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: Tom Lorz, CRITFC

FROM: Michele DeHart

DATE: March 2, 2010

RE: John Day Dam Operations in 2011, COE White Paper Sensitivity Analysis

In response to your request we reviewed the sensitivity analysis included in the Corps of Engineers "White Paper" regarding the 2011 tests of 30% versus 40% spill for fish passage. We offer the following comments for your consideration.

- **The sensitivity analysis is incomplete in that it does not assess risk.**
- **Sensitivity analyses are a component of decision analyses, there is no decision analysis framework presented in the "white paper" for determination of project operations for fish passage. A decision framework would incorporate other data and additional passage metrics.**
- **The "white paper" does not address important factors that should be incorporated into sensitivity analyses, such as differences in behavior and survival of acoustic tag fish compared to the run-at-large.**
- **The sensitivity analyses presented by the COE shows that the calculated project survival is completely dependent on the survival of the reference groups, indicating that the calculated performance standard survival is extremely sensitive to handling, tagging, transportation effects on the reference group.**

Sensitivity Analyses

Sensitivity analyses are commonly used in decision analyses as a means of evaluating risk. An objective of a sensitivity analysis is to identify the most important factor or factors in a complex model. Important factors are those that have the most influence on the variance of the model output (Saltelli 2002).

Sensitivity analysis is the study of how the variation (uncertainty) in the output of a mathematical model can be assigned, qualitatively or quantitatively, to different sources of variation in the input of the model. In other words, it is a technique for systematically changing parameters in a model to determine the effects of such changes. Understanding of the relationship between input factors (what goes into the model) and output (the model's dependent variables) is important in evaluating potential decisions based upon the model output.

John Day Sensitivity Analysis

The John Day Sensitivity Analysis is not describing the variation in a mathematical model per se, but describing the relationship between the "output" project survival at John Day and the fixed reach survival of the reference or control group representing reach survival. The modeled relationship in this table is basically a series of divisions of the dam survival by the reference group survival at 30% and 40% spill. **The John Day sensitivity analysis indicates that the dam survival estimate generated by the 2010 study is completely dependent on the estimate of the reference group survival. The sensitivity analyses shows that any influence such as marking, handling, tagging effects that would reduce the reference group estimate could bias the dam survival estimate high. The sensitivity of the dam passage survival estimate to the reach survival estimate is further illustrated by the sensitivity table, in which a reference survival of .976 causes the project survival to exceed 1.0 which is highly unlikely.**

Risk

The sensitivity analysis presented in the White Paper ignores an important component of sensitivity analyses, and that is the assessment of risk. Assessment of risk of options is an important component of decision making. The John Day "white paper" does not address two important uncertainties: the likelihood of alternative reach survival estimates and the likelihood of alternative reference group survival rates. Both of these uncertainties impact the risk of failing to meet the performance standards. To better account for these uncertainties and quantify the inherent risks, the COE could have conducted a simple simulation study. They could have quantified the likelihood of alternative reach survival estimates and reference group survival estimates occurring.

To illustrate this concept, we simulated alternative reach and reference group survival estimates that may occur under the two spill operations. To quantify the likelihood of alternative reach survival estimates, we simulated normally distributed random variables with means and standard errors for the two operations equal to those presented in the white paper (Table 1, below). These simulated reach survival estimates quantify the likelihood of alternative reach survival rates that may occur under the two operations. There are no estimates of reference group survival rates through The Dalles reservoir under the proposed "triple-release" design. However, there were estimates of reference group survival through Bonneville reservoir under the triple-release design in 2010. Those estimates were 0.9757 for yearling Chinook and 0.9993 for steelhead. To quantify the likelihood of alternative reference group survival rates that may occur using the triple-release design at John Day, we simulated alternative reference group survival rates as uniformly distributed random variables with a range of 0.9757 to 0.9993. Dam survival was calculated as the reach survival divided by the reference group survival. Our measure of risk is the proportion of the simulations where the dam survival estimates were below 0.96.

Results indicate that there is substantial risk of failing to meet the performance standard for both species at the 30% spill operation (Table 2, below). We estimate that there is a 77% chance of missing the performance standard for steelhead with the 30% spill operation. Similarly for yearling Chinook, we estimate that there is a 66% chance of missing the performance standard with the 30% spill operation. In contrast, the simulation results indicate that the performance standard was never missed with the 40% spill operation for steelhead. For yearling Chinook, we estimate that there is a 45% chance of missing the performance standard at a 40% spill operation. To increase the likelihood of meeting the performance standard for Chinook, these results indicate that spill percentages of greater than 40% may be necessary. This example of a risk assessment indicates that the 30% spill operation has a much higher risk of missing the performance standards for both yearling Chinook and steelhead.

Table 1. Estimates of reach survival (with standard error) at John Day Dam in 2010 from the Corps of Engineers white paper.

Spill Operation	yearling Chinook	steelhead
30%	94.4 (0.8)	94.1 (0.6)
40%	95.0 (0.9)	97.4 (0.7)

Table 2. Proportion of simulations where the estimated dam survival was less than 0.96 for yearling Chinook and steelhead based on reach survival estimates presented in the White Paper and observed reference group survivals from The Dalles study in 2010.

Spill Operation	yearling Chinook	steelhead
30%	0.66	0.77
40%	0.45	0.00

Sensitivity to assumptions of the methodology

A basic question to be considered before performing a marking program is: what are the effects of handling and tagging on the survival and behavior of the organism (Neilsen and Johnson 1983)? The paired-release methodology assumes no effect of handling/tagging on the 'reference' group. The reference group measures survival from the tailrace of the dam of interest to the forebay of the next dam. This value is removed from the forebay to forebay survival in order to indirectly measure survival within the dam of interest. Mathematically, this is a simple relationship, whereas $S_{Tailrace\_to\_Forebay}$ *decreases*, the survival in the dam of interest *increases* (see equation below). The paired-release methodology is dangerous because any handling/tagging effects expressed in the reference release ($S_{Tailrace\_to\_Forebay}$) have the potential to bias the survival within the dam *high*.

$$\uparrow S_{DAM} = \frac{S_{ForeBay\_to\_ForeBay}}{\downarrow S_{Tailrace\_to\_ForeBay}}$$

$where:$

S_{DAM}

$S_{ForeBay\_to\_ForeBay}$

$S_{Tailrace\_to\_ForeBay}$

The sensitivity analysis performed in the 'white paper', *Draft John Day Dam Fish Passage Project Operation* (February 22, 2011) provides an excellent example as to how sensitive the survival indirectly measured for John Day can be affected by a handling/tagging effect within the reference group. For example, in table 4 for Yearling Chinook at 30% spill, if a tagging/handling effect decreased survival in the reference group by 1%, then the estimated dam survival has a biased increase in survival of 1%. Approximately the same relationship holds true for yearling Chinook at 40% spill. Nearly the same relationship holds true for all species at all both spill levels shown in table 4 with a lesser bias at lower values for the forebay_to_forebay survival.

Combining reference survivals for different groups or years has the potential to further confound the measurement for survival. Different years undoubtedly have many varying factors other than spill percentage and to our knowledge, there are no other survival estimates available during these exact time periods to combine with the forebay_to_forebay survival to arrive at a within dam survival.

Sensitivity Analyses are applied to decision frameworks

Complicated methodologies that require extensive handling, marking and transportation of fish, releases of several test and control groups, and selection of the highest quality fish for tagging (< 20% descaling) introduce effects and biases into the analytical results. Results are highly sensitive to assumptions regarding the reference groups and test groups. Handling effects can bias the estimate. Studies have shown that acoustic tags affect fish behavior and survival. Acoustic tag results from these COE studies have not been compared to other data utilizing other tagging methods and other methodologies. Given that the effects of methodologies are recognized, the long term decision regarding operations should incorporate all available data and should assess the degree to which acoustic tag results can be applied to the run at large. Long term and delayed effects of route of passage should be considered in a decision framework. For example, The acoustic tag data for the 2010 study at John Day indicates that 2-3% more of the run-at-large will pass through the bypass system at John Day under the 30% spill operation. Considering the passage index for 2010 at John Day, this would result in approximately an additional 20,000 juvenile steelhead and 30,000 juvenile Chinook passing through the bypass system at John Day and suffering the delayed and latent mortality associated with bypass passage. The degree to which acoustic tagged fish represent the run-at-large has not been assessed.

References

Nielsen, L. A, and D. L Johnson. 1983. Fisheries techniques.
Saltelli, A. 2002. Sensitivity analysis for importance assessment. Risk Analysis 22, no. 3: 579–590.

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

DATA REQUEST FORM

Request Taken By: MJF **Date:** 2/23/11

Data Requested By:
Name: Tom Lorz **Phone:**
Address: CRITFC **Fax:**
Email:

Data Requested:
Look at the sensitivity analysis on John Day and compare with PIT tag data if available

Data Format: Hardcopy ☐ Text ☐ Excel ☐

Delivery: Mail ☐ Email ☐ Fax ☐ Phone ☐

Comments:

Data Compiled By: FPC Staff **Date:** 3/02/01

Request # 19

G:\STAFF\DOCUMENT\FORMS\Templates\data request form template.doc