FISH PASSAGE CENTER

1827 NE 44th Ave., 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
Rick Kruger, ODFW
Tony Nigro, ODFW

FROM: Michele DeHart

DATE: March 23, 2012

RE: Comments on BON and TDA Performance Standards Testing in 2010

In response to your request the FPC staff has reviewed the PNNL reports prepared for the US Army Corps of Engineers titled "Survival and Passage of Juvenile Chinook Salmon and Steelhead Passing Through Bonneville Dam, 2010" and "Survival and Passage of Yearling and Subyearling Chinook Salmon and Steelhead at The Dalles Dam, 2010." These reports document acoustic tagging studies conducted to address if individual projects are meeting the performance standards required in the 2008 Federal Columbia River Power System Biological Opinion (BiOp). These performance criteria include dam passage survival of 96% for yearling Chinook and Steelhead, and 93% for subyearling Chinook. Both of these studies raise concerns about experimental design, methodology, statistical analysis, and the limitations of these types of studies. Our overall conclusion is that neither of the studies and results completed for Bonneville or The Dalles dams is adequately robust to support a hydroelectric project operations decision. Our summarized comments are listed below, followed by a detailed discussion of each article.

The 2010 study at Bonneville Dam was a single release design utilizing fish tagged upstream for studies at other projects. Because of this, the study differs significantly from the design approved for performance standards testing at other projects.

- All fish utilized in this study were tagged at one of three upstream sites. Utilizing these fish for downstream studies requires that survival of each tagging group is

equal in reaches they all pass through. This was not true for all groups in this study, indicating increased mortality over time associated with acoustic tags. This may result in a high-grading of tagged fish if only the largest or healthiest tagged fish survival tagging mortality to the Bonneville forebay.

- The report provides misleading survival estimates for discussion. The single-release design used at Bonneville lacks a control group. Consequently, the estimates include tailrace mortality and are theoretically lower than expected with a paired release design that addresses mortality that occurs away from the concrete. To compensate for this the report makes estimates of what survival would have been if the study had been a paired-release study, using survival estimates from the B2 corner collector as a "pseudo" control. This constructed estimate violates basic tenets of experimental design and generates a significant upward bias. However, it is misleadingly repeated within the report, rather than the results of the single-release study that was actually conducted.

- At The Dalles Dam, a virtual/paired-release study design was used. The use of a third release group, utilized as a second control, may artificially inflate dam survival estimates. This upward bias in survival estimates may be caused by differential mortality between groups due to random sampling effects or environmental factors such predation.

- The studies at both projects have similar issues due to the limitations of using acoustic tagging.

  - Acoustic tags require the rejection of a high percentage of fish due to size or condition. The rejection rate in 2010 was 16%, so survival estimates are not likely to represent the run-at-large.

  - The assumption that tagged fish should experience equal mortality over stretches of river they share, regardless of their tagging location, was violated in the 2010 study. This required the elimination of some groups for consideration in the BON study, and calls into questions the assumptions of limited tag-related mortality throughout the area covered by these studies.

  - The short tag life in acoustic tagging studies means that these studies can only provide survival estimates for short reaches. Long term effects of passage routes cannot be evaluated with this method.

- The limitations of acoustic tag studies indicate that they should not be used as the sole measure of hydrosystem survival. Decisions on project operations should incorporate all available data, including studies on the cumulative effects of multiple dam passage and delayed mortality associated with passage route.

Survival and Passage of Juvenile Chinook Salmon and Steelhead Passing Through Bonneville Dam, 2010

The 2010 acoustic tag study at BON was not intended as a compliance test for performance standards. The single-release study design is not the same as the compliance testing at other dams, the spill patterns were not finalized and varied over the course of the season, and total spill volumes were not controlled during the yearling Chinook and juvenile Steelhead migrations.

This methodology used in the study requires the assumption that there are no effects of tagging, such as differential mortality among tagging groups that would compromise the applicability of the results to the run-at-large. However, this assumption was violated for subyearling Chinook, where fish tagged at the most upriver site (Roosevelt, WA) had significantly higher mortality than groups tagged further downriver (The Dalles Dam tailrace, and Hood River, OR) in the sections of river that both groups migrate through (Beeman et al. 2011). This indicates that tagged fish may undergo selective pressures relative to the distance travelled while tagged. The fish that survive to BON from upriver tagging sites may be significantly more fit than the general population of tagged fish, inflating survival estimates that would not be representative of the run-at-large.

The single-release design used in this study lacks a control group. This design avoids upward bias due to random sampling effects or differential mortality between groups, as in the 2010 studies at TDA (see discussion below). However, PNNL presents an "estimated survival" as if the study had been a virtual/paired-release. This calculation uses estimated survival through the BON Corner Collector as a pseudo "control." This inflated survival estimate is not an appropriate modification to the single-release design and violates basic principles of experimental design. Despite this fact, these values are utilized throughout the document as survival estimates, including comparisons to historical values that were obtained through actual virtual/paired-release designs. The survival estimates are upwardly revised enough that yearling Chinook and Steelhead are modified from not meeting performance standards to exceeding them. This is extremely misleading as it does not reflect the actual results and limitations for this study.

Although the summer subyearling Chinook study design called for comparison of survival at two different spill operations (24-h, 95-Kcfs and 85-Kcfs day/120-Kcfs night) in 16 block treatments. However, spill could only be controlled from July 2 to July 18 so only 9 blocks were used. One of the blocks had very few fish and so was pooled with another block, leaving 8 testing blocks in total. No statistically significant difference between operations was detected, although test power was low. On July 15, the 85-Kcfs day/120-Kcfs night black had only 48 fish, the smallest sample size in the study. The survival of this group was much lower than other testing blocks and has a much larger confidence interval. This single group may have had a disproportionate effect on the treatment mean and affected the final analysis. No power analysis was done to determine the required sample sizes and number of blocks to detect a difference between the two spill operations.

Although a difference in survival under different spill operations was not observed in this study, the power was low and many sample sizes were low. If there is an undetected difference in survival under spill operations, pooling the results from all testing blocks to generate a single survival estimate, as done for 2010 performance standards, will be statistically inappropriate.

Survival and Passage of Yearling and Subyearling Chinook Salmon and Steelhead at The Dalles Dam, 2010

In contrast to the 2010 study at Bonneville, the study at The Dalles Dam used a virtual/paired-release design with two control groups, one released in the tailrace of the dam (R_2) and one released further downstream (R_3). The R_3 group is intended to account for any handling mortality experienced by the R_2 group. The survival estimates of these two groups are used together (S_2/S_3) as a control for the experimental group passing the dam. The intent of the R_3 group is to avoid upwardly biasing dam survival estimates due to handling mortality expressed in the tailrace of the dam.

However, survival estimates generated with this multiple-release design actually further increased dam survival estimates due to random sampling effects, in some cases moving survival estimates upward enough to meet performance standards when they would not have with only one control group. If there is limited handling and transportation mortality, the use of the R_3 group will introduce additional variation to the study. Beeman et al. (2011) concluded that this result is "contrary to the goal of adjusting a paired-release estimate downward to account for handling mortality."

Upward biasing of survival estimates could also be caused by higher mortality in the R_2 group. It is unlikely that tagged fish in both stretches of river encounter the same environmental conditions, especially since predation rates are higher in the forebay and tailrace than mid-reservoir at many projects (Petersen 1994, Ward et al. 1995). If survival in the R_2 group is lower than survival in the R_3 group, the ratio of survivals (S_2/S_3) will be biased low and will artificially increase estimates of dam survival. Please see Beeman et al. (2011) and the March 24, 2011 FPC Memo for detailed descriptions upward biases inherent in this study design.

A further cause of differential mortality may be the fact that fish that are released at a specific location will not have the vertical or horizontal distribution of fish that have been released upriver. At The Dalles Dam, release of the R_2 group occurs near islands downriver of the dam. At the February 6, 2012 SRWG meeting, concern was expressed that this release occurs in an equal distribution across the river, rather than attempting to mimic natural migration patterns. Therefore, it is unlikely that mortality will be equal between release groups and that these releases represent mortality of the run-at-large.

General Comments on 2010 Acoustic Tagging Studies

Acoustic tagging studies have a number of limitations that seriously affect their ability to predict the effects of project operations on the survival of juveniles through the entire

hydrosystem. FPC has expressed particular concern over the rejection of fish for tagging (FPC Memos June 24, 2009, March 24, 2011, and February 15, 2012). In 2010, 16% of fish were rejected for tagging. Of rejected fish, 19% were rejected because of size, mostly subyearling Chinook and Steelhead. There are a number of conditions that can cause rejection other than size, including disease and body injury. The largest numbers of fish were rejected due to descaling (22% of rejected fish). The large numbers of rejected fish mean that survival estimates do not represent the run-at-large, but instead survival estimates for the largest, least injured and healthiest 84% of migrants. A study that accurately calculates survival estimates for the overall population will reject fewer fish due to size or condition.

Project survival estimates are a function of survival of individual passage routes and the number of fish migrating through that route. The rate at which fish travel through different passage routes may be affected by acoustic tags. If tags effect migration behavior, the survival estimate will not accurately reflect the survival estimate of the run-at-large. This issue has been discussed by FPC Memos on June 24, 2009 and February 15, 2012. Additionally, there is extensive transport of tagged fish to release sites via trucks. The effects of long trucking times on fish behavior is not considered in this study, but may have significant effects on passage behavior.

The limited life of acoustic tags means they can only accurately assess survival over very short reaches over a short period of time, while the different life stages of salmonids cover a large area and many years. An increasing body of evidence indicates that dam passage affects survival well into the estuary and ocean, and that at-dam survival estimates do not fully represent impact of hydrosystem operations on adult returns (Schaller and Petrosky 2007, Petrosky and Schaller 2010, Tuomikoski et al. 2010, Haeseker et al. 2012). Acoustic tags are unsuitable for evaluating the effects of project passage through the entire hydrosystem, including delayed mortality due to route passage or the cumulative effects of multiple projects.

In previous analyses of acoustic tagging studies, the rejection of some fish detections has occurred during the post-hoc data selection (FPC Memos July 29, 2010, and February 16, 2011). If this type of data rejection was utilized in 2010 performance testing, it is not explicit in these reports. A comprehensive and publicly accessible database of the detection data would allow for more comprehensive analyses of these data.

The limitations of specifically these reports, and of acoustic tagging in general, indicate that project operations should not be made solely on the results of these types of studies. An appropriate decision making framework should incorporate multiple types of data, including those that can provide information on the long-term results of project operations such as delayed mortality. For a detailed discussion of this topic, please see FPC Memo February 16, 2012.

References

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