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MEMORANDUM TO: D. Robert Lohn
Regional Administrator, NW Region

Usha Varanasi

FROM: Usha Varanasi, Ph.D.
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SUBJECT: Comment on the DRAFT Comparative Survival Study (CSS) 2007 Ten-year Retrospective Analysis Report

At the request of Paul Wagner and Ritchie Graves, we reviewed the DRAFT "Comparative Survival Study (CSS) of PIT-tagged Spring/Summer Chinook and Steelhead in the Columbia River Basin Ten-year Retrospective Analyses Report." The report is extraordinarily long (377 pages); too long to read, digest, and provide finely detailed commentary in the review time available. The following paragraphs summarize our major concerns with the report. Please call John Williams (206.860.3277) if you have any questions regarding these comments.

1. Most strikingly, despite its title and the fact that the CSS study group has PIT tagged hundreds of thousands of juvenile Chinook salmon and steelhead, the CSS retrospective report does not contain a holistic analysis of this 10-year effort or an integration of the results across all species that considers different migration conditions.

2. The data presented, and the discussion and conclusion sections all seem focused through the lens of specific positions favored by the authors: hydropower system-related latent mortality is large in magnitude, transportation is not beneficial, management actions directed at the hydropower system have generally failed, and consequently SARs have been low in recent years and drastic actions are needed to recover the wild Chinook salmon populations, as PIT-tagged wild fish fail to meet a minimum 2% SAR. Results that do not support desired positions are usually discounted by carefully placed language. For example, from the conclusions in Chapter 8 (*all italics are ours*):

"Variation in [survival] in the MCN-BON reach was explained by temperature and Julian day. However, there was substantial uncertainty in the lower reach due to reduced numbers of PIT-tagged fish available, which may have affected the ability to identify *the important factors.*"

"In general, transportation provided benefits most years to Snake River hatchery spring/summer Chinook 1997-2004, *however* benefits *varied* among hatcheries."

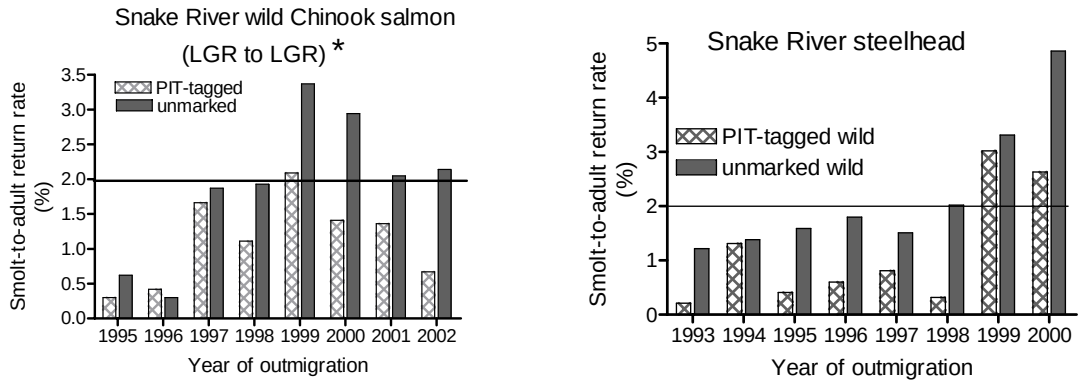
"Migration year 2001 had very high, *but imprecise* TIRs, for both wild and hatchery steelhead."

"Overall SARs for wild spring/summer Chinook fell short of the NPCC SAR objectives. Overall SARs of wild steelhead also fell short of NPCC SAR objectives, although they exceeded those of wild Chinook. Based on these CSS SAR results relative to NPPC SAR objectives, it appears that collecting juvenile fish at dams and transporting them downstream in barges and trucks and releasing them downstream of Bonneville Dam did not compensate for the effect of the FCRPS on survival of wild Snake Basin spring/summer Chinook and steelhead migrating through the hydrosystem."

And finally, the tacit assumption exists that differential post-Bonneville mortality between transported and in-river fish is "delayed mortality", i.e., an actual mortality event separated in time from its cause (once stated in the text specifically as "delayed mortality *from* transport".)

We point out that: 1) whether or not the observed SAR in these years fell short of NPCC objectives provides no evidence one way or the other about compensating for effects of the FCRPS; 2) the authors of the report have no knowledge of what the SAR would have been in these years if the FCRPS had not been in place; and 3) data now clearly provide the evidence that post-Bonneville mortality of transported fish is higher than for in-river migrants, but the reasons for this difference are still hypothetical.

3. The authors *repeatedly* state that wild Chinook salmon do not meet the minimum 2% return rate goals of the region. Granted the CSS study uses only PIT-tagged fish, but in all cases where the comments on the 2% SAR goal are stated, no caveat exists that this represents data from PIT-tagged fish returns. The ISAB (2006) specifically indicated in comments on the 2005 CSS report that CSS participants needed to look into the potential disparity between PIT-tag returns and the unmarked population. Yet, in this report the ISAB comments are treated by a short discussion indicating that it was not clear how many actual wild spring-summer Chinook salmon passed Lower Granite Dam because some fish without ad-clips (ostensibly wild) were actually hatchery fish. Nonetheless, Copeland et al. (2007) provided analyses of SARs for run-at-large nonad-clipped fish from the Snake River basin. In 3 of the 5 years included in the CSS study (migration years 1998-2002, Fig. 5.11), Copeland et al. (2007) found that SARs exceed 2%, and more than 3.1% in 2 of them. They did not adjust for non-clipped hatchery fish in either the smolt or adult life stages, so some bias in SARs may occur if a differential survival existed between unmarked hatchery smolts and wild returns. Some unpublished analyses by NWFSC staff estimated the number of non-clipped hatchery smolts in the outmigration and used that to adjust adult hatchery returns to estimate numbers of wild fish (Figure 1). These analyses derived slightly different SARs than Copeland et al. (2007), but they were similar.



* Not adjusted for harvest

Figure 1. Comparison of SARS for PIT-tagged and run-at-large Snake River wild spring-summer Chinook salmon and steelhead.

Clearly, these analyses indicate higher SARs for unmarked wild fish compared to PIT-tagged wild spring-summer Chinook salmon. The geometric return rate of PIT-tagged fish was only 60% that of wild fish comparing CSS results to those of Copeland et al. (2007). These, however, are not the only data that exist indicating differences in return rates between PIT-tagged and unmarked fish. Petrosky (unpublished data and an author of this report) estimated SARs for the unmarked population of Snake River wild steelhead and submitted this to the Interior Columbia River Technical Recovery Team. The NWFSC's analysis that compared SARs of these fish to an estimated SAR for the PIT-tagged population (no data for the unmarked population exists beyond the 2000 outmigration) also showed in all years PIT-tagged fish returned at rates less than the unmarked population (Figure 1).

Despite the ISAB recommendation to do so, this report does not include analyses of return rates of PIT tagged and unmarked fish based on data in the CSS 2005 report (Berggren et al. 2005). This seems most surprising given that the first four conclusions of this retrospective report laud the ability of the CSS group to PIT tag over 2 million hatchery fish and analyze data from them. The absence of these analyses begs the questions as to why, and implies the analyses may have weakened the report's statements about wild fish SARs. When NWFSC staff analyzed the CSS data we found that unmarked hatchery Chinook salmon returned at higher rates than PIT-tagged fish (Figure 2), which is similar to results from the analyses of wild Chinook salmon and steelhead (Figure 1).

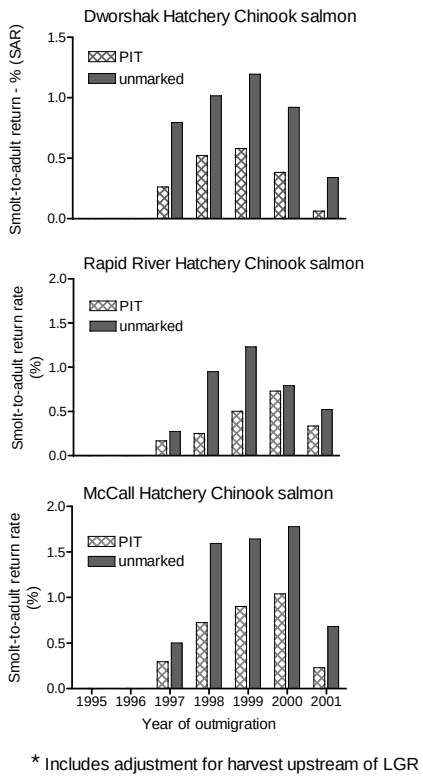


Figure 2. Hatchery to hatchery SARs (no adjustment for differences in downstream migration history for PIT and unmarked fish). Data after Berggren et al. (2005).

4. The reported SARs in this report are biased downward compared to standard SARs (e.g., Petrosky et al. (2001)) because the authors base their SARs for Chinook salmon on adult returns only, not including jacks. This is important because the oft stated goal of reaching SARs of 2% is based on SARs that include jacks.

5. Chapter 2. The chapter deals extensively with within-season estimates of the following 4 quantities: water travel time (WTT), fish travel time (FTT), fish (cohort) survival (S), and "instantaneous mortality rate" (Z), which is derived as $S = \exp(-Z \cdot WTT)$ or equivalently, $\log(S) = -Z \cdot FTT$. This formulation posits that a given cohort (as used here, weekly groups of fish arriving at Lower Granite Dam) has a particular instantaneous mortality rate and that direct survival through the hydropower system is directly related to fish travel time. This formulation ignores that a substantial portion of mortality occurs at the dams and is unrelated to fish travel time. As the authors note, FTT generally decreases within a season, and S (and log(S)) generally remains constant. Thus, if two different groups of fish take a different amount of time to travel through a reach but their probability of surviving is the same, then the per-day mortality of the two groups must be different. To conclude that decreasing FTT by managing the river to

decrease WTT will result in increasing S (survival) requires the assumption that the quantity Z is an intrinsic characteristic of a group of fish; i.e., that the instantaneous mortality rate of the group is fixed at the time they leave Lower Granite Dam and that if we could only decrease their travel time to McNary Dam, then less mortality would occur.

At least equally plausible and supported by observed data using the exact same relationship is a conclusion that management actions to decrease fish travel time would increase instantaneous mortality and that survival would remain the same. With respect to Chinook salmon, a more parsimonious explanation for the observed results is that most of the estimated mortality in the LGR-MCN reach occurs during passage at dams, independent of flow, WTT, and FTT, and very little occurs in the reservoirs themselves. Available survival data for dam passage from both PIT-tag and radio-tag studies for Chinook salmon lend more support to dams as the area where changes in survival occur. Therefore, the conclusion by the authors that decreasing FTT by half a day in the lower river would decrease steelhead mortality by 5.6% is highly questionable. Furthermore, the authors have incorrectly interpreted their result to derive this estimate. A Z of 0.112 does not imply a mortality of 11.2% per day. The correct interpretation is that the daily mortality is 1.0 – exp(-0.112), or 10.6%. Note that this discrepancy grows larger as FTT increases.

When the authors relate Z to a variety of factors, an additional problem is encountered. WTT and FTT are correlated with each other and relatively variable within seasons, and as stated above, S (and log(S)) has repeatedly remained relatively constant within seasons, especially for spring-summer Chinook salmon. The final quantity (Z) is derived by dividing the relatively constant quantity log(S) by the relatively variable FTT. It is no surprise, then, that Z and WTT are correlated. In fact, this is inevitable because of the relationships described above and is a classic example of a "spurious correlation."

6. Chapter 3. The chapter focuses mostly on wild Chinook salmon, and therefore does a poor job of comparing the results of analyses among wild and hatchery Chinook salmon, and wild and hatchery steelhead. Without these comparisons, managers have little ability to determine the best strategies that will lead to the optimum return for the different species and types (wild or hatchery).

Another shortcoming of the analyses derives from the authors' insistence on only using C_o fish as "true controls". They argue that because these fish are not seen at transport dams, no temporal analyses are possible. Thus, the analyses presented in this chapter will provide little guidance on the important management questions for each transport dam related to when to begin transportation within a season, and when and how much spill should occur. The emphasis on 'true controls' in the CSS study seems misplaced. A better foundation for analyses would use data similar to what is presented in Table 5.16. Here, data comparing C_o to C_1 fish (for fish observed at Bonneville Dam) indicate that in the preponderance of comparisons, C_1 fish have equivalent SARs of the C_o fish (point estimates in most years for most bi-weekly comparisons are higher). These are the fish that make it successfully to Bonneville Dam from the different

categories. Thus, it appears that use of C_1 fish would provide some useful insight into temporal changes in return rates of transported and non-transported fish. Analyses along this line would significantly improve this chapter.

Additionally, nearly all the analyses discussed presume that survival estimates for non-transported fish (the "true controls") are the same as those of the marked population used to make juvenile survival estimates. However, using the CSS argument, the PIT-tagged fish returned to the river do not represent "true controls" and do not measure the survival of fish not detected at transport dams because they are based on the combined population of detected and non-detected fish. A disconnect thus occurs. Since non-detected fish mostly pass through spill, one might reasonably assume they have a higher survival than the combined population.

Finally, even the data presented in the CSS study, when considered on an annual basis, do not indicate that transportation harms wild Chinook salmon; just that it provides no benefit. The annual data for hatchery Chinook salmon and steelhead all show a substantial benefit that would potentially translate into thousands of additional adult returns if spilling or collecting and transporting fish were optimized for all species at each dam. Caution on potential benefits for hatchery Chinook salmon is warranted, however, as the CSS associated hatcheries and numbers of PIT-tagged fish released from each do not mirror the total hatchery production released in the basin.

7. The graphs in Chapter 4 always indicate the 2% SAR line when the majority of estimates fall below the line, but often do not include the 2% SAR line when the majority of estimates fall above it.

8. The continued emphasis by CSS to compare upstream/downstream population productivity appears misplaced and has limited utility for estimating overall hydropower system impacts. We concur with the conclusion of the ISAB Latent Mortality Report (2007) which stated "The ISAB concludes that the hydrosystem causes some fish to experience latent mortality, but strongly advises against continuing to try to measure absolute latent mortality. Latent mortality relative to a damless reference is not measurable. Instead, the focus should be on the total mortality of the in-river migrants and transported fish, which is the critical issue for recovery of listed salmonids. Efforts would be better expended on estimation of processes, such as in-river versus transport mortality that can be measured directly."

In addition to the ISAB's comments and flaws of the upstream/downstream approach that have been identified previously (Zabel and Williams 2000; Williams et al. 2005), we provide two additional comments:

- Weak scientific methodology. The standard scientific method operates by stating a null and alternative hypotheses and considering *all* available information in an effort to reject the null hypothesis. Science does not work by laying out a hypothesis, then saying it is

correct unless positive proof exists to show that it is wrong. Yet, this is what has occurred here.

- Ignores data from other systems. Data on natural sockeye salmon populations in Bristol Bay have shown similar trends in overall productivity as have the upstream/downstream comparisons used by CSS. Overall productivity of the Bristol Bay populations increased and decreased over a period of decades, concomitant with major changes in ocean conditions. However, some of these eight closely related populations demonstrated strikingly divergent temporal patterns (Hilborn et al. 2003; Peterman et al. 2003). Yet, the analyses comparing Snake River and John Day River Chinook salmon populations assume that changes in temporal patterns do not exist. The Bristol Bay data suggest a lack of foundation for this assumption.

9. No clear direction exists to argue for continuing the large releases of hatchery fish for the purposes of 'comparative' survival. This is based on: 1) It does not appear that hatchery Chinook salmon provide any useful information related to wild Chinook salmon other than when SARs for hatchery Chinook salmon go way up or way down, proportionately, so do SARs for wild Chinook salmon. This could be determined from a much smaller number of PIT-tagged fish or from adult returns by comparing the clipped to unclipped population. 2) The CSS results indicate that on an annual basis, transportation would benefit hatchery Chinook salmon but not wild Chinook salmon. Since the distribution of hatchery Chinook salmon past lower Granite Dam is much more compressed than that of wild Chinook salmon, it is not clear that even analyses on a temporal basis with hatchery Chinook salmon would provide information on how best to operate the system for wild Chinook salmon. 3) Hatchery Chinook salmon have a wide range in return rates. McCall fish do particularly well, and have a different distribution than Dworshak fish. Which hatchery fish then represent wild fish?

cc: John Stein
John Ferguson
John G. Williams
Bruce Suzumoto

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