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August 23, 2002

Northwest Power Planning Council
Attention Judi Hertz
Response to ISRP
851 SW 6th Avenue, Suite 1100
Portland, Oregon 97204

RE: Project ID: 199602000 – Comparative Survival Study (CSS) of Hatchery PIT tagged chinook and the Comparative Survival Study Oversight Committee.

Dear Ms. Hertz:

Attached, please find the response to ISRP comments on the subject proposal.

Sincerely,

Michele DeHart

Response to ISRP comments

Project ID 199602000

Comparative Survival Rate Study (CSS) of PIT tagged Chinook
&
Comparative survival Study Oversight Committee

1. ISRP Comment: "The response must include an outside peer review of the estimation process by a qualified statistician(s) or there must be a programmatic review by the ISRP allowing adequate time for careful evaluation of the estimation process before a positive recommendation for funding can be given. Previous reviews by the ISAB and the ISRP resulted in the conclusion that the overall design of the data collection was adequate to meet the primary objectives of the project, but that the statistical properties of the proposed analysis procedures (mathematical formulas) should be further investigated before conclusions are based on data from this study. The previous ISRP and ISAB reviews did not approve the specific mathematical formulas in the reports issued by this project. Adequate review of the proposed analysis procedures is not feasible in the time allocated for the review for all proposals in the Mainstem and System wide Province."

Response: The study has been reviewed in detail by the ISAB on January 14, 1997, and January 8, 1998, and most recently in December 2001. John Skalski, University of Washington, provided the most recent review comments on the present study design, on December 3, 2001. A copy of those comments and the response to comments are attached. In addition, those comments and the response to those comments were appended to the annual report for 2001, which is available at http://www.fpc.org/fpc_docs/css/CSS_Report_FINAL.pdf in Appendix F.

The CSS Oversight Committee is amenable to outside independent reviews and to the ISRP detailed review discussed in their comments. The CSS Oversight Committee is scheduled to discuss the statistical and study design details with the ISRP on September 24, 2002 to facilitate the ISRP detailed review. Additionally, in response to Question # 4 posed by the ISRP, the Oversight Committee plans to begin work to publish results this winter. A broad range of peer review of statistical analysis and methodology will occur through that process.

2. ISRP Comment: "When will the project end? The reason for the project stated on page 2 is to answer, *can transportation of fish to below Bonneville compensate for the effect of the hydro system on juvenile survival rates of Snake River spring and summer chinook salmon during their downstream migration?* It appears that the direction of the project is changing to the point that the proposal should be considered a new proposal. The project began in 1996 yet the proposal notes a rather tentative goal on page 2, and repeated on page 3, *This study is intended to begin to provide the basis for the Mainstem Monitoring and Evaluation (M&E) Program's analysis of long term alternatives for recovery of depressed listed and unlisted stocks of chinook and steelhead."*

Response: This is an ongoing, long-term project, which monitors and evaluates salmon survival (smolt to adult) related to existing hydrosystem management actions (in-river migration and transportation) across a broad range of environmental conditions (e.g., runoff volumes,

estuary/ocean). The project has maintained a consistent scope, which has since its inception included the identified transportation question but also several questions which are outlined in tasks and objectives of the proposal (see proposal Section 9 f). These include upstream-downstream comparisons, the development of long-term, consistent, time series of SARs, and the hydro system passage history of smolts. The CSS Oversight Committee previously responded to this question of project duration by the Northwest Power Planning Council (September 8, 1997 memo, DeHart to Casavant) as follows: *"The Salmon Managers initially proposed the PIT tagging at hatcheries as a means of evaluating mitigation measures aimed at recovery of listed wild chinook. Since recovery will take many years, there will be the need for the release of marked fish for the evaluation of recovery measures. Therefore, we will consider this study a long-term effort. Although hatchery stocks are predominately used now, as wild stock population sizes increase, they would be considered for tagging. The key element of this PIT tagging effort is to provide a level of consistent marking over time to address the effects of the primary mitigation measures. This long-term study is designed to conform with and compliment the NPPC adaptive management approach as outlined in the draft framework paper*." The ISAB review (January 8, 1998) also recommended a long-term, expanded CSS project (recommendation 2): *"So long as the present configuration and operation of the hydroelectric system exists, extend (or continue) PIT tagging to include naturally reproducing populations of spring chinook whenever population sizes may permit. Continue PIT tagging other life history types, and extend PIT tagging to other life history types of other species of salmon, including steelhead, whenever possible*."

The direction of the project is essentially the same as proposed in 1996 and 1997; however, the project has proposed additions of specific study populations to better meet the project goals, respond to project reviews by the ISAB and other reviewers, and adapt to changes in the Fish and Wildlife Program, additional ESA listings and regional programs. The key response variables have continued to be empirical smolt-to-adult return rates (SARs) compared to those needed for survival and recovery, and SAR comparisons between transport and inriver migration routes and upstream and downstream populations. The project has contained since its inception the task of exploring feasibility of developing lower river wild spring chinook index stocks to estimate smolt-to-adult return rates to compare with those of Snake River wild stocks. The current proposal, which adds steelhead groups, is consistent with the original project vision and the specific recommendation of the ISAB cited above.

The initial and present intent of this study is *"to begin to provide the basis for the Mainstem Monitoring and Evaluation (M&E) Program's analysis of long term alternatives for recovery of depressed listed and unlisted stocks of chinook and steelhead*." The basic challenge identified by the ISRP is that some components of a mainstem / systemwide M&E program are in place (including the CSS study), but the overall M&E program is not. Clearly, these component programs (including CSS) will need to mesh functionally in the future for a successful systemwide M&E program. As discussed below, formally combining projects does not seem to be necessary or beneficial at this stage so long as data collection and analytical activities are closely coordinated through the proposed umbrella project.

3. ISRP Comment: "The response should contain a careful self-review evaluating the advantages and disadvantages of combining this project with the CBFWA proposal #35033 to form a system wide monitoring and evaluation project."

Response: The CBFWA proposal #35033 for collaborative, systemwide monitoring and evaluation (if funded) would provide a framework within which the CSS (and other projects of similar scale) could operate to monitor and evaluate life cycle survival of listed and unlisted Columbia Basin salmon, steelhead (as well as resident species). Note that the CBFWA proposal did not propose to incorporate administration and implementation of projects like CSS, but rather to integrate Tier 1, 2 and 3 data from these component projects into a systemwide M&E program, and make recommendations for filling critical information gaps related to key management questions facing the region.

Until a systemwide M&E program is actually established, there does not seem to be any advantage to combining the ongoing CSS project with an un-funded proposal such as #35033. In the future, an advantage of combining this project with the CBFWA proposal #35033 might be to ensure project coordination and to prioritize CSS M&E activities. The alternative model is to keep projects separate but have close coordination between the CBFWA M&E project and the various components (including CSS) to ensure efficiency of data collection and analyses. The disadvantage to combining CSS with CBFWA proposal #35033 is primarily one of logistics of project administration and implementation. The scale of CSS is currently workable, with implementation carried out by the Smolt Monitoring Program, and project design, data analyses and oversight carried out by an interagency oversight committee. We foresee no advantages to CSS project administration or implementation from a formal incorporation of CSS into the CBFWA project, because the existing logistical burden would simply fall to the CBFWA project (and subsequently back to the Smolt Monitoring Project). Potential benefits to the CSS study design or data analyses tasks from combining projects could be achieved alternatively through coordination between the CSS project and the CBFWA proposed M&E project, especially considering the overlap of sponsoring agencies and biologists/biometricians on the two projects.

4. ISRP Comment: "The proponents should summarize progress toward publication of the results and methods in the peer reviewed literature, if any attempt has been made."

Response: A part of the CSS results concerning survival rates by route of passage has been published in the North American Journal of Fisheries Management (Budy et al. 2002). However, the majority of the methods and results are contained in the report "Comparative Survival Study of PIT tagged spring/summer Chinook Status Report for Migration Years 1997-2000 Mark/Recapture Activities" in great detail (Bouwes et al. 2002). The CSS oversight committee has been planning to submit a couple of publications, one on the methodologies and another on the results of basinwide comparisons for spring/summer chinook survival rate patterns. The publications rely on finishing the analysis of the non-parametric bootstrap technique for confidence limits for smolt-to adult return rates. In addition, we could not publish results in previous years because the adult returns were not complete until 3 years after marking. Therefore, in order to have three years of data the returns were not complete until 2002. We anticipate submitting these manuscripts for publication this winter.

5. ISRP Comment: "It was mentioned that bootstrapping would be used to obtain confidence intervals on the point estimates and we agree that this may be an appropriate procedure. However, the problem is deeper than estimation of variances. The formulas proposed are ratios of ratios and the magnitude of mathematical bias in the point estimates should also be evaluated. In addition, maximum likelihood estimators and perhaps others

should be developed and contrasted to the proposed ad hoc estimators to determine the most accurate and precise estimates possible with the available data."

Response: The ISRP agrees that the bootstrap may be an appropriate procedure for estimation of variance, but they would like to see an evaluation of potential bias in SARs, ratios of SARs, and the delayed mortality index D. The CSS researchers realize that there is a potential for biases in the estimation process that should be evaluated. For example, estimating the number of smolts in the T_0 (total transported in LGR equivalents) and C_1 (in-river migrating smolts detected at a transportation site in LGR equivalents) categories requires unbiased estimates of survival from Lower Granite Dam tailrace to Lower Monumental Dam tailrace (this expands to McNary Dam tailrace in years that springtime transportation at McNary occurs). As part of the estimation process, we look for patterns in the survival estimates between these dams that may be reflective of potential biases. An unbiased estimate of the number of smolts in the C_0 (in-river migrating smolts not detected at a transportation site in LGR equivalents) category requires unbiased survival estimates to produce results in LGR equivalents and an unbiased estimate of the population of PIT tagged fish at Lower Granite Dam (undetected and detected fish). Most of the variance and potential bias of the estimated number of smolts in Category C_0 will arise from the estimation of population at Lower Granite Dam.

We ran simulations of the process of estimating the number of undetected wild fish at Lower Granite Dam, which included seasonally and randomly varying detection probabilities, smolt travel times, and survival rates. The results suggest that our proposed method results in very small (< 1%) bias in estimates of undetected smolts at Lower Granite, with 95% confidence intervals well within ± 10% of the true value. This method must be used for wild fish, and can also be used with hatchery fish.

The ISRP recommends that we should develop maximum likelihood estimators and contrast them to our "ad hoc" estimators to determine which provides more accurate and precise parameter estimates. However, some of the quantities we already estimate, such as reach survival rates, in fact use maximum likelihood estimation, and the Lower Granite Dam population estimates are generated using components that are maximum likelihood estimators (*e.g.*, estimated collection efficiency). It is these estimates that determine the accuracy and precision of the estimated smolt numbers. These estimates in combination with the actual count data create the estimated number of smolts in each category. This is not an "ad hoc" approach as implied by the ISRP, but rather a set of computational formula based on the underlying probabilities of survival between dams, probability of collection at a dam, and probability of being transported once collected at a dam.

Where practicable, theoretical formulas for variance and/or profile confidence intervals from maximum likelihood estimation (MLE) will be employed with the original data to compare with estimates of variance and confidence intervals generated from the bootstrap program. Likelihood profiles for SARs (where the denominator is known with little error) can be generated using the binomial probability distribution and observed releases and recaptures. Variance for log-transformed ratios of SARs with denominators that are presumed to be known with little error [*e.g.*, SAR(T_{LGR}) and SAR(C_1)] can be estimated with the formula derived from the ratio of two binomial random variables [see Equation (1) of Townsend and Skalski (1997)]. Additionally, MLE for ratios of these SARs will be performed using a likelihood formula similar to Equation (14) of Townsend and Skalski (1997), generating likelihood curves and support functions, which will give means and confidence intervals which can be compared to those

generated from the bootstrap. If the bootstrap estimates of these relatively simple SAR and T/C estimates exhibit low bias and robust confidence intervals, it will provide assurance that more involved estimation procedures (*e.g.*, for D) are reasonable.

Because estimates of in-river survival from Lower Granite Dam tailrace to Bonneville Dam tailrace (LGRBON reach) have generally required some extrapolation of survival across sections of river for which no direct estimate is possible, there is the potential for biases to enter into the estimation of D. In years prior to 1998, there were greater chances of biases in these expansions because of the limited PIT tag detection capabilities at John Day and Bonneville dams, compared to 1998 and subsequent years. In 1998 and subsequent years the distance of river over which in-river survival has had to be extrapolated has been reduced, thus reducing the potential for biases in the LGRBON reach survival estimate. In the bootstrapping program, we have added a feature that allows the researcher to pre-select the number of reaches over which to use existing estimates of in-river survival and to choose among alternative methods of extrapolation. This will allow us to compare the sensitivity of the resulting LGRBON reach survival estimate to the amount of reach (distance) being extrapolated, and the method used.

6. ISRP Comment: "Why is NMFS not on the interagency Comparative Survival (CSS) Oversight Committee? It seems that they are one of the primary users of the results and should be directly involved in oversight of the project."

Response: NMFS was invited to join the Oversight Committee at the inception of the Committee and the CSS study. NMFS declined to participate in day-to-day Oversight Committee discussions. However, NMFS Science Center staff participated in the early stages of study statistical design development. NMFS has not been excluded from the Oversight Committee and has a standing invitation to join if they so desire. NMFS as well as any other agency or individual is provided the opportunity to review and comment on the CSS, annual report, annual proposal study designs and any other aspect of the CSS. NMFS has taken the opportunity to provide comments on this study through the NMFS ESA Section 10 permit process for the CSS.

7. Action Agencies/ NMFS RME Group Comments: "The RME Hydro subgroup recognizes that the proposed research has the potential to provide data and estimates useful in satisfying elements in those RPAs, Hydro-related RME RPAs 185, 187, 188, and 189. The smolt survival estimates have further application in the context of testing compliance with the Hydro performance standards as noted for other proposals in this review. The proposal was thorough in specifying sample sizes comprising key index treatment groups. However it would be beneficial if that information was translated into precision estimates. Alternatively power analyses for key hypothesis tests could be presented to demonstrate the estimates will be satisfactory for evaluating key hypothesis remaining in the region. This would also aid in assessing the utility of the information in performance tests that would be performed at the check-ins."

Response: The CSS provides data useful to addressing hydro-related RPA 185 (SARs of in-river and transported smolts and associated estimation of delayed mortality of transported fish), RPA 187 (relation between ocean entry timing and SARs of in-river and transported smolts), RPA 188 (SARs of lower Columbia River basin wild stocks for use in evaluating effects of

hydro system on upriver stocks), and RPA 189 (SARs of smolts with different passage histories through the hydro system, including effects such as number of bypasses detected and which particular bypasses detected). Through the large scale PIT tagging of hatchery yearling chinook and steelhead, the CSS will provide a database containing smolt passage histories and adult return histories. For Snake River basin smolts, this database will provide direct comparisons of SARs of in-river and transported smolts with a 90% power of detecting differences of at least 50% between the two outmigration routes as long as the smaller SAR does not drop below 1%. For Mid-Columbia River basin smolts, this database will provided direct comparisons of SARs of in-river smolts against the COE's McNary Dam transported smolts with a 90% power of detecting differences of at least 30% between the two outmigration routes as long as the smaller SAR does not drop below 1%. Once any other specific hypothesis of interest to the region is formulated, it would be feasible to evaluate the power of testing that hypothesis using the CSS database. However, we cannot guarantee that the power will be as high for those specific tests if the numbers of smolts available for these new hypothesis tests are much lower than the number of smolts required for the original hypotheses. The PIT tagging of wild smolts at tributary traps will provide marked fish in addition to those NMFS is PIT tagging at the dams for use in estimating SARs from and back to Lower Granite Dam. From the composite of wild stocks, estimates of SARs and ratios of SARs will be possible, but given the uncertainty of collecting large enough numbers of fish of wild origin, the power of the tests will typically be lower than what is possible with the fish of hatchery origin.

The precision of the estimated SARs for in-river and transported smolts will be obtained through bootstrapping techniques. The bootstrap will also provide precision of the ratios of SARs and the associated delayed mortality "D" index. The bootstrap can be an effective tool to obtain a valid measure of variability in a parameter, even when that parameter is a computation based on a set of values, each of which must be estimated. For example, when the ratio of returning adults to a known (fixed) number of smolts is used to generate an estimated SAR, the underlying binomial distribution may be used to obtain the associated measure of precision of the SAR estimate. However, when the number of smolts must also be estimated, the underlying distribution of the ratio of two estimated parameters becomes more complex. For these situations, the non-parametric bootstrap technique is useful (Dixon 1993). Likewise, the ratio of pairs of these SARs (*e.g.*, ratio of transported LGR-LGR SAR to in-river LGR-LGR SAR) would form a complex underlying distribution for which the use of the bootstrap is a preferred approach. This is also true of the estimation of delayed transportation mortality, the D parameter or the ratio of BON-LGR SARs . Programmers at the Fish Passage Center are currently writing a computer program to perform bootstrapped estimates of variance and confidence intervals for individual SARs, ratios of SARs, and D. The next CSS annual status report will contain bootstrapped estimates of precision for all parameters presented. This will allow NMFS to assess the utility of using the CSS's estimated parameters at their periodic check-ins.

References

Bouwes, N., C. Petrosky, H. Schaller, P. Wilson, E. Weber, S. Scott, and R. Boyce. February 2002. Comparative Survival Study of PIT tagged spring/summer Chinook Status Report for Migration Years 1997-2000Mark/Recapture Activities. BPA contract number 8712702. Columbia Basin Fish and Wildlife Authority, Fish Passage Center Report. www.FPC.ORG.

Budy, P., G. P. Thiede, N. Bouwes, C. E. Petrosky, and H. Schaller. 2002. Evidence linking delayed mortality of Snake River Salmon to their earlier hydrosystem experience. North American Journal of Fisheries Management Vol. 22 (1), pp 35-51.

Dixon, P. M. 1993. The bootstrap and jackknife: describing the precision of ecological indices. Pages 290-318 in S. M. Scheiner and J. Gurevitch, editors. Designs and analysis of ecological experiments. Chapman and Hall, New York

Townsend, R.L. and J. L. Skalski. 1997. A comparison of statistical methods of estimating treatment-control ratios (transportation benefit ratios) based on spring chinook salmon on the Columbia River, 1986-1988. The design and analysis of salmonid tagging studies in the Columbia basin, Volume IX. BPA Project Number 91-051, Portland OR.