook stock survivals under the Bi-Op and two alternative summer spill programs using the Columbia River Salmon Passage Model (CRiSP). The two summer spill programs consisted of: first, BiOp spill in July with no August spill and, second, Bi-Op operations without July and August spill. CRiSP models salmonid passage and survival through the Columbia River, its tributaries, and estuary. A brief description of the model is presented at the end of this report and complete details are available at www.cbr.washington.edu/crisp/crisp.html.

CRiSP takes the following parameters as inputs for each pool and project: daily water temperature, daily flow, hourly spill, daily water elevation, daily headwater dissolved gas, daily transport operation, and daily fish release schedules. In this case, the analysis was done for a medium flow year (1960).

CRiSP is most effective as an analysis tool when few parameters are changed from scenario to scenario. Monthly and semi-monthly project flows and spills were provided by the NPPC for the BiOp scenario. Taking into account operation limits, spill percents were then reduced to their minimums for the two alternative spill scenarios. All scenarios were run with the same stock release schedules, headwater dissolved gas levels, water temperatures, and transport schedules.

The potential impacts on Snake and Upper Columbia fall chinook stocks were examined by using the average smolt index profile at Rock Island (RIS) and Lower Granite (LGR) dams. Snake River fall chinook were released at LGR Dam with a release timing modeled after the average smolt index at the dam from 1995-2003. Upper Columbia fall chinook were released in the Rock Island tailrace with a release timing modeled after the average smolt index at RIS from 1995-2003. Hanford Reach fall Chinook were released at river kilometer 593 with a single release profile modeled after the cumulative "1 3 W" PIT-tag releases in the Hanford Reach. All stocks were modeled through the Bonneville tailrace. The CRiSP travel time and survival parameters used in these scenarios were calibrated using PIT-tag survival estimates and observed travel times for each stock. The population size for each stock was scaled to equal the population estimate used in the SIMPAS results presented at the February 4th, 2004, TMT meeting shown in Table 4.

Table 4. Smolt Population estimates used in SIMPAS modeling for the Summer Spill Alternatives

Stock	Population Estimate
Hanford Reach Fall Chinook	25,000,000
Wild Snake River Fall Chinook	1,052,000
Upper Columbia Summer Chinook	2,574,000

The results of the *Average flow Bi-Op scenarios* relative to the *no spill options* are presented in Table 5. For Hanford Reach fall chinook, the model projects an additional 0.4% mortality with no August spill and an additional 4.0% mortality with no summer spill. For wild Snake River fall chinook, CRiSP projects 0.1% additional mortality with no August spill and 0.5% mortality with no summer spill. For Upper Columbia Summer chinook, the model projects 0.5% additional mortality with no August spill and 1.6% additional mortality with no summer spill.

Table 5. Wild fall chinook average survival and transport percents for Bi-Op conditions with the modeled losses for the alternative spill scenarios.

CRiSP Modeled Average Survival and Transport under Bi-Op conditions								2004 Smolts Lost due to	
Wild Fall Chinook Stocks	Release Site	2004 Modeled Population Estimate	In-river Survival to BON Tailrace	Total System Survival to BON Tailrace	Percent Transport	Total Passage to BON Tailrace	Median MCN Arrival Date	No August Spill	No Summer Spill
Hanford Reach	Hanford Reach	25,000,000	42.2%	49.6%	20.0%	12,387,000	20-Jun	54,000 (-0.4%)	497,000 (-4.0%)
Snake River	Lower Granite	1,051,615	9.4%	34.72%	35.21%	365,254	12-Jul	700 (-0.1%)	4600 (-0.5%)
Upper Columbia	Rock Island	2,573,832	7.7%	17.6%	16.78%	452,973	12-Jul	2,200 (-0.5%)	7,400 (-1.6%)

The limited impact of the no August spill scenarios on the Hanford Reach fall chinook is due mainly to the earlier migration of these fish. The median arrival day of the modeled Hanford Reach stock at McNary Dam is June 20th. The No Summer Spill scenario has a more significant impact on these migrants as they encounter only one transport project. The in-river migrants from the Snake River experience up to 4.1 percent more mortality under the No Summer Spill scenario relative to the Bi-Op spill. However, because the majority of this stock is transported before encountering altered spills at the John Day, Dalles, and Bonneville dams, the final impact on system survival is below 1 percent. For the Rock Island stock, a combination of transport at McNary, and the limited number of remaining in-river migrants affected by spill changes at the last three projects limits the effects of the spill alternatives.

SIMPAS and CRiSP are two models commonly used to examine various hydrosystem scenario impacts on salmonid migration and survivals in the Columbia Basin. A major difference between the two is that SIMPAS uses a single annual time step to calculate results. CRiSP, on the other hand, uses a daily time step to pass migrants through river segments, encountering daily hydro-system and transport conditions along the migration route. Every effort has been made to match CRiSP dam passage parameters such as FGEs, spill efficiencies, and project routing mortalities to the estimates used in Simpas. CRiSP also contains pool predation mortalities and migration equations calibrated to observed migration and survival data. Both models indicate a negative impact of reduced summer spill and summer migrants as can be seen in Table 6.

Table 6. Comparison of the federal agencies' Feb 2004 Simpas-based impacts analysis and CRiSP results for summer spill alternatives

Projected 2004 Smolt Migrants Losses Compared to BiOp Spill Operation				
Stock	No August Spill		No July-August Spill	
	Simpas-based Estimate	CRiSP Estimate	Simpas-based Estimate	CRiSP Estimate
Hanford Reach Fall Chinook	177,000 (-1.6%)	54,000 (-0.4%)	541,000 (-5.2%)	497,000 (-4.0%)
Wild Snake River Fall Chinook	900 (-0.3%)	700 (-0.1%)	2,000 (-1.0%)	4,600 (-0.5%)
Upper Columbia Summer Chinook	18,000 (-1.6%)	2,200 (-0.5%)	56,000 (-5.2%)	7,400 (-1.6%)

For Hanford Reach fall chinook, both models indicate a loss of approximately 500,000 smolts under the no July-August spill scenario given an initial population of 25,000,000 juveniles. The federal agencies impacts analysis using Simpas and Excel indicates a larger impact of the no August spill scenario on these smolts primarily due to the difference in migration timing between the two analyses. CRiSP indicates the median passage of these Hanford reach smolts at McNary dam is on June 20th, i.e. half of them have passed by June 20th. The federal agencies' impacts analysis assumed 66% of this population pass in July and August. The Snake fall chinook results for the two models are very similar. For the Upper Columbia fall chinook, CRiSP models a much lower overall survival rate (20.16%) than SIMPAS (41.11%). CRiSP models these releases from the tailrace of Rock Island Dam, providing a longer migration path and increased mortality before reaching the FCRPS. The Upper Columbia summer chinook estimates are the most significantly different estimates between the two methods. The federal agencies' estimate of summer chinook impacts appears to be high compared to the CriSP estimate.

CriSP Model Description. CRiSP.1 models passage and survival of multiple salmon stocks through the Snake and Columbia rivers, their tributaries, and the Columbia River Estuary. The model recognizes and accounts for several aspects of the life-cycle of migratory fish including fish survival, migration, passage, and their interaction with the river system in which they live.

Fish survival through reservoirs depends on:
- Predator density and activity
- Total dissolved gas (TDG) super saturation levels dependent on spill
- Travel time through a reservoir.

Fish migration rate depends on:
- Fish behavior and age
- Water velocity which depends on flow, cross-sectional area of a reach, and

Reservoir elevation.

Fish passage through dams depends on:

Water spilled at the dam
Bypass screens at turbine entrances and fish guidance sluiceways
Fish delay at dams
Turbine operations

CRiSP.1 computes daily fish passage on a release-specific basis for all river segments and dams. Passage and survival of fish through a reservoir is expressed in terms of the fish travel time through the reservoir, the predation rate in the reservoir, and a mortality rate resulting from fish exposure to total dissolved gas supersaturation, an effect called gas bubble disease (GBD). Fish enter the forebay of a dam from the reservoir and may experience predation during delays due to diel and flow related processes. They leave the forebay and pass the dam mainly at night through spill, bypass or turbine routes, or the fish are diverted to barges or trucks for transportation. Once they leave the forebay, each route has an associated mortality rate and fish returning to the river are exposed to predators in the dam tailrace before they enter the next reservoir.

CRiSP.1 integrates a number of submodels that describe interactions of isolated components. Together they represent the complete model.

Travel Time ─ The smolt migration submodel, which moves and spreads releases of fish down river, incorporates flow, river geometry, fish age and date of release. The arrival of fish at a given point in the river is expressed through a probability distribution.

The underlying fish migration theory was developed from ecological principles. Each fish stock travels at an intrinsic velocity as well as a particular velocity relative to the water velocity. The velocities can be set to vary with fish age. In addition, within a single release, fish spread as they move down the river.

PIT-tagged data over the past 10 years was used to calibrate the travel time parameters and are calibrated for spring and fall chinook and steelhead from the Snake River Basin and the Upper Columbia River Basin. Travel time parameters are derived from calibrations to PIT tag data collected over the years 1992 through 2003.

Dam Passage ─Timing of fish passage at dams is developed in terms of a species dependent distribution factor and the distribution of fish in the forebay. The model uses the current best estimates of fish guidance efficiency (FGE) and spill efficiency compliant with the SIMPAS model to route fish though various passage options.

Predation Rate ─ The predation rate submodel distinguishes mortality in the reservoir, the forebay, and the tailrace of dams. The rate of predation depends on temperature, smolt age, predator density, and reservoir elevation.

The predation rate parameters are calibrated using laboratory studies of the response of predators to temperature and field studies of smolt migration survival. The model is calibrated for spring and fall chinook and steelhead from the Snake River Basin and the Upper Columbia

River Basin using NMFS published survival data and in-house survival estimates based on SURPH an mark recapture estimation model. The survival parameters are derived from calibrations to PIT tag data collected over the years 1992 through 2003.

Gas Bubble Disease ─ A separate component of the mortality submodel is mortality from gas bubble disease produced by total dissolved gas (TDG) supersaturation. The mortality rate is species specific, and it is adjusted to reflect the relationship of fish length and population depth distribution to TDG supersaturation experienced by the fish. The gas bubble disease rate is calibrated from laboratory studies.

Total Dissolved Gas Super saturation ─Total dissolved gas (TDG) supersaturation are described by mechanistic models which include information on geometry of the spill bay and physics of gas entrainment.

The TDG generation equations used for gas production include the newest developments by U.S. Army Corps of Engineers, Waterways Experiment Station (WES) as well as additional work done by Columbia Basin Research. The gas calibration has been verified for 13 dams for the years 1995 through 2001.

Flow ─In these scenarios, flow is specified at dams using results of system hydro regulation models and historical flows as provided by the NWPPC.

Water Velocity ─Water velocity is used in CRiSP.1 as one of the elements defining fish migration. Velocity is determined from flow, reservoir geometry and reservoir elevation. *Transportation Passage* ─Transportation of fish at collection dams is in accordance with the methods implemented by the U.S. Army Corps of Engineers. Low flow years employ full transport at Snake River projects.

<u>Delayed Mortality</u>

Regarding delayed mortality, we checked the analysis for sensitivity to transportation delayed mortality to respond to concerns that we may have underestimated delayed effects of transport.

The "D" value was invented in PATH (Process for Analyzing and Testing Hypotheses, 1995-2000) to help account for the fact that ratios of smolt-to-adult survival rates (SARs) often cannot be explained solely by the in-river survival rates for transported groups and corresponding in-river migrant groups. Transported fish are usually thought to have survival rates in the barges, for example, from Lower Granite (LGR) to Bonneville (BON) near 100 percent with 98 percent being commonly used in calculations. In contrast, survival rates of in-river migrants vary widely. Although fall chinook have not attracted much study, for spring migrants (e.g., Snake spring chinook and steelhead), in-river survival rates often range from 10%-60%. If transported groups survived at the same rate after release below BON as the in-river groups, then transport/inriver ratios would be approximately:

$1 / (\text{LGR to BON survival}_{\text{inriver}})$.

What often happens in practice, however, is that when one compares SARs for the two groups, (i.e., transport SAR / in-river SAR) the formula above over-states the difference between the two, and transportation delayed mortality "D" was invented to help describe the discrepancy. The formula for "D" for fish transported from LGR can be written as:

$D = (SAR_{transported} / SAR_{inriver}) * (\text{LGR to BONN survival}_{inriver})$

As a practical matter, the higher the "D" value, the higher the survival benefits of transportation, and *vice versa*. While PATH generated many possible explanations for why "D" varies over time and between stocks, empirical estimates of "D" are generally less than one, often substantially so. In the impacts analysis, we used a "D" value of 24% for Snake River fall chinook, as this is the value used in the NMFS 2000 BiOp. We did not use a D value for Columbia River stocks since no estimate of D for these stocks is available and the NMFS 2000 BiOp did not use a D value for Columbia River stocks.

While the SIMPASS results are, to some degree, sensitive to the value of "D" assumed, it may come as something of a surprise that the proportion of smolts transported does not vary among scenarios (see tables 1 and 2 for mid-Columbia and Snake fall chinook transport proportions, below). This occurs because, for either a BiOp spill operation or a no summer spill operation (used for the examples in the tables), spill at transport projects is either zero (at LGR, LGS, and LMN) or is fixed (at 25 KCFS involuntary spill for 185 KCFS total river discharge at MCN). In other words, this occurs because the potential spill operations that we are analyzing only change at non-transport projects. The result is that regardless of the spill scenario, the proportion of the run being transported hardly varies for stocks above McNary and is always zero for lower-river stocks. This in turn means that concerns about fish bypassed multiple times (often raised with regard to spring migrants) are essentially moot, since bypass histories would remain unchanged. Finally, fall chinook juveniles that do not migrate until late in the season (e.g., September-October), or until the following spring would not be affected by the change in operations.

In addition, however, the value of "D" that one assumes (in, as noted, the near-total absence of empirical data) does not greatly alter the outcomes. Here, we define the outcome as "system" survival, which uses different "D" values to account for post-release mortality of transported fish, as described above. For example, comparing BiOp spill to the no-spill alternative for Hanford stocks in Table 7, we see a 5.4% decrease for the no-spill alternative if "D" equals one (i.e., transport is very beneficial), vs. a 9.9% decrease if "D" equals 0.4. While the 9.8% change may appear quite large, it is relatively small in comparison to inter-annual fluctuations in Hanford Reach wild spawning escapement as shown in Figure 1.

For listed Snake River wild chinook, the differences between scenarios for different "D" values are quite small as shown in Table 8. This is because, regardless of the scenario, the vast majority (98 to 99%) of Snake River smolts that arrive at Bonneville alive are transported there. While "D" values surely vary from year to year, the differences between scenarios are essentially insensitive to them.

Table 7. Mid-Columbia (Hanford, Priest) D value sensitivity

	BiOp Spill	No spill	% change, No Spill vs. BiOp Spill
Proportion of smolts transported from MCN	0.536	0.536	0.0%
In-river survival, MCN-BON	0.39	0.306	-21.5%
"System" survival, MCN to below BON, various "D" values			
1	0.71696	0.677984	-5.4%
0.8	0.60976	0.570784	-6.4%
0.6	0.50256	0.463584	-7.8%
0.4	0.39536*	0.356384*	-9.9%
0.2	0.28816*	0.249184*	-13.5%

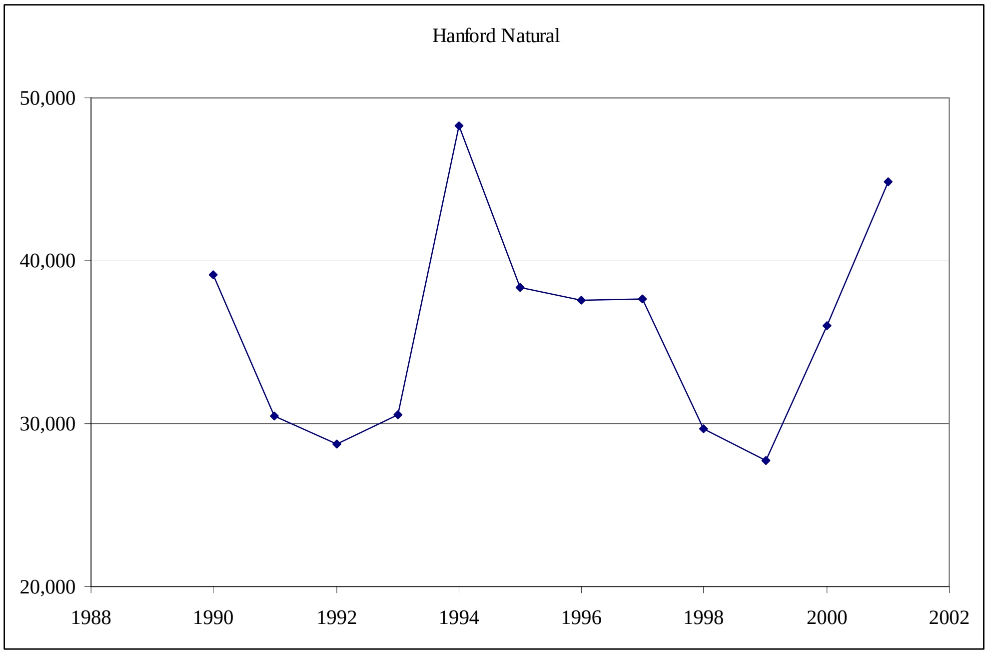
*Note: if "D" value is less than in-river survival (shaded cells), then best not to transport, regardless of spill scenario.

Table 8. Snake wild chinook D value sensitivity

	BiOp Spill	No spill	% change
Proportion of smolts alive above project transported at:			
LGR	0.53	0.53	0.0%
LGS	0.53	0.53	0.0%
LMN	0.49	0.49	0.0%
IHR	0	0	0.0%
MCN	0.53	0.53	0.0%
JDA	0	0	0.0%
TDA	0	0	0.0%
BON	0	0	0.0%
Prop. of Smolts alive @ BON transported there	0.989	0.990	0.2%
In-river survival, head of LGR Pool to BON	0.14	0.12	-14.3%
"System" survival, LGR to below BON, various "D" values			
0.4	0.3980	0.3961	-0.5%
0.3	0.2992	0.2982	-0.3%
0.25	0.2498	0.2492	-0.2%
0.2	0.2003	0.2003	0.0%
0.15	0.1509*	0.1513*	0.3%
0.1	0.1015*	0.1024*	0.9%
0.05	0.0520*	0.0534*	2.6%

Note: if "D" value is less than in-river survival (shaded cells), then best not to transport, regardless of spill scenario

Figure 1. Hanford Reach Natural Spawning Escapement



Comparing the Analysis to Reach Survival Data

Some comments expressed concern that the SIMPAS estimates do not correspond to historical performance data. However, the system survival estimates appear to be reasonable. As evidence, see Table 9, where we crosscheck survival estimates from the impacts analysis with empirical data. More specifically, we compare results from our BiOp operations survival evaluation for Snake River populations to the subyearling chinook reach survival empirical data in Appendix D of the NMFS 2000 BiOp, Tables D-13 through D-17. We also performed another analysis where we reduced river flows and pool survival. In making these comparisons, we conclude that the Simpas Survival estimate appears to be reasonable and within the range of past in-river survival estimates based on empirical data.

Table 9. Comparing System Survival from the Impacts Analysis to Empirical Data from the NMFS BiOp Appendix D.

Year	Release to LWG	LWG to LGS	LGS to LMN	LMN to IHR	IHR to MCN	MCN to JDA	JDA to TDA	TDA to BON	System Survival
1995	0.668	0.890	0.795	0.878	0.820	0.738	0.815	0.804	0.165
1996	0.479	0.898	0.782	0.873	0.828	0.727	0.811	0.791	0.113
1997	0.353	0.566	0.644	0.635	0.546	0.340	0.639	0.504	0.005
1998	0.558	0.771	0.921	0.878	0.830	0.737	0.815	0.802	0.139
1999	0.766	0.665	0.890	0.804	0.743	0.595	0.762	0.703	0.086
Impacts Analysis in-river survival for BiOp operations from cell "M56" from the "Simpass Results" tab:									
Main analysis:									0.143
Low flow and low pool survival analysis:									0.005

Migration Timing

To ensure that our impacts were not off by an order of magnitude due to the assumption of average migration timing, we evaluated impacts using a couple of different assumptions. First, we evaluating impacts assuming that 100% of the migration occurred in July and August, using the average shape of run timing. Second, we evaluating impacts assuming that the migration timing was the same as a past year that had the most fish migrating in August, which was selected from post-1995 data. As expected, these alternative analyses resulted in higher estimates of impacts but not an order of magnitude higher. We concluded that our estimates were still within reason. We also note that these estimates with worse-case migration timing assumptions are very near the high end of the CRITFC and NOAA estimates.

TABLE 10. Comparing Estimates of Survival Reductions of the Proposed Operation with Different Migration Run-timings

FALL CHINOOK	**Average Timing**	**100% Migrating in July and August**	**Maximum Migration in August**
Upriver Bright			
Priest Rapids & Ringold Hatcheries	72,000	109,000	172,000
Hanford Reach Natural	177,000	266,000	423,000
Yakima River & Marion Drain	5,000	10,000	7,000
Snake River Bright			
Listed Wild Snake River	900	1,000	1,300
Lyons Ferry Hatchery	1,000	1,000	2,000
Nez Perce Hatchery and Hatchery Releases at Hells Canyon	1,000	1,000	1,000
Mid-Columbia Bright			
Deschutes River	10,000	23,000	24,000
Klickitat River	13,000	32,000	29,000
Umatilla River	5,000	14,000	14,000
Little White Salmon River	7,000	16,000	14,000
SUMMER CHINOOK			
Upper-Columbia	18,000	28,000	43,000
TOTAL LISTED Juveniles	900	1,000	1,300
TOTAL Juveniles	309,000	501,000	733,000