FISH PASSAGE CENTER

1827 NE 44th Avenue, Suite 240, Portland, OR 97213
Phone: (503) 230-4099 Fax: (503) 230-7559
http://www.fpc.org/
e-mail us at fpcstaff@fpc.org

MEMORANDUM

TO: Ed Bowles, ODFW
Guy Norman, WDFW
Rob Lothrop, CRITFC

Michele DeHart

FROM: Michele DeHart

DATE: February 7, 2006

RE: Presentation of Comparative Survival Study to the ISAB

At the December meeting of the Northwest Power Conservation Council, the Council members asked the ISAB to review the 2005 Comparative Survival Study and the NOAA/BPA comments and the Oversight Committee response to the comments. The specific request from the NPCC to the ISAB was:

- The Council requests that the Independent Scientific Advisory Board (ISAB) review the 2005 Annual Report for the Comparative Survival Study (CSS) prepared by the Fish Passage Center (FPC) and the Comparative Survival Study Oversight Committee. This is a study of PIT-tagged Spring/Summer Chinook and PIT-tagged Summer Steelhead that uses mark/recapture and bootstrap analyses to estimate smolt-to-adult survival rates for transported and inriver migrants. The CSS is important, as it is one of the few organized attempts to systematically release PIT-tagged, hatchery-reared fish, and wild smolts into the Columbia River for the purpose of monitoring and evaluation.

- In response to the release of the draft version of this report, both the Bonneville Power Administration and NOAA Fisheries provided the FPC with letters setting forth both broad concerns and detailed criticisms of the findings and results reported in the draft report. Before finalizing the report, the FPC and CSS Oversight Committee provided detailed responses to both Bonneville and NOAA addressing their concerns. The Council would like to contribute to the resolution of these important and technically complex issues by asking the ISAB to conduct its own review of the final report and the attendant letters. In conducting the review, the Council asks that the ISAB assess the overall integrity and scientific soundness of the CSS report and address the following specific questions.

1. Are the design, implementation, and interpretation of the statistical analyses underpinning the report based on the best available methods? Does the ISAB have suggestions for improving the analyses?

2. What is the applicability of the CSS results, taking into account whatever scientific criticisms of the analyses that the ISAB decides are valid, if any? In other words, what weight should the analyses be given and what qualifiers should be considered when using the analyses for decision-making?

The CSS Oversight Committee had received comments from NOAA and from BPA on the draft 2005 CSS report. The Oversight Committee and FPC staff addressed the NOAA/BPA comments, conducting additional analysis and modifying the draft report. In accordance with our normal procedures all comments received and the written response to comments were appended to the final report, which is on the FPC web site (see attached response to comments). Subsequently the NPCC requested the ISAB review.

On January 27, 2006, Oversight Committee members, Tom Berggren, FPC, Howard Schaller, USFWS, Charlie Petrosky, IDFG and Paul Wilson, USFWS met with the ISAB and delivered the attached presentation to the ISAB. Overall the Oversight Committee members felt that the presentation went well. They answered questions about possible bias identified in the BPA/NOAA comments and asked again at the meeting by Steve Waste of the NPCC. The primary criticism from BPA/NOAA was that the estimates produced by the CSS were biased due to the estimation of the transport and inriver SARs. The Oversight Committee explained that the CSS technique appropriately answers a specific set of questions. These questions are (1) what is the SAR of fish arriving Lower Granite Dam "destined" for transportation and (2) what is the SAR of fish arriving Lower Granite Dam "destined" to remain inriver and undetected at Lower Granite, Little Goose, and Lower Monumental dams. By starting at Lower Granite Dam we are comparing the transported and inriver fish over the same reach (i.e., from Lower Granite Dam as smolts to Lower Granite Dam as adults). The BPA recommendation is to start the estimation only after the fish to be transported are in the barge or truck. We told the ISAB that both approaches are unbiased, and the only difference is in where you want to start indexing the SAR for transported fish. Dr. John Skalski, in 2000 recommended using Lower Monumental Dam tailrace as the starting location for the inriver migrants in order to obtain an "unbiased" SAR. As we explained to the ISAB, if we take the BPA recommended transport SAR and divide it by Dr. Skalski's recommended inriver SAR we would obtain lower T/C ratios than what we obtain when starting all fish at Lower Granite Dam. These differences still don't mean that one method is bias and the other is not biased; instead they only reflect the differences in SARs that will be obtained when the starting location for indexing SARs changes. The difference is that the CSS approach measures the SARs that the run at large experienced for transport and inriver fish. In other words, the CSS approach is measuring transport and inriver SARs, T/Cs and D values for a set of conditions the fish experienced. Using the BPA recommended approach would be for a set of conditions the fish do not experience presently. The differences in approach become more of a philosophical question (Should we measure a set of conditions that does not exist precisely, or should we measure the actual set of conditions that fish experience with slightly less precision?) than a statistical question.

A large proportion of the presentation was geared at informing the ISAB on the purposes and modeling approach used in the upstream/downstream comparison. We presented the ISAB with the background, hypotheses, and rationale behind the design of the CSS.. The ISAB asked many questions and the session ended with them having a much better understanding of the background, history, motivation for the study and evaluation techniques used in the CSS project. The Oversight Committee encouraged the ISAB to contact them for further discussion on any additional questions regarding the study design or analysis.

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December 2, 2005

William Maslen, Director Fish and Wildlife
Bonneville Power Administration
905 NE 11th Ave.
PO Box 3621
Portland, OR 97208

Dear Mr. Maslen,

Thank you and the staff at Bonneville Power Administration for your thorough review of the 2005 Comparative Survival Study (CSS). The CSS study is a joint agencies and tribes study, which is conducted under the auspices of the CSS Oversight Committee. The study design and its implementation are determined by deliberations and agreement among the state, federal and tribal fishery managers. Specific determinations of fish groups used in analyses, analytical tools, and implementation questions are all determined through Committee review, deliberations and agreement. The Committee has and continues to respond to review comments and recommendations from ISAB and ISRP. The CSS is designed to monitor and evaluate SARs by passage route under the passage management conditions prevailing in any particular year. In this way it represents a monitoring evaluation with underlying specific analytical design. The program is intended and designed to continue annually to provide a consistent and continuous database for short-term and long-term management decisions. The tagging program is designed and implemented to address multiple uses. The CSS tag data is utilized by various entities throughout the region, including NOAA fisheries, in their consideration of passage management throughout the basin.

Our specific responses to comments provided in your letter dated November 10, 2005 are addressed in the attached document. If you need further clarification of our responses or other aspects of the CSS, please do not hesitate to contact us.

Sincerely,

Michele DeHart
Fish Passage Center Manager

cc:
Mr. Brian Lipscomb, Columbia Basin Fish and Wildlife Authority
Mr. Randy Fisher, Pacific States Marine Fisheries Commission
Fish Passage Center Oversight Board Members:
Joan Dukes, Northwest Power and Conservation Council
Mr. Larry Cassidy, Northwest Power and Conservation Council
Mr. John Ferguson, NOAA Fisheries
Mr. Tim Peone, Upper Columbia River Basin Tribes
Mr. Pete Hassemer, Idaho Department of Fish and Game
Mr. Greg Schildwachter, Office of Species Conservation
Ms. Liz Hamilton, Northwest Sportfishing Industry Association
Ms. Shauna McReynolds, Pacific Northwest Utilities Conference Committee

Response to BPA reviews on draft 2005 CSS Annual Report

1. BPA Comment: Parameter estimation in the CSS is based on heuristic analytical approach and not based on underlying statistical model, resulting in the SARs for transportation, namely $SAR_1(T_0)$ and $SAR_2(T_0)$, being negatively biased.

Answer:

This is not the case since we are not simply estimating the SAR starting from each Snake River collector dam, but from the starting population at LGR. Therefore, in-river survival from LGR to LGS and LMN must be taken into account when estimating the overall transportation SAR. At the bottom of page 4 of your comments, you state that the CSS transport estimate is conditional on being "destined" at Lower Granite to be transported at one of the Snake River dams. This is exactly what $SAR_1(T_0)$ and $SAR_2(T_0)$ were designed to estimate, so they are not biased. By not including the survival components to LGS and LMN dams, the BPA recommended transport SARs only measure the survival after the fish reach each dam and are placed into the transportation barge or truck. That approach would give estimates biased high relative to the starting population at LGR "destined" to the transportation mitigation strategy.

In the Appendix A of the Comparative Survival Rates Study (CSS) 2002 Design and Analysis Report (Technical Report 2002, DOE/BP-00006203-3) we show how the weights and SARs in LGR equivalents simplified to the form of the equation presented in the draft report.

$$
\begin{aligned}
SAR_1(T_0) &= \{t_2 \bullet SAR(T_{LGR}) + (t_3/S_2) \bullet SAR(T_{LGS|LGR\text{-}LGR}) \\
&\qquad + (t_4/S_2S_3) \bullet SAR(T_{LMN|LGR\text{-}LGR})\}/\{t_2 + (t_3/S_2) + (t_4/S_2S_3)\} \\
&= \{t_2 \bullet SAR(T_{LGR}) + (t_3/S_2) \bullet [S_2 \bullet SAR(T_{LGS})] \\
&\qquad + (t_4/S_2S_3) \bullet [S_2S_3 \bullet SAR(T_{LMN})]\}/\{t_2 + (t_3/S_2) + (t_4/S_2S_3)\} \\
&= \{t_2 \bullet SAR(T_{LGR}) + t_3 \bullet SAR(T_{LGS}) + t_4 \bullet SAR(T_{LMN})\}/\{t_2 + (t_3/S_2) + (t_4/S_2S_3)\}
\end{aligned}
$$

With the second estimator $SAR_2(T_0)$, the same logic applies except that now we directly substitute the number of PIT-tagged smolts with capture histories X_{12} into t_2, X_{102} into t_3, and X_{1002} into t_4, which is equivalent to the sum of PIT-tagged returning adults divided by sum of transported PIT-tagged smolts in LGR equivalents. When the probability of routing first-time detected fish from the collection to transportation is the same at each collector dam, there is self-weighting in t_j across the dams resulting in equality between $SAR_2(T_0)$ and $SAR_1(T_0)$.

An updated version of the Design and Analysis Report will be prepared during the 2006 contract year to detail all estimators such as inriver reach survivals, estimated smolt numbers in each study group, SARs, T/C ratios, and *D*, showing the underlying likelihood equations and associated expectation of the random variables that comprise these estimators. Additional analyses planned for upcoming CSS annual status reports will also be discussed in this document. The goal is have this document competed by the end of March 2006 and submitted to BPA as a project deliverable.

2. <u>BPA Comment: Since $SAR_1(T_0)$ and $SAR_2(T_0)$ are negatively biased, and $SAR(C_0)$ and $SAR(C_1)$ are unbiased, then the T/C ratio is negatively biased and all conclusions based on $SAR_1(T_0)$, $SAR_2(T_0)$, or T/C are incorrect.</u>

<u>Answer:</u>

This is not the case since all SARs were properly computed in LGR equivalents.

3. <u>BPA Comment: Since V_T (survival to and during transport) is similarly negatively biased, the expression for *D* (delayed mortality) is unbiased.</u>

<u>Answer:</u>

The assigned $V_T = 0.98$ used in conjunction with $SAR_2(T_0)$ in the computation of *D* is not negatively biased, but instead is biased high. Across all years, species, and rear types used in the report, the computed V_T estimates should range between 88 and 98% (Table 1), not a fixed 98%, to take into account the inriver survival from LGR to LGS and LMN prior to transportation. When using $SAR_2(T_0)$ in computing of *D*, the estimate of V_T should equal $0.98 \bullet (t_2 + t_3 + t_4)/(t_2 + t_3/S_2 + t_4/S_2S_3)$ just as it did when *D* was computed with $SAR_1(T_0)$ in prior CSS reports. By assigning a fixed $V_T = 0.98$ with $SAR_2(T_0)$, the estimates of D reported in the draft report were underestimated. The statement regarding self-weighting causing *D*'s numerator of $SAR_2(T_0)/V_T$ to simplified to $SAR_2(T_0)/0.98$ was incorrect and has been dropped. The effect of this correction on estimated *D* is small as shown in Table 2.

Table 1. Corrected estimates of V_T for PIT-tagged wild Chinook, hatchery Chinook, wild steelhead, and hatchery steelhead.

Group	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
H-CH:										
RAPH				0.94	0.96	0.92	0.93	0.97	0.94	0.94
DWOR				0.97	0.97	0.88	0.89	0.97	0.91	0.93
MCCA				0.95	0.95	0.91	0.93	0.96	0.95	0.94
IMNA				0.94	0.95	0.92	0.91	0.96	0.93	0.93
CATH								0.96	0.95	0.96
W-CH	0.89	0.94	0.91	0.95	0.96	0.94	0.90	0.97	0.91	0.92
W-ST				0.97	0.95	0.95	0.88	0.96	0.98	
H- ST				0.96	0.95	0.94	0.88	0.95	0.91	

Table 2. Reported (old) and corrected (new) estimates of D for PIT-tagged wild Chinook, hatchery Chinook, wild steelhead, and hatchery steelhead.

Group		1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
H-CH:											
RAPH	Old				0.58	0.99	0.74	0.78	7.22	1.09	0.73
	New				0.61	1.01	0.79	0.82	7.33	1.14	0.76
DWOR	Old				0.87	0.37	0.55	0.49	2.16	0.78	0.81
	New				0.88	0.37	0.60	0.53	2.19	0.84	0.86
MCCA	Old				0.61	1.13	0.80	1.19	8.75	0.85	1.07
	New				0.64	1.17	0.87	1.25	8.95	0.88	1.12
IMNA	Old				0.43	0.84	1.04	0.76	4.11	0.91	0.93
	New				0.45	0.87	1.12	0.82	4.17	0.96	0.97
CATH	Old								1.35	1.20	0.91
	New								1.38	1.23	0.93
W-CH	Old	0.32	0.40	0.86	0.39	0.54	0.69	0.30	2.13	0.41	0.65
	New	0.36	0.42	0.92	0.40	0.55	0.72	0.32	2.16	0.44	0.69
W-ST	Old				1.18	0.11	1.04	0.45	1.43	2.27	
	New				1.18	0.11	1.07	0.50	1.46	2.27	
H- ST	Old				0.90	0.38	0.40	0.50	2.32	0.55	
	New				0.92	0.39	0.41	0.55	2.40	0.59	

4. BPA Comment: The hatchery-to-hatchery SARs of PIT-tagged fish were lower than the robust run-at-large values, apparently due to the negative bias in the estimated transportation SARs.

Answer:

The lower estimates of hatchery-to-hatchery SARs of PIT-tagged fish are not due to the transport $SAR_{LGR\text{-}to\text{-}LGR}$ portion of the overall $SAR_{LGR\text{-}to\text{-}LGR}$ for each hatchery group. Since we compute a large drop from LGR back to the hatchery even after adjusting for tributary harvest rate, which is obtained from the run-at-large data, it appears that most of the difficulty in survival estimation is occurring above LGR, and not with the $SAR_{LGR\text{-}to\text{-}LGR}$ estimate.

5. BPA Comment: A re-analysis with proper and unbiased estimates of SARs for the transported smolts will result in higher and more realistic estimates of the benefits of transportation.

Answer:

Since the method to estimate the SARs for transported smolts is proper and will give unbiased estimates, a re-analysis will not change the results. The low precision in much of the transportation SARs from past years is due to the fact that relatively few of the PIT-tagged wild Chinook, wild steelhead, and hatchery steelhead smolt that passed into the collection facility at the Snake River dams were transported even though most of the run-at-large of untagged fish were transported. Typically only the small proportion of PIT-tagged smolts either collected in the sample tank during a timed sampling interval or inadvertently passed to the raceways was transported since the default operation was to divert PIT-tagged fish back to the river. This trend is changing in more recent years as more researchers are routing a portion of their PIT-tagged fish to the raceways for transportation evaluation. If your goal is to obtain more realistic estimates of the benefits of transportation, then you need to work toward seeing more PIT-tagged fish from numerous studies transported.

6. BPA Comment: The focus of *D* as a gauge of the effectiveness of the transport system is misguided; it is better assessed by the T/C ratios.

Answer:

The report did not give greater emphasis to *D* than it did to the T/C ratios, but instead tried to show that when the inriver survival from LGR to BON ranges around 50%, we should see T/C ratios at 2 and *D* at 1 if there were no differential survival between transported and inriver migrants after passing below BON. Since the goal was to ascertain whether transportation was fully mitigating for passage through the hydrosystem, we were simply stating whether the resulting T/C ratios and *D*s showed success in that goal or not.

Estimates of the magnitude of delayed mortality from transportation can help in discriminating between hypotheses about the cause of that mortality. Further, the *D* parameter is used in modeling of alternative hydrosystem management scenarios. The BiOp remand modeling process is exploring hypotheses about the value of *D* and causes of delayed mortality from transportation, for use in conjunction with passage and life cycle models. NOAA estimates *D*, and NOAA's technical memorandum on the effects of the FCRPS (Williams et al. 2005) expounds on the implications of different *D* values for hydrosystem management.

7. BPA Comment: The upriver-downriver comparison of Chinook salmon stocks to extract hydrosystem effects has been misguided from conception.

Answer:

The report draft failed to show how the upriver-downriver comparison is being used in spawner-recruit modeling, and therefore may appear of questionable utility. This was rectified in the final document by expanding Chapter 6 to provide the scientific basis for differential mortality and common year effect contrasts and show the results of these contrasts for wild and hatchery sp/su Chinook that outmigrated in 2000 to 2002.

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December 2, 2005

John Ferguson, Director
Fish Ecology Division
NOAA Fisheries
Northwest Fisheries Science Center
2725 Montlake Blvd., East
Seattle, WA 98112

Dear Mr. Ferguson,

Thank you and the staff at Northwest Fisheries Science Center for your thorough review of the 2005 Comparative Survival Study (CSS). The CSS study is a joint agencies and tribes study, which is conducted under the auspices of the CSS Oversight Committee. The study design and its implementation are determined by deliberations and agreement among the state, federal and tribal fishery managers. Specific determinations of fish groups used in analyses, analytical tools, and implementation questions are all determined through Committee review, deliberations and agreement. The Committee has and continues to respond to review comments and recommendations from ISAB and ISRP. The CSS is designed to monitor and evaluate SARs by passage route under the passage management conditions prevailing in any particular year. In this way it represents a monitoring evaluation with underlying specific analytical design. The program is intended and designed to continue annually to provide a consistent and continuous database for short-term and long-term management decisions. The tagging program is designed and implemented to address multiple uses. The CSS tag data is utilized by various entities throughout the region, including NOAA fisheries, in their consideration of passage management throughout the basin.

Our specific responses to comments provided in your letter dated November 10, 2005 are addressed in the attached document. If you need further clarification of our responses or other aspects of the CSS, please do not hesitate to contact us.

Sincerely,

Michele DeHart
Fish Passage Center Manager

cc:
Mr. Brian Lipscomb, Columbia Basin Fish and Wildlife Authority
Mr. Randy Fisher, Pacific States Marine Fisheries Commission
Fish Passage Center Oversight Board Members:
Joan Dukes, Northwest Power and Conservation Council
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Ms. Liz Hamilton, Northwest Sportfishing Industry Association
Ms. Shauna McReynolds, Pacific Northwest Utilities Conference Committee

Attachment

Responses to NOAA Fisheries Comments

<u>NOAA Fisheries introductory comment:</u> "We believe the analyses in the report are incomplete, do not fully support the findings in the executive summary and chapters, and lack a holistic approach to analyzing all available data."

<u>Answer:</u> The 2005 CSS Annual Report is a status report of ongoing data collection and analysis. The last CSS Report was finalized in April of 2005. The contractual deadline for future CSS reports was established as the last day of the contract year in BPA's PISCES timeline for deliverables. So the addition of another brood year of Chinook to the existing time series of data plus the addition of wild and hatchery steelhead, which had not been covered before in a CSS report, was decided upon as the most important components for this latest annual report. It was not meant to be a complete and final analysis of all available data. There are future plans to look at temporal changes in inriver reach survival estimates, dam collection efficiencies, and SARs within years through simulation studies as well as with the existing PIT-tag data. However, contractual time constraints precluded these further analyses for this particular annual status report. As for the findings (conclusion bullets) present at the end of the chapters, and restated in the executive summary, we will look closely at the concerns of NOAA Fisheries and make sure that the conclusions are properly supported by the presented analyses.

General Comments

<u>NOAA Fisheries Comment:</u> 1. *PIT-tagged fish do not represent the untagged population. The report adequately deals with average annual returns of PIT-tagged fish, but lacks clarity because there is no explanation that PIT-tagged fish do not provide absolute measures of adult return rates, but only comparative measures when analyzing differences between two treatments. Thus the comments that smolt-to-adult return rates (SARs) seldom meet the ad hoc level of 2% identified in PATH as 'minimum' targets for recovery are inadequate on two accounts: 1) the PIT-tag SARs are not a measure of SARs for the untagged population (Williams et al. 2005), and 2) the statement implies that these low SARs are below levels necessary for stocks to recover. Biological recovery goals will be forthcoming from the Interior Columbia Technical Recovery Team.*

<u>Answer:</u> The PIT-tag SARs would be biased if: 1) stock composition of the sample population did not represent that of the run-at-large and survival of different components differed substantially; or 2) if PIT-tagging reduced survival to adult returns compared to the survival of untagged fish (delayed mortality due to tagging).

With regard to the first case, the aggregates of PIT-tagged fish that make up wild Chinook, wild steelhead, and hatchery steelhead, respectively, are created with marked fish from a wide cross-section of the four tributaries and mainstem locations where these fish exist above Lower Granite Dam. Other than size and time of tagging related constraints aimed at assuring yearling migrants are being considered, we used all available PIT-tagged wild Chinook, wild steelhead, and hatchery steelhead released above Lower Granite Dam for each migration year analyzed. We acknowledge that the tagging effort in each stream is not directly proportion to population numbers, but given the extensive tagging effort from summer through fall and then spring months on many different streams, we feel that the aggregate of PIT-tagged fish created adequately reflects the experience of both tagged and untagged fish passing through the hydrosystem either inriver or through transportation. NOAA Fisheries cites the Williams et al. (2005) paper stating SARs of PIT-tagged fish do not provide measures of SARs for untagged fish because fish diverted by the screens into the bypass/collection systems at the dams tend to be smaller, on average, than fish passing through non-bypass routes (turbines and spillways). On page 1437 of that paper, the authors state that "differential capture probabilities may result in a sample of tagged animals that is not representative of the entire population. When differential capture probabilities are combined with size-related selection, a nonrepresentative sample of individuals can produce a biased estimate of population survival, …" If a smolt size-related influence on collection efficiency occurs universally as shown with several some years of data by NOAA Fisheries, then there will be impacts on the inriver reach survival estimates and tagged smolt population number at Lower Granite Dam (detected and undetected fish) generated with the CJS models will be biased. But the level of bias and overall effect on potential SARs needs further evaluation through simulation studies. The CSS has been working on a simulation program during this contract year that will be useful in future evaluation of this concern. However, it is unclear why NOAA Fisheries views this as an issue of representativeness of PIT-tagged data to the untagged population. The question of representativeness should be directed to how well does the PIT-tagging in the basin above Lower Granite Dam cover the total population of smolts there. In the case of the hatchery Chinook, where the CSS PIT-tags a fixed number at a particular hatchery, the resulting PIT-tags would be viewed as completely representative of the untagged population from that hatchery. However, if fish size effects both collection efficiency and survival, i.e., smaller fish have higher probability of being collected at a dam, but lower probability of survival to and through the hydrosystem, then there will biases in CJS survival estimates. This is an area of research that needs further evaluation. Future simulation analyses are planned to address these types of impacts on CJS survival estimates.

With regard to the second case, the question is not resolved whether the PIT-tag SARs for wild spring/summer Chinook are biased low relative to the run-at-large. This question was assessed in the 2004 CSS Workshop on Delayed Mortality (Marmorek et al. 2004). The workshop assessment concluded that due to the complexity of accounting wild adult numbers in the Williams et al. run reconstruction, a difference between SARs may imply bias for the run reconstruction method, the PIT tagging or both (Marmorek et al. 2004). Wild adult accounting at LGR has become quite complex since the late 1990s due to releases of non-adipose clipped supplementation fish. Alternative run reconstructions by IDFG (using wild adult estimates from *US v. Oregon* Technical Advisory Committee) did not suggest a systematic bias; SAR point estimates from the IDFG run reconstruction fell within confidence intervals from PIT tag groups for all years except smolt year 2000 (Marmorek et al. 2004; Fig. 3.1). Due to the uncertainty in wild SAR run reconstruction estimates, it is questionable whether a bias exists for SARs derived from PIT-tagging wild fish.

The PATH minimum targets for survival and recovery were far more rigorous than "ad hoc" as suggested in the comment. The FY 1998 PATH report (Marmorek et al. 1998) modeled SARs relative to the NMFS 1995 interim jeopardy standards for the seven Snake River index stocks. This simulation modeling indicated median SARs must exceed 4% to achieve complete certainty of meeting the (NMFS interim) 48-year recovery standard, while meeting the (NMFS interim)100-year survival standard required a median SAR of at least 2%. We also stated that the 2-6% range of SAR was adopted as an interim target by the Northwest Power and Conservation Council. (pg. 13 of NPCC mainstem amendments of 2003-2004: www.nwcouncil.org/library/2003/2003-11.pdf), which called for continued evaluation of their biological appropriateness.

Further support for the 2-6% SAR targets for recovery comes from sources other than the PATH analyses and independent of the survival and recovery standard used by PATH. For instance, using the matrix model employed by Wilson (2003) to explore efficacy of alternative recovery actions, SARs necessary to achieve a growth rate of 1.0 can be derived. The SAR needed to achieve this growth rate was calculated for each of the seven index stocks. A mean growth rate of 1.0 is an absolute minimum for recovery and likely unrealistically low, since it doesn't consider population growth necessary to meet abundance targets and would correspond to a population that has a 50% chance of actually declining. In addition, we assumed that harvest rates remain into the future at present low levels, which allows SARs to be low and still result in positive growth rates. The resulting SARs range from 1.51% to 4.56%, with a mean of 2.84%. This suggests the minimum SAR target is not unrealistically high.

A time series of SARs and spawner recruit data will be essential to evaluate these various biological objectives for SARs. CSS will incorporate SAR goals from the Interior Columbia TRT in the future when they are formally defined. Addressing potential bias in SARs from both the run reconstruction and PIT-tag methods will be important in addressing both NPCC and future NOAA Recovery goals.

<u>NOAA Fisheries Comment:</u> 2. *Selective use of data – concern that conclusions are drawn based on partial analyses of available date, and do not provide a comprehensive evaluation of the strengths and weaknesses of the various comparisons of the various comparison made between fish from different regions in the Basin and fish with different juvenile migration histories.*

a). *For example, the available evidence clearly shows that benefits of transportation vary temporally within a season.... Thus comparing annual results from transportation studies provides limited information, and possible misinforms managers about how to manipulate the system to provide the greatest benefits to fish. Not only does this draft report ignore this, but it is at odds with finding from the CSS Workshop in February 2004 that found seasonal variability of SARs.*

<u>Answer</u>: The fact that SARs may change over the season does not obviate the utility of estimating a seasonal SAR (or a seasonal ratio of SARs). In order to fit retrospective models, an annual estimate of various parameters is needed, one of which is *D*. Annual estimates are

also needed to investigate the magnitude of inter-annual variation in these parameters, which has consequences for future population viability, and to compare to target values of these parameters. This is no different from other parameters relating to the effect of the hydrosystem on fish survival, or survival in other salmon habitat, that many investigators, including NOAA scientists, have estimated. For instance, downstream in-river survival probability is undoubtedly influenced by environmental conditions which change within a migration season, yet annual estimates of annual survival rate are made (e.g. Williams et al. 2001).

Within-season estimates of SARs and their ratios are complicated by the limited number of fish (especially wild fish) able to be marked, and the low number of adult returns that would correspond to a small subset of the migration. These low numbers result in wide confidence intervals (or inability to make confidence intervals of ratios), making analysis and inference especially difficult. Further, estimation of SARs of true control fish by day or week is impossible on fine time scale, due to the inability to know on which days they passed LGR Dam. Lastly, the patterns of survival may differ between different species (or origins) which are transported contemporaneously. These complicating factors may limit our ability to optimize transportation strategies, or limit damage to listed species. In the meantime, we still must determine both the short-term and long-term utility of transportation under wide inter-annual environmental variation.

The hypothesis that the utility of transportation can vary widely within the season is an interesting one. In the past, other mechanisms have been advanced to explain why a particular modification of the transportation system will result in vastly improved benefits in the future (e.g., barging instead of trucking, improvements collection facilities and handling). Despite all the research and modifications of the system to date, the benefits of transportation, especially for wild Chinook, still appear marginal. However, even with the inherent difficulties, research into the question of seasonal trends in T/C or *D* may prove fruitful. This research is not hindered by CSS fulfilling its original goal of estimating SARs on an annual basis.

b). *The conclusion that average SAR of transported wild Chinook was lower than the average SAR of non-transported wild fish is misleading since in 5 or 10 years, the annual point estimate of transported wild fish was higher than inriver migrants, and in 5 years lower.*

<u>Answer:</u> Because of the annual trend in SARs of both transported and inriver migrants of wild Chinook have varied widely from years of very low SARs for migration years 1994 to 1996 and 2003 to years of much higher SARs for migration years 1997 to 2000, the presentation of an average 10-yr in Table 10 for PIT-tagged wild Chinook may be misleading. Figure 2 showing the trend over time for fish in the transport and inriver study categories better portrays the inter-relation between transport and inriver SARs. To remove the potential for misinterpretation of the SAR tables by readers, we have removed all arithmetic averages from those tables. The conclusions listed at the end of the chapter and in the executive summary will be changed to reflect dropping the reference to the multi-year average SAR.

c). *The T/C ratios for PIT-tagged hatchery Chinook and wild steelhead showed a 40% increase in adult returns, which the report does not acknowledge as a substantial increase, being much higher than computed for the wild Chinook*.

Answer: In the conclusions, the wording "transportation provided some benefit most years" will be changed to "transportation provided benefit most years" with regard to the hatchery Chinook and wild steelhead bullets.

NOAA Fisheries Comment: 3. *Lack of consistent use of statistical significance of results.*

Answer: Non-overlapping bootstrap confidence intervals on SAR, T/C ratio, and D estimates are used to evaluate statistical significance. However, with regard to the hatchery-to-hatchery SARs and upstream/downstream point estimates, we do not currently have bootstrapped confidence intervals available. Computer programming to generate confidence intervals for those estimates are currently underway.

NOAA Fisheries comment: 4. *Differences between treatment and control – report lacks discussion about potential biases from using only fish not detected in the system as a comparison to those transported or fish marked at dams.*

Answer: We will add language to the effect that NOAA Fisheries researchers [Williams et al. (2005) and Zabel et al. (2005)] have found evidence that fish size may influence collection efficiency with smaller fish more prone to be collected and transported and larger fish more prone to pass the dams through non-detection routes (turbines and spill). This could potentially explain some of the differences in SARs between fish in the T_0 and C_0 study categories since the smaller fish tended to have lower SARs than larger fish (Zabel and Williams 2002). However, this does not mean that the PIT-tagged based estimates of SAR for transported and inriver migrants are biased since both tagged and untagged fish would share in the effect of size on survival. But it would help explain why post-Bonneville mortality on transported fish tends to be higher than that of inriver migrating fish. These NOAA Fisheries finding may support greater spread-the-risk between transportation and inriver migration strategies for salmonids to improve overall survival for smolts of all sizes.

Specific NOAA Fisheries comments on conclusions in the executive summary

1). *The continued evaluation of whether hatchery Chinook are good surrogates for wild Chinook seems at odds with other results that show considerable differences between wild and hatchery fish.*

Answer: While wild and hatchery populations demonstrated differences in magnitude for some parameters (T/C, D and SARs), the annual patterns of these parameters were highly correlated among wild and hatchery populations. See additional figures and discussion added to Chapter 6.

2). <u>Chapter 3 Findings:</u>

a) <u>Bullet 1:</u> *SARs of PIT-tagged fish do not match the untagged population; SARs of fish returning to hatchery show SARs were lower for PIT-tagged fish than untagged population.*

<u>Answer:</u> It is unclear why hatchery-to-hatchery SARs based on PIT-tags are lower than those based on the run-at-large (tagged and untagged) returning to the hatchery. But it does not seem likely that differential survival between transported and inriver migrants as a function of smolt size is the answer as postulated by NOAA Fisheries.

b) <u>Bullet 2:</u> *Misleading in that the annual return of transported wild Chinook was higher in half of the 10 years studied.*

<u>Answer:</u> The wording in the report will be changed to indicate that the SARs of transported PIT-tagged wild Chinook across the 10-yr time series were higher in 5 years and lower in 5 years indicating no consistent improvement in SAR based on transportation as a mitigation measure.c).

c). <u>Bullet 3</u>: *Although the overall T:C was 0.99 (excluding 2001), the use of annual average returns provides no information about temporal changes in ratios, which might lead to actions that managers could use to increase overall returns by use of within-season variations in transport operations.*

<u>Answer:</u> We plan to look closer at the question of temporal changes in SARs for transported fish (T_0 Group) and fish returned to river from the bypass collection facilities (C_1 Group), and have begun additions to the bootstrap program to provide confidence intervals about temporal estimates of SARs conditioned on fish first being detected at Lower Granite Dam. These analyses are planned for the next CSS annual status report.

d). <u>Bullet 6:</u> *The significance of this is unclear. As detection probabilities are different for fish of different lengths [Zabel et al. (2005) and William et al. (2005)], the C_1 fish arguable probe the best comparison to the collected fish that get transported.*

<u>Answer:</u> When asking the question of what to do with fish collected at a dam, either transport or bypass, then it is true that comparisons with the C_1 Group is required. However, the CSS was designed to compare collected and transported fish against the uncollected fish since for the run-at-large, virtually all collected fish are transported, leaving the inriver migrating population made up of PIT-tagged fish without a detection at any of the three Snake River collector dams. The extent to which differential collection efficiency of smolts due to fish size at these three collector dams will affect SAR estimates needs to be more thoroughly evaluated through simulation studies.

e). Bullet 7: *True, SARs vary by hatchery. Wouldn't one expect this because of different rearing practices at different hatcheries?*

Answer: Yes, rearing practices and distances for fish to migrate before arriving at the start of the hydrosystem will contribute to the difference observed in the estimated SARs between hatcheries. Because of these hatchery differences, the estimates of SARs in the CSS are done separately for each hatchery instead on an overall hatchery composite.

f). Bullet 8: *The average of the T:Cs provided here would lead to more than "some benefit" for hatchery fish. It appears likely that an average annual benefit over all hatcheries would exceed 40%, or more than 30,000 to 40,000 adult fish compared to a no-transportation scenario.*

Answer: The word "some" will be dropped as recommend.

g). Bullet 11: *See comment d.*

Answer: See answer d above.

h). Bullet 14: *Despite "confidence intervals were wide," the geometric mean T:C presented here (if a reasonable approximation) would lead to more than "some benefit." As discussed above, this would lead to substantially increased adult returns. Further, the geometric mean is heavily weighted to a lower value by 1998 which is an extreme outlier compared to the other years. Without 1998, the geometric T:C was approximately 2.4, indicating a very large annual difference in rates of return compared to non-transported fish.*

Answer: The word "some" will be dropped as recommend.

3). Chapter 4 Findings – Bullet 2: *Was there any statistical difference in the results?*

Answer: Results on dropout rates between dams presented in tables 43 and 45 are descriptive; no statistical test was conducted.

4). Chapter 5 Findings – Bullets 1 and 2: *The results are correct as stated, but a statement about why differences might have occurred would make these more meaningful.*

Answer: Both the $SAR_{\text{hatchery-to-hatchery}}$ and $SAR_{\text{LGR-to-LGR}}$ estimates increased across hatcheries with lower values for Dworshak Hatchery, midrange values for Rapid River Hatchery, and higher values for McCall Hatchery. As stated earlier, rearing practices and distances for fish to migrated before arriving at the start of the hydrosystem will contribute to the difference observed in the estimated SARs between hatcheries.

5). Chapter 6 Findings

a). Bullet 1: *This statement relies on a selective use of available hatchery data.….*

Answer: This inconsistency was addressed in Chapter 6 by including the hatchery summer Chinook stocks. The bullet as originally written was deleted.

b). Bullet 3: *Point out that the D-value was less <1 which indicates that transportation does not mitigate for all direct mortality measure for fish passing through the hydrosystem.*

Answer: The bullet as originally written was deleted. Edits to Chapter 6 partially address NOAA comments. Values of D < 1 (as reported in Chapter 3) do provide strong evidence that transportation did not mitigate for hydrosystem passage relative only to survival of in-river fish. Because in-river migrants face delays and exposure to multiple stressors, they may also experience substantial delayed mortality that is not captured in estimates of D (Marmorek et al. 2004; Budy et al. 2002; Williams et al. 2005). Indirect methods are required to estimate this component of delayed mortality, including upriver and downriver SAR and spawner recruit comparisons.

Specific NOAA Fisheries comments on Chapter 1

1). *The report would benefit by including a discussion about the rationale for Objectives 3 and 4. For Objective 3, the report states that it will "compute and compare overall SARs for selected upriver and downriver" stocks. The report needs a discussion about the choice of the selected hatcheries. Clearly alternative viewpoints exits based on the scientific literature, and suggest that direct comparisons of select upriver and downriver stocks will not provide valid information for making management decisions.*

Answer: Each of the upriver hatcheries was chosen because it is a major producer of hatchery fish for its specific drainage (Clearwater, Salmon, Imnaha, and Grande Ronde rivers). The history of PIT tagging at selected downriver hatcheries was described in the 2003/2004 annual report (Berggren et al. 2004), and is also addressed in the response to NOAA Fisheries questions in Chapter 6. The Chapter 6 discussion was expanded to provide rationale for upstream/downstream comparisons, and to compare differential mortality estimates from spawner-recruit data and SAR data for both wild and hatchery populations.

2). *For Objective 4, it is not clear how a time series of SARs will inform management decisions. This could use more rigorous discussion... Additionally, the text needs more rationale about how these monitoring efforts of PIT-tagged fish "will be valuable in diagnosing the salmonid population response to management actions undertaken in the face of changing climatic and ocean conditions."*

Answer: The draft CSS report cited several analyses (Schaller et al. 1999; Deriso et al. 2001; Petrosky et al. 2001; Marmorek et al. 2004), which provided context for how spatial and temporal patterns of spawner-recruit and SAR data from the Snake and Columbia Rivers can be analyzed. We believe the level of discussion in the draft was appropriate for the introduction, but will provide an expanded discussion in Chapter 6 to address this comment.

Specific NOAA Fisheries comments on Chapter 2

1). Second paragraph – *The last sentence states that the PIT-tag releases do not proportionally represent hatchery production. This is a critical point, but it is never brought up in the rest of the text when discussing SARs for populations.*

Answer: The statement in the text refers only to the hatchery steelhead and not the hatchery Chinook where large enough PIT-tag releases were made to estimate SARs for each hatchery population separately. For hatchery steelhead, since there multiple stream releases from numerous hatcheries, and virtually every release had some PIT-tags present, we believe that the aggregate of available PIT-tagged fish provides a good cross-section of the hatchery production in each year even though the allocation of PIT-tags are not directly proportion to the production release numbers at each location. NOAA Fisheries states this is a critical point, but does not inform us in what regard they feel this is critical.

2). Tables 1 and 2. *What is the average size of fish from the different sources when they arrive at LGR? Differences in fish size can have a large influence on survival and detection and collection efficiency.*

Answer: PIT-tagged fish arriving at LGR were passively detected and not handled unless for specific purposes of that research. The CSS did not specifically collect and handle PIT-tagged fish for purposes of obtaining length data at that site.

3). Page 10. Annual overall SAR estimates. *In our view, these have limited use for management purposes and presume that PIT-tagged fish have the same SARs throughout the season (outmigration) as the untagged population. See discussion of this on page 16 and 17 of Williams et al. (2005).*

Answer: As stated in an earlier response, the fact that SARs may change over the season does not obviate the utility of estimating a seasonal SAR (or a seasonal ratio of SARs). In order to fit retrospective models, an annual estimate of various parameters is needed, one of which is D. Annual estimates are also needed to investigate the magnitude of inter-annual variation in these parameters, which has consequences for future population viability, and to compare to target values of these parameters. This is no different from other parameters relating to the effect of the hydrosystem on fish survival, or survival in other salmon habitat, that many investigators, including NOAA scientists, have estimated.

4). Page 11. *On what basis can one assume fish that passing through turbines might not have a lower SAR than fish in bypasses? … In the early 1990's Elliot et al. (NOAA annual reports to COE) showed that fish collected in the bypass at LGR at higher levels of BKD than fish collected in nets below the traveling screens. Differences in disease load might have significantly more influences on adult return rates than changes in direct survival from passage through different routes at dams.*

Answer: On page 11 in the draft report, we state that the fish in the C_1 Group was utilized in migration year 2001 in comparisons with transported fish because only around 1-2% of the run passed all three Snake River collector dams inriver through turbine routes that year. Even if survival through the turbines were higher in 2001 than through the bypasses as alluded to by NOAA Fisheries, we would have still seen a much larger SAR of transported fish than inriver migrants for migration 2001. The reasoning behind NOAA Fisheries' concern is unclear.

5). Page 11 bottom, second to last sentence. *Again, all evidence collected to date indicates PIT-tagged fish do not represent the untagged population (see Williams et al. (2005) and details below related to Chapter 5).*

Answer: The sentence in the draft report to which NOAA Fisheries comment is directed states that "the numbers of fish PIT-tagged in each tributary are not expected to be proportional to the total population; however, with PIT tagging occurring across a wide range of the total population, the resulting SARs of this aggregate PIT-tag population should be reflective of the total population." It is unclear whether NOAA Fisheries is suggesting that existing PIT-tag data from the multitude of marking studies in the tributaries above Lower Granite Dam is not of value in assessing SARs for wild Chinook and wild steelhead or whether they feel the creation of aggregate groups of PIT-tagged fish is the problem. If this comment is referring to differences between SARs estimated by PIT tags compared to SARs from the Williams et al. (2005) run reconstruction, the question of bias is not resolved. Due to the complexities of accounting wild adults numbers in the Williams et al. run reconstruction, a difference in SARs may imply bias for the run reconstruction method, the PIT tagging or both (see response to NOAA Fisheries General Comment 1).

Specific NOAA Fisheries comments on Chapter 3

1). Table 11 *incorrectly states that the weighted SARs represent the combined tagged and untagged wild population. The SARs of PIT-tagged fish do not represent the unmarked population.*

Answer: The weighted SARs are an estimate of the overall SAR for the run-at-large in that the transport and in-river SARs of the PIT-tagged fish are weighted by the proportion of the run-at-large arriving Lower Granite Dam "destined" to be transported at a collector dam or remain in-river below Lower Monumental Dam. Even with the NOAA Fisheries concerns regarding the collected and transported fishes' length distribution being shift toward smaller fish than their in-river counterparts, this phenomenon if true across years, should apply equally to both the untagged and tagged fish. Therefore, the weighted SARs would still remain a valid estimate for the run-at-large of each species and rearing type studied.

2). Page 18. *Annual estimates of SARs have little management applicability when considering transportation strategies that could vary within season to provide the maximum possible benefits.*

Answer: Although only annual estimates of SARs are presented in the report, the PIT-tag data collected may be used in evaluating changes in SARs over the season as was done for the CSS Workshop in 2002. As stated above in response to an early comment, we plan to look closer at the question of temporal changes in SARs for transported fish (T_0 Group) and fish returned to river from the bypass collection facilities (C_1 Group), and have begun additions to the bootstrap program to provide confidence intervals about temporal estimates of SARs conditioned on fish first being detected at Lower Granite Dam. These analyses are planned for the next CSS annual status report.

3). Figure 6. *Placing a target minimum SAR on the graph is inappropriate. The target SAR provided was based on an ad hoc value developed early in the PATH process. The value merely represented historic conditions when stocks were apparently sustainable. The value did not represent a known minimum value necessary to assure stock survival. Given natural variability in stocks, and until the analyses of the Technical Recovery Team are completed, the "minimum overall 'average' level" of SAR necessary to maintain existence of listed Snake River stocks is undefined.*

Answer: We agree that any target SAR range that results from updated methods in TRT process should supercede the current range. In the meantime, we do not believe the current target is irrelevant. The 2-6% range of SAR was adopted as an interim target by the Northwest Power and Conservation Council (page 13 of 2003-04 NPCC mainstem amendments: www.nwcouncil.org/library/2003/2003-11.pdf). The range comes not merely from historic conditions and is actually not *ad hoc*. It is true that the initial source of the range was a review of historical data on SAR. However, in prospective modeling analyses, PATH found this range corresponded well with meeting the survival and recovery targets in place at the time, with the range in SARs defined by the range of assumptions about key variables (see PATH [1998], *Preliminary Decision Analysis Report on Snake River Spring/Summer Chinook*: page 87-88 and Appendix B).

Further support for the 2-6% SAR targets for recovery comes from sources other than the PATH analyses and independent of the survival and recovery standard used by PATH. For instance, using the matrix model employed by Wilson (2003) to explore efficacy of alternative recovery actions, SARs necessary to achieve a growth rate of 1.0 can be derived. The SAR needed to achieve this growth rate was calculated for each of the seven index stocks. A mean growth rate of 1.0 is an absolute minimum for recovery and likely unrealistically low, since it doesn't consider population growth necessary to meet abundance targets and would correspond to a population that has a 50% chance of actually declining. In addition, we assumed that harvest rates remain into the future at present low levels, which allows SARs to be low and still result in positive growth rates. The resulting SARs range from 1.51% to 4.56%, with a mean of 2.84%. This suggests the minimum SAR target is not unrealistically high.

4). Conclusions

a). Bullet 1: *There is no basis for presuming PIT-tagged fish represent the untagged population.*

Answer: This comment has previously been address in General Comments 1.

b). Bullet 2: *There is no apparent statistical significance between an average of 1.04 and 1.07. This statement, although mathematically correct, does not appear to have any biological significance.*

Answer: The bullet was addressing both the arithmetic and weight means, which showed lower SARs for transported (albeit very close with the arithmetic mean). As stated in an earlier response to this concern, the wording in the report will be changed to indicate that the SARs of transported PIT-tagged wild Chinook across the 10-yr time series were higher in 5 years and lower in 5 years indicating no consistent improvement in SAR based on transportation as a mitigation measure.

c). *This statement relies on the hypothesis that undetected fish represent the collected population. Zabel et al. (2005) shows that this is not the case. Thus, not only do annual averages fail to provide an indication of the variability in transport benefits, comparison of these two types of fish may bias results and lead to erroneous conclusions. The C_1 fish are most characteristic of fish transported and thus provide the best comparison to transported fish. Results from such comparisons would lead to different conclusions (based on differences in SAR for C_0 and C_1 fish – see bullet 6).*

Answer: The undetected PIT-tagged fish represent, as they should, only the undetected population. You are mixing how tagged fish from C_0 and C_1 groups should be used in comparisons with transport fish. As stated earlier when addressing a similar comment, when asking the question of what to do with fish collected at a dam, either transport or bypass, then it is true that comparisons with the C_1 Group is required. However, the CSS was designed to compare collected and transported fish against the uncollected fish since for the run-at-large, virtually all collected fish are transported, leaving the inriver migrating population made up of PIT-tagged fish without a detection at any of the three Snake River collector dams. The extent to which differential collection efficiency of smolts due to fish size at these three collector dams will affect SAR estimates needs to be more thoroughly evaluated through simulation studies.

d). Bullet 8: *Define "some benefits." It appears that transported hatchery Chinook return at rates, on average across all hatcheries and release, about 40% higher than non-transported fish. This implies annual returns of 30,000 to 40,000 more adult salmon in recent years than would have occurred without transportation.*

Answer: As state earlier in response to a similar comment, the word "some" will be dropped as recommend.

e). Bullet 12: *This state is confusing as written. The first clause of the sentence states hatchery fish are not a reliable surrogate for wild Chinook in terms of T/C and D; however, the second clause states patterns of transportation metrics (T/C and D) track those of wild fish.*

Answer: Bullet 12 will be dropped due to this confusion. The question of whether any hatchery stock is a good surrogate for wild Chinook is better answered by looking at the SARs as was done in Bullet 7.f).

Bullet 13: *These SARs represent PIT-tagged fish. The unmarked population would have had even higher adult returns and this should be noted.*

Answer: This bullet referred to the transported PIT-tagged wild steelhead and will be corrected as such. But the NOAA Fisheries statement that "the unmarked population would have had even higher adult returns" is without basis. Even with the potential for fish size to have an effect on its probability of being transported, this probability would be similar for PIT-tagged and untagged fish as long as the PIT-tagged fish make up a good cross-section of the total wild steelhead run. The real concern should be whether the existing PIT-tag database on wild steelhead is a good enough cross-section of the wild steelhead run originating above Lower Granite Dam. The PIT-tagging of wild steelhead is not as extensive as that of wild Chinook, and in some years, the tagging at Fish Creek Trap in the Clearwater River basin makes up a large component of the total tags released. There is potential for the aggregate of PIT-tagged wild steelhead to be less representative to the total wild steelhead population than the other groups, but there is no reason to believe that untagged wild steelhead have a greater survival probability than their tagged counterparts.

g) Bullet 14: *This very weak conclusion does not appear to comport very well with the majority of the data. .... The 1998 data point is an extreme outlier to the other data and considerably lowers the geometric mean T:C. .... One might even reasonably conclude that transportation led directly to the estimated SARs of PIT-tagged fish that were greater than 2% for the last 4 years. (see NOAA Fisheries letter for full text of this comment)*

Answer: First, as state earlier in response to a similar comment, the word "some" will be dropped as recommend. Second, the low SAR for 1998 may not totally be an outlier, since PIT-tagged hatchery steelhead also had the lowest SAR in 1998 from the 6-yr period 1997 to 2002.

h). Bullet 16: *This is a relative weak, and possibly a misleading conclusion. With the exception of the outlier year for wild fish in 1998, Figure 23 suggest that wild steelhead, on average, return at about twice the rate of hatchery fish.*

Answer: The bullet will be reworded to state that in 4 of 6 years, the estimated overall SAR for hatchery steelhead was half that of their wild steelhead countparts.

Specific NOAA Fisheries comments on Chapter 5

1). *This chapter provides the data to show that PIT-tagged fish do not return at the same rates as untagged fish. Tables 47, 48, and 49 provide data on adult returns to the hatchery for the unmarked population and the PIT-tagged population. The adult returns to each hatchery for each group divided by the number of fish released at each hatchery for each group provides overall estimates of hatchery-to-hatchery SAR. One can easily compare these estimates to the PIT-tag estimates for the same hatchery.*

Answer: A plot of the comparison you suggest was conducted in the previous CSS 2003/04 Annual Report and showed lower hatchery-to-hatchery SARs for the PIT-tagged Chinook than run-at-large (tagged and untagged) Chinook return to each hatchery studied. But the run-at-large Chinook return data to each hatchery also is not without its own uncertainties. Total numbers of hatchery fish released are estimates and numbers of returning adults partitioned by brood year are typically based solely on length distribution thresholds. So rather than just showing unaccountable differences again between PIT-tag and run-at-large estimates of hatchery-to-hatchery SARs, we decided to concentrate in the 2005 Annual Report on the overall PIT-tag generated hatchery-to-hatchery SARs and how it partitions into the components of hatchery release to Lower Granite Dam survival as smolts, $SAR_{LGR\text{-}to\text{-}LGR}$, and Lower Granite Dam back to hatchery as adults (with run-at-large based adjustment for terminal harvest).

2). *Also, all of the multiple factors (page 62) hypothesized to result in low returns of PIT-tagged fish to the hatchery rack all affect the untagged population. The only difference relates to number 4, and unless it can account for all losses, the analyses of the data confirm lower returns for PIT-tagged fish.*

Answer: It seems unlikely that factor number 4, "missed detections of PIT-tagged adults or shed tags at the hatchery," would account for all the difference between PIT-tag and run-at-large estimated return rates to individual hatcheries, but it would contribute to that difference.

3). *Although no estimate for the effect of Factor 4 is available, and ignoring the difference that it might cause, the geometric mean ratios of PIT-tagged fish returns to the unmarked fish return to Dworshak, Rapid River, and McCall hatcheries were 0.39, 0.52, and 0.49, respectively. However, these returns do not take into account that the unmarked population was transported when collected at downstream dams, whereas some of the PIT-tagged fish were returned to the river. Based on results in Chapter 3, the unmarked population received a* *benefit from transportation , but not nearly enough to account for the differences between hatchery-to-hatchery SARs of the unmarked population and those of the PIT-tagged population.*

Answer: You have an interesting comment, but I am unsure of your concern.

Specific NOAA Fisheries comments on Chapter 6

NOAA Fisheries First Comment: *This chapter lacks the scientific rigor and analyses needed to justify the conclusions drawn. Foremost the section needs to discuss the scientific basis for assuming that the only difference for changes in productivity between upstream and downstream stocks over time should relate to hydropower system construction. Williams et al. (2005) has a section that outlines arguments for and against this position. The CSS report needs the same type of discussion to avoid any bias in reporting results and to provide proper context for the reader. The report should discuss how underlying differences in age class distributions of adult returns (see comparisons of Tables 7 and 60 for wild fish and Tables 26, 46, and 54 for hatchery fish), which leads to different exposures of the stocks to changing ocean conditions, would or would not possibly bias comparisons between stocks.*

Answer: The Chapter 6 discussion was expanded to provide scientific basis for differential mortality and common year effect contrasts (see response on Chapter 1 comments).

The issues that Williams et al. (2005) raise concerning the upstream/downstream comparison have been addressed in Marmorek and Peters 1998, Schaller et al. 2000, Budy et al. 2002, and the CSS workshop report (Marmorek et al. 2004). The greater reduction in productivity and survival rates experienced by Snake River spring/summer Chinook, relative to that of downriver stocks coincident with hydrosystem development (Deriso et al. 2001) would not likely be sensitive to different age composition of upriver vs. downriver stocks. Different adult age composition might influence differences in productivity and survival rates, but would not explain the observed systematic shift in the Snake River survival rates relative to downriver populations. Further, the ratio of SARs for upriver and downriver stocks corresponded closely in recent years with the differential mortality estimated from spawner and recruit data.
The literature points to the first months at sea as critical to establishing cohort success (Pearcy 1992; Schaller et al. 2000; Pyper et al. 2005; Meuter et al. 2005). Researchers have typically correlated SARs or spawner-recruit residuals to oceanic/climatic factors during and immediately following the period of ocean entry. For example, Scheuerell and Williams (2005) correlated Snake River SARs with ocean upwelling indices in April and October during the first year of saltwater rearing; Zabel et al. (in review) correlated recruitment success of Snake River spring/summer Chinook with the PDO (a broad-scale measure of sea surface temperature) following ocean entry. Adult age structure differences would seemingly be more influential if cohort success were established later in the ocean rearing.

NOAA Fisheries Second Comment: The treatment of upstream and downstream hatchery stocks seems particularly biased. Why are more downriver hatcheries not used in the comparisons? Adult return rates from upriver hatcheries vary considerably; wouldn't similar variability occur for those downriver? Carson is not the only hatchery upstream of Bonneville Dam that produces spring Chinook salmon. Although p. 69 presents a rationale for comparing just hatcheries with spring Chinook salmon based on adult harvest rates, this rationale seems weak. Table 51 provides comparisons of estimated SARs (hatchery-to-hatchery) for all Snake River stocks after harvest adjustment. Surely, by extension, these data provide the ability to compare all upriver hatcheries to Carson Hatchery. Doing so would show that McCall Hatchery had substantially higher SARs than Carson Hatchery in several years.

Answer: Chapter 6 now includes SAR ratios between all possible Snake River hatcheries and Carson (see response on Chapter 1 comments).
The history of PIT tagging by CSS at downriver hatcheries was summarized in the 2003/2004 annual report (Berggren et al. 2005). Round Butte hatchery was dropped from the study when it developed severe BKD problems, which would clearly bias the SAR ratios of interest. Cowlitz was initially selected and dropped because of the larger genetic divergence from Snake River stocks. Carson Hatchery stock is genetically very similar to Snake River spring Chinook, since it was developed from the upriver spring Chinook run crossing BON. Other downriver hatcheries include Warm Springs and Klickitat, which may be suitable to add to CSS tagging, if logistical and funding issues can be addressed.

NOAA Fisheries Third Comment: *The fact that different hatcheries have different return rates is not surprising. No two hatcheries have the same facilities, water sources, broods, or raise fish in exactly the same way. Juveniles do not all have the same fitness, are not all released at the same time nor do they have the same timing through the hydrosystem, downstream of Bonneville Dam, or into the ocean…*

Answer: Also among the factors affecting fitness of hatchery (and wild) stocks is the degree of exposure to the hydropower system, which is markedly different between upriver and downriver stocks (Marmorek et al. 2004; Budy et al. 2002). The 2003/2004 CSS report (Figure 9) showed timing of Carson hatchery smolts at the lower Columbia trawl compared to transported and in-river migrant hatchery fish from the Snake River, migration years 1998-2002. Timing of the Carson stock was similar most years (except 1999) to that of transported fish from Rapid River, Dworshak and Imnaha hatcheries, and earlier than that of McCall Hatchery transported fish. Migration delays in the hydrosystem contributed to later arrival (by 1 to 4 weeks) of in-river migrants from Snake River hatcheries compared to Carson. However, the temporal patterns for population attributes (estimates of Vc, ln(T/C), ln(D) and ln(SAR)) of Snake River hatcheries and wild stocks are similar across years (Chapter 6 figures z1-z4).

NOAA Fisheries Comments in the Chapter 6 Conclusions:

1) Bullet 1: *What's the justification for comparing wild spring-summer Chinook salmon when hatchery summer Chinook salmon were not used for comparison?*

Answer: This inconsistency was addressed in Chapter 6 by including the hatchery summer Chinook stocks. The bullet as originally written was deleted.

2) Bullet 2: *Because of considerable differences between upstream and downstream hatcheries, it appears inappropriate to use these as a foundation to argue that transportation did not mitigate for all mortality from hydropower system passage. Values of D < 1 based on transportation studies provide a stronger rationale for this conclusion.*

Answer: The bullet as originally written was deleted. Edits to Chapter 6 partially address NOAA comments. Values of D < 1 (as reported in Chapter 3) do provide strong evidence that transportation did not mitigate for hydrosystem passage relative only to survival of in-river fish. Because in-river migrants face delays and exposure to multiple stressors, they may also experience substantial delayed mortality that is not captured in estimates of D (Marmorek et al. 2004; Budy et al. 2002; Williams et al. 2005). Indirect methods are required to estimate this component of delayed mortality, including upriver and downriver SAR and spawner recruit comparisons.