Independent Scientific Advisory Board
for the Northwest Power and Conservation Council,
Columbia River Basin Indian Tribes,
and National Marine Fisheries Service
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Memorandum (ISAB 2011-3) **September 16, 2011**

To: ISAB Administrative Oversight Panel
Bruce Measure, Chair, Northwest Power and Conservation Council
Paul Lumley, Executive Director, Columbia River Inter-Tribal Fish Commission
John Stein, Science Director, NOAA-Fisheries Northwest Fisheries Science Center

From: Rich Alldredge, ISAB Chair

Subject: ISAB Review of Three Fish Passage Center Technical Memoranda

Background

The Northwest Power and Conservation Council's 2009 amendments to the Columbia River Basin Fish and Wildlife Program call for the continuation of the fish passage related functions currently conducted by the Fish Passage Center. The primary functions are to provide technical assistance and information to fish and wildlife agencies in particular, and to the public in general, on matters related to water management, spill, and other passage measures. The Program also calls for the Fish Passage Center's Oversight Board to ensure that the functions are implemented consistent with the Program. To do this, the Program specifies that the Oversight Board will work with the Center and the Independent Scientific Advisory Board (ISAB) to organize a regular system of independent and timely science reviews of the Center's analytical products.

This regular system of reviews includes evaluation of technical memos or analyses that meet criteria established in the October 12, 2010, *Review Guidelines for the Independent Scientific Advisory Board Review of Fish Passage Center Products*, and that would be of interest to the region. These criteria include whether new or novel analyses are introduced; new conditions or data bring old analyses into question; and/or consensus cannot be reached in the region on the science involved in the product. Three Fish Passage Center (FPC) technical memos on the topics of latent mortality and effects on in-river survival were identified as meeting the criteria for review. The three memos address latent mortality of in-river migrants due to route of dam passage.

The three FPC technical memoranda (with associated links) are:

1) Memo #134-10 dated October 5, 2010, "Delayed/latent Mortality and Dam Passage"

   www.fpc.org/documents/memos/134-10.pdf

2) Memo #135-10 dated October 6, 2010, "Delayed/latent Mortality and Dam Passage, Fish Passage Operations Implications" and

   www.fpc.org/documents/memos/135-10.pdf

3) Memo #08-11 dated January 19, 2011, "Effects of Passage through Juvenile Powerhouse Bypass Systems at Mainstem Dams on the Snake and Columbia Rivers."

   www.fpc.org/documents/memos/08-11.pdf

Conversations between a member of the Fish Passage Center Oversight Board, Jim Ruff, Erik Merrill, and Rich Alldredge resulted in questions designed to guide and focus the ISAB review to be most useful to regional policy makers as they judge whether the conclusions in the memos are supported by "sound science." The questions designed to frame this science review are provided below.

Review Questions and Answers

a) *Are the original FPC analyses cited in the memos scientifically rigorous and relevant to the topics in the memos?*

The memos all summarize evidence related to the hypothesis that passage of juvenile salmonids through bypass systems at Federal Snake-Columbia River hydropower dams reduces subsequent adult return rates. The earliest of the three memos (134-10) cites eleven references. Four of these references are refereed publications, and the remaining seven are unpublished agency reports or draft agency reports. The second memo (135-10) is essentially identical to memo 134-10 except for the addition of two paragraphs that address "Potential implications for fish passage operations." The third and most recent memo (08-11) appends the earlier memo 135-10 and adds a short section on "Previous Fish Passage Center Analyses" that cites memos 71-09 (May 21, 2009) and 13-10 (February 3, 2010). These latter two memos, which report original FPC analyses, are discussed below.

Memo 71-09 compares the adult returns of juvenile Chinook that were detected in the juvenile bypass system at Ice Harbor Dam in 2006 with returns of juvenile Chinook that passed the dam undetected (data for the 2005 outmigration are also reported, but with the comment that adult returns were too few for the data to be useful). The hypothesis of no difference between passage routes is tested by calculating the ratio of smolt-to-adult returns for detected (SAR-d) and

undetected (SAR-ud) fish, i.e. SAR-d/SAR-ud, with 90% confidence limits. In the absence of an effect and without error, this ratio would be 1.0. For Chinook salmon outmigrating in 2006 the ratio is about 0.6, with an upper 90% confidence limit of approximately 0.95. However, no information is given on the sample sizes for undetected juveniles or for returning adults in the "detected as smolts" and "undetected as smolts" categories (the total number of adults returning was 127).

Memo 13-10 compares the adult returns of juvenile spring/summer Chinook and juvenile steelhead that were detected in the juvenile bypass system at Lower Monumental Dam in 2006 and 2007 with returns of, respectively, juvenile Chinook and juvenile steelhead that passed the dam undetected. Using the same methodology as described above for the analysis reported in memo 71-09, this memo reports that for the four tests (two species in two years) the SAR-d/SAR-ud ratio is above 1.0 in two instances and below 1.0 in two instances. Confidence limits (90%) are wide and broadly overlap 1.0 in three instances. For one group (Chinook in 2007) the point estimate for the ratio is about 0.5 and the upper 90% confidence bound falls just below 1.0. Again, no information is given on sample sizes for detected or undetected juveniles or for returning adults in the "detected as smolts" and "undetected as smolts" categories. Providing this information would clarify the origin of particular SARs. In this memo (as in memo 71-09), several reasons are given why the experimental conditions could have biased SAR-d/SAR-ud ratios upward by increasing estimated SARs for detected fish and decreasing estimated SARs for undetected fish. These biases potentially decreased the possibility of detecting differences between detected and undetected groups.

Memo 71-09 fairly concludes, "These results are preliminary at best." This memo and memo 13-10 provide weak support for the hypothesis that exposure to juvenile fish bypasses can decrease long-term survival.

b) Does the work by others cited in the memos represent the "universe" of studies or information relevant to the topics addressed by the memos?

In general, the references summarize most of the key analytical efforts on the topic. The cited work by others is relevant to the memos. However, there is not much of an effort to use the broader biological and ecological literature in an effort to explain variation in SARs and issues relevant to data reliability (e.g., propagation of error). In view of the focused intent of the memos, the approach used by the FPC may be justified, but other factors may affect interpretation of the analyses presented. For example, the following publications also reported relevant analyses.

Sandford, B.P. and S.G. Smith. 2002. Estimation of smolt-to-adult return percentages for Snake River basin anadromous salmonids, 1990–1997. Journal of Agricultural, Biological, and Environmental Statistics 7(2):243–263.

Zydlewski J., Zydlewski, G., Danner, G.R. 2010. Descaling injury impairs osmoregulatory ability of Atlantic salmon smolts entering seawater. Transactions of the American Fisheries Society, Volume 139, Issue 1, 2010, Pages 129 – 136.

NOAA Technical memo. 2005. Effects of the Federal Columbia River Power System on Salmonid Population. NMFS-NWFSC-63, by Williams et al.

c) Does the FPC completely and accurately characterize the work by others cited in the memos with respect to their relevance to the topics addressed in the memos (e.g., does the FPC accurately and objectively describe what was done, why it was done, what was found and what it may mean)?

The ISAB notes that the FPC produces a large amount of work, often on a very short time line. This is especially true for FPC technical memoranda. The technical memos reviewed were very succinct, which is typical of FPC memoranda. Despite these time and space constraints, the memos clearly described what was done, the results, and some possible implications. In general, the FPC has improved the completeness and accuracy with which it characterizes the work cited in technical memos.

d) Are the syntheses of the results from the relevant studies and original FPC analyses scientifically sound; i.e. are the interpretations of the weight of evidence represented by the body of work cited in the memos reasonable and scientifically defensible?

Please see the response to part e below.

e) Are the conclusions reached as a result of the syntheses and interpretations of the relevant studies and original FPC analyses reasonable and scientifically defensible? Can one reach other reasonable and scientifically defensible conclusions based on the "universe" of studies or information relevant to the topics addressed by the memos?

The conclusions reached are reasonable and scientifically defensible based on the data used. However, other reasonable conclusions could also be reached, and issues remain concerning the data used. For example, as noted in technical memo 134-10 when summarizing Buchanan et al. (2010), "The ROSTER model could have assumption violations due to heterogeneity in capture probabilities for smolts at dams." The concern about biased sampling also may apply to Tuomikoski et al. (2010). The issue of possible bypass selectivity for less-fit fish, for example injured, diseased, less advanced in the smoltification process, smaller, or with lower energy reserves, rendering them less likely to survive to return remains unresolved and is in need of evaluation. The complex issue of the relationships among descaling, disease resistance, osmoregulation capability, and survival (See Zydlewski et al. reference above) is another issue in need of investigation. These largely unexamined biological and ecological factors potentially

affecting SARs have not been thoroughly evaluated. The memos use analytical approaches taking SARs at face value without discussing these unexamined factors.

The technical memos report that according to Petrosky and Schaller (2010), "Best fit, simplest models indicate that lower survival rates for Chinook salmon are associated with warmer ocean conditions, reduced upwelling in the spring and with slower river velocity during the smolt migration or multiple passages through powerhouses at dams." It should be noted that multiple powerhouse passages appeared in some models for Chinook but not all. However, multiple powerhouse passages were not included in the best-fit models for steelhead, and this should be noted in the memos. A critical evaluation of this cited work might also include mention of the use of indirect estimates of delayed mortality with attendant difficulties in assessing variation in estimation when one is attempting to detect subtle responses of mortality rates. Another concern that could be raised when interpreting support for the latent mortality hypothesis is the difficulty of separating delayed effects of the passage system over the long time period from confounding effects and long-term trends, perhaps undocumented, in-river conditions.

The interpretation that Schaller and Petrosky (2007) provide that latent mortality occurs in fish passing the powerhouse collection bypass systems should also include mention of the ISAB concern over using comparisons of upriver and downriver stocks to make such conclusions due to confounding from other factors in establishing cause(s) of upriver/downriver differences (see ISAB 2007-1 and ISAB/ISRP 2007-6[1]). Another concern that could be raised before accepting the latent mortality conclusion is the issue of propagation of error when analyses are conducted with models, such as the Ricker model, for estimating productivity due to difficulties in assessing the appropriateness of this approach and the sensitivity of its results.

Other works cited in the technical memos provide little or no support for the latent mortality hypothesis. The Ferguson et al. (2006) work does not directly address fish entering the bypass system but rather focuses on fish passage through turbines. As the FPC memos correctly state, Ham et al. (2009) found little evidence of bypass effects and Weiland et al. (2010) found that bypass increased survival through John Day Dam. It was useful to have this literature cited in the memos, demonstrating consideration of other results related to latent mortality.

f) *Is there adequate evidence available to establish that latent mortality associated with bypass passage/powerhouse passage is indeed an issue for juvenile fish and fish passage management?*

Based on our review, the studies and analyses cited in these technical memos do not provide an adequate base of reliable information to support a "weight of evidence" conclusion on the strength of a relationship between multiple bypass passage and latent mortality of juvenile

[1] ISAB Latent Mortality Report. 2007-1. http://www.nwcouncil.org/library/isab/isab2007-1.htm and ISAB and ISRP Review of the CSS Ten-Year Retrospective Summary Report, 2007-6, http://www.nwcouncil.org/library/isab/isab2007-1.htm

Chinook and steelhead. That is, the relationships observed between latent mortality and bypass passage are confounded with other factors that obscure unambiguous interpretation.

References from the FPC Tech Memo 134-10 and others cited in this ISAB memo

Buchanan, R., R. Townsend, J. Skalski, K. Hamm. 2010. DRAFT REPORT: The Effect of Bypass Passage on Adult Returns of Salmon and Steelhead: An Analysis of PIT-Tag Data Using the Program ROSTER.

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 22:35-51.

Ferguson, J. W., R. F. Absolon, T. J. Carlson, and B. P. Sandford. 2006. Evidence of delayed mortality on juvenile pacific salmon passing through turbines at Columbia River dams. Transactions of the American Fisheries Society 135: 139-150.

Ham K.D., C.I.I. Arimescu, M.A. Simmons, J.P. Duncan, M.A. Chamness, and A. Solcz. 2009. Synthesis of biological research on juvenile fish passage and survival 1990-2006: McNary Dam. Report prepared for U.S. Army Corps of Engineers, Contract W9127N-06-D-005.

Marsh D.M., B.P. Sanford, S.G. Smith, G.M. Matthews, W.D. Muir. 2009 Transportation of Columbia River salmonids from McNary Dam: Final Adult Returns from Hatchery Spring Chinook of 2002-2004 and hatchery Steelhead of 2003-2005. Draft report prepared for the U.S. Army Corps of Engineers.

McMichael, G.A., R.A. Harnish, B.J. Bellgraph, J.A. Carter, K.D. Ham, P.S. Titzler, and M.D. Hughes. 2010. Migratory behavior and survival of juvenile salmonids in the Lower Columbia River and estuary in 2009. Draft report for the U.S. Army Corps of Engineers.

Petrosky C., and H. Schaller 2010. Influence of river conditions during seaward migration and ocean conditions on survival rates of Snake River Chinook salmon and steelhead. Ecology of Freshwater Fish 2010. 2010 John Wiley& sons A/C

Schaller, H. A, and C. E Petrosky. 2007. Assessing hydrosystem influence on delayed mortality of Snake River stream-type Chinook salmon. *North American Journal of Fisheries Management* 27, no. 3: 810–824.

Scheuerell, M, and R.Zabel. 2006. Seasonal differences in migration timing leads to changes in the smolt-to-adult survival of two anadromous salmonids. Unpublished Draft technical paper. This work has been published as: Mark D. Scheuerell, Richard W. Zabel1 and Benjamin P. Sandford. Relating juvenile migration timing and survival to adulthood in two species of threatened Pacific salmon (Oncorhynchus spp.) Journal of Applied Ecology 2009, 46, 983–990

Tuomikoski, J., J. McCann, T. Berggren, H. Schaller, P. Wilson, S. Haeseker, J. Fryer, C. Petrosky, E. Tinus, T. Dalton, and R. Ehlke. 2010. DRAFT REPORT: Comparative Survival Study (CSS) of PIT-tagged Spring/Summer Chinook and Summer Steelhead, 2010 Annual Report, Project No. 1996-020-00. http://www.fpc.org/documents/CSS/CSSDRAFTRPT2010.pdf

Weiland, M.A., G.R. Ploskey, J.S. Hughes, Z. Deng, T. Fu, T.J. Monter, G.E. Johnson, F. Khan, M.C. Wilderding, A.W. Cushing, S.A Zimmerman, D.M. Faber, K.M. Carter, J.W. Boyd, R.L. Townsendm, J.R. Skalski, J. Kim, E.S. Fischer, and M.M. Meyer. 2010. Acoustic telemetry evaluation of juvenile salmonid passage and survival proportions at John Day Dam, 2009. Draft report prepared for the U.S. Army Corps of Engineers (PNNL-19422 DRAFT).