



# FISH PASSAGE CENTER

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## MEMORANDUM

TO: Russ Kiefer, IDFG  
FPAC

FROM: Michele DeHart

DATE: March 5, 2014

RE: Modeling the Effects of Idaho Change Form for Ice Harbor Dam Spring Spill Operations on Proportion of Yearling Chinook and Steelhead Passing in Spill

In response to a request from the Fish Passage Advisory Committee (FPAC), the Fish Passage Center (FPC) reviewed the proposed Idaho Change Form for spill operations at Ice Harbor Dam (February 25, 2014, <http://www.fpc.org/documents/memos/22-14.pdf>). During discussion of the review at the February 25<sup>th</sup> FPAC meeting you requested that the FPC determine whether the Comparative Survival Study (CSS) models developed for the Experimental Spill Management modeling could be used to estimate the SPE that would result from the implementation of the Idaho proposal. The FPC applied the SPE curves from the CSS Experimental Spill Management to estimate the effect of the proposed Idaho Change Form for IHR operations on the overall proportion of yearling Chinook and steelhead passing in spill.

Below is a summary of our findings, followed by a detailed discussion of the analyses.

- The conclusions must all be evaluated within the constraints of the information and assumptions used in the analysis.
  - The analysis was limited to one low flow and one high flow year.
  - The CSS SPE curves asymptote at 100% SPE at a proportion spill near 80%. Other relations between spill proportion and SPE (see February 25<sup>th</sup> memo) that were not investigated in this analysis describe an increase in SPE above an 80% spill proportion.
  - Diel passage information was based on radio tag fish from a 2009 study.
  - The modeling of the Idaho proposal is sensitive to differences between ESP forecasted and actual flows. The forecasted flows for the modeling exercise were

not modified within the weekly time frame as the Idaho Change Form proposes for actual implementation.

- Under all three modeled operations, estimates of daily proportion of fish passing in spill were variable. This variability was more pronounced under the alternating 30%/30% and 45 Kcfs/Gas Cap scenarios, particularly in the low flow year (2013).
- When summarized over the entire period (April 28–July 13), the average proportion of fish passing in spill was either the same or slightly lower under the alternating 30%/30% and 45 Kcfs/Gas Cap than the proposed Idaho Change Form, but always highest under the 45 Kcfs/Gas Cap operation. These differences were generally small in the high flow year (2011) but larger in the low flow year (2013).
  - However, when summarized over weekly periods, the proportion of fish passing in spill under the Idaho proposal was not always higher than under the alternating 30%/30% and 45 Kcfs/Gas Cap operations.
  - From these modeled results, within the described constraints of the assumptions made in this analysis, the Idaho proposal can be best described as not likely to adversely affect average SPE for the season.
- The preferred operation of the project is the 45 Kcfs/gas cap since it provides a higher SPE, higher survival, and decreased forebay residence time.

## **Background**

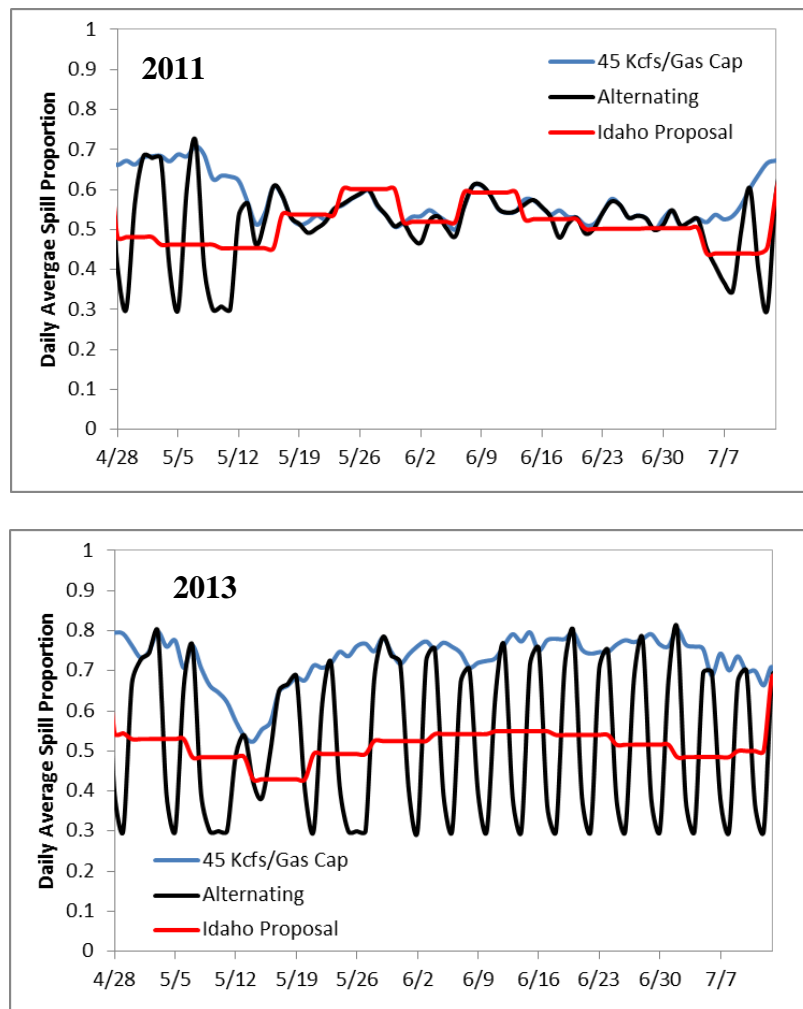
The Biological Opinion (2004) originally included spill at Ice Harbor Dam as 45 Kcfs during daytime hours and spill to the gas cap during nighttime hours (45 Kcfs/Gas Cap). Subsequent to the installation of the RSW in 2005, tests were conducted to compare the operation of the project at two different spill levels. The test operation became part of the Court Ordered spill as summarized in the Fish Operations Plan (FOP). Due to the roll-over operations under the Court Order, the alternating 30%/30% and 45 Kcfs/Gas Cap spill operation was retained in the FOP by the Action Agencies. The issue with this alternating operation for fish passage is that by including a spill level equal to 30% day and night, spill passage efficiency and survival are likely lower than under the 45Kcfs/Gas Cap operation. The preferred operation of the project is the 45 Kcfs/gas cap operation, since it provides a higher SPE, higher survival, and decreased forebay residence time.

The Idaho proposal does not attempt to achieve the 45 Kcfs/gas cap spill levels. It accepts the lower total overall spill volume that is provided during the simulated study time period (alternating 30%/30% and 45 Kcfs/Gas Cap), but attempts to rearrange that spill to determine if the SPE can be increased under an alternative average spill operation. The methodology requires the U.S. Army Corps of Engineers to use the flow prediction for the upcoming week and make real time changes to the spill percentage based on volume changes due to forecast errors. The February 25<sup>th</sup> memo illustrates that actual flows can be very different than forecast flows and, consequently, the real time changes to the predicted spill volume will be important in preserving the volume of spill in a specific time period.

## Methods

### *Spill Operations at IHR*

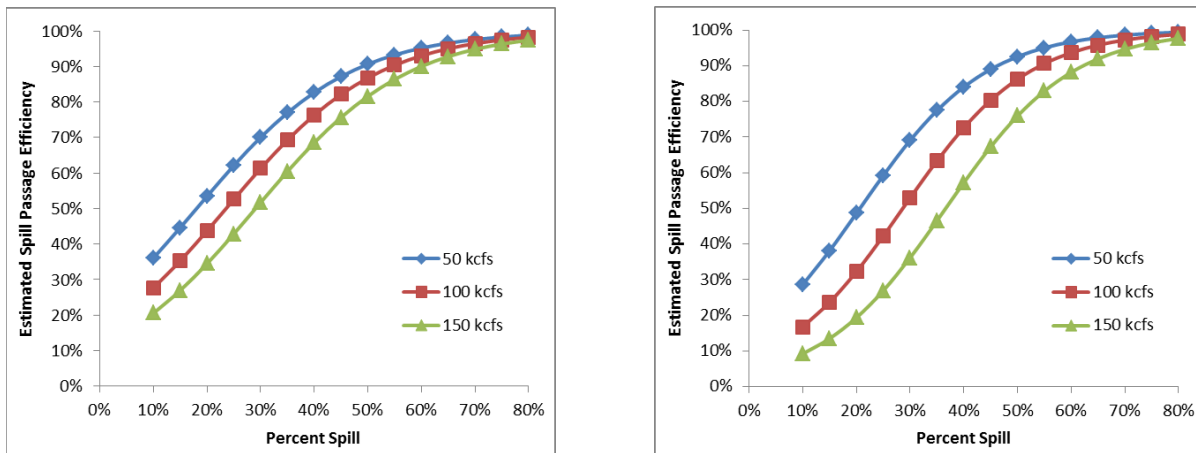
The FPC staff modeled spill under the proposed Idaho Change Form and presented these results in a memo on February 25, 2014, (<http://www.fpc.org/documents/memos/22-14.pdf>). Only two years were modeled, a low and high flow year, because of the time associated with these analyses. Figure 1 is provided below as a summary of the results from the previous modeling effort. Figure 1 also plots the expected operations under a consistent 45 Kcfs/Gas Cap spill to describe the original and recommended spill operation at this project. The proposed Idaho Change Form had two general impacts on spill at IHR. First, in the two years we modeled, the Idaho proposal eliminated all days where daily average spill at IHR was 30% (Figure 1). Second, the Idaho proposal also eliminated all days where the daily average spill proportion at IHR exceeded 70% (Figure 1).



**Figure 1.** Modeled results (daily proportion spill) of 45 Kcfs/Gas Cap Spill (blue), Alternating 30%/30% and 45 Kcfs/Gas Cap (black), and proposed Idaho Change Form (red) during April 28–July 13 period.

## CSS Model of SPE

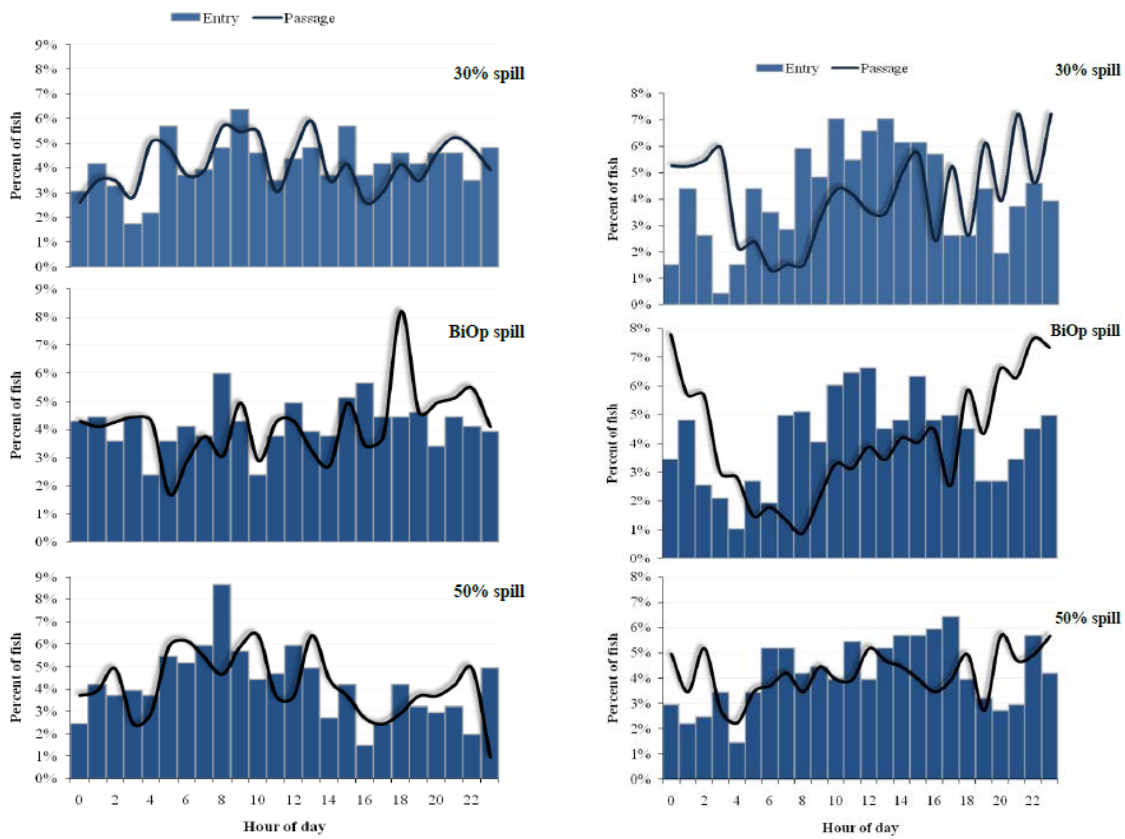
Due to limited PIT-tag detection capabilities at IHR, CSS modeling of SPE for the Experimental Spill Management modeling efforts was based on radio-telemetry data (Hall and Marmorek 2013). Estimates of total spillway passage were modeled as a function of flow, proportion spill, and the presence of an RSW (steelhead only). Figure 2 is provided below to illustrate how SPE at IHR changes as a function of flow and spill proportion for hatchery and wild yearling Chinook and steelhead. Under all flow conditions, SPE of yearling Chinook and steelhead at IHR increases as spill proportions increase. In addition, for a given spill proportion, SPE estimates are generally higher at lower flows than higher flows.



**Figure 2.** Estimated spillway passage efficiency for hatchery and wild yearling Chinook (left) and steelhead (right) at IHR under various flow conditions and spill proportions. Curves are based on CSS modeling efforts for Experimental Spill Management (Hall and Marmorek 2013) and assume the presence of an RSW.

## Estimating SPE Under Alternating 30%/30% and 45 Kcfs/Gas Cap Operations vs. Proposed Idaho Change Form

In their report, Axel et al. (2010) indicated that the hourly passage timing of yearling Chinook and steelhead at IHR differs at different spill operations at IHR (Figure 3). For example, under the 45 Kcfs/Gas Cap spill levels, Axel et al. (2010) found that yearling Chinook passage peaked at about 1800 hours and remained highest at night. Therefore, we used data presented in Axel et al. (2010) to estimate hourly proportion passing under 30% spill, 45 Kcfs/Gas Cap, and 50% spill. We then used these estimates of hourly proportion passing to model passage timing under each of the modeled scenarios. For the 45 Kcfs/Gas Cap scenario, we assumed the hourly passage data from what Axel et al. (2010) terms the BiOp treatment. When modeling the alternating 30%/30% and 45 Kcfs/Gas Cap, we assumed the hourly passage data for both the 30% and BiOp operations from Axel et al. (2010). When modeling the proposed Idaho Change Form, we assumed the hourly passage data for the 50% operation from Axel et al. (2010), since spill under the Idaho proposal generally fell in the 50%–60% range (Figure 1).



**Figure 3.** Percent of radio-tagged yearling Chinook (left) and steelhead (right) arriving and passing Ice Harbor Dam by hour of day during spring spill treatments, 2009. These figures were taken from Figures 11 (Chinook) and 12 (steelhead) of Axel et al. (2010). BiOp in Axel et al. (2010) is 45 Kcfs/Gas Cap.

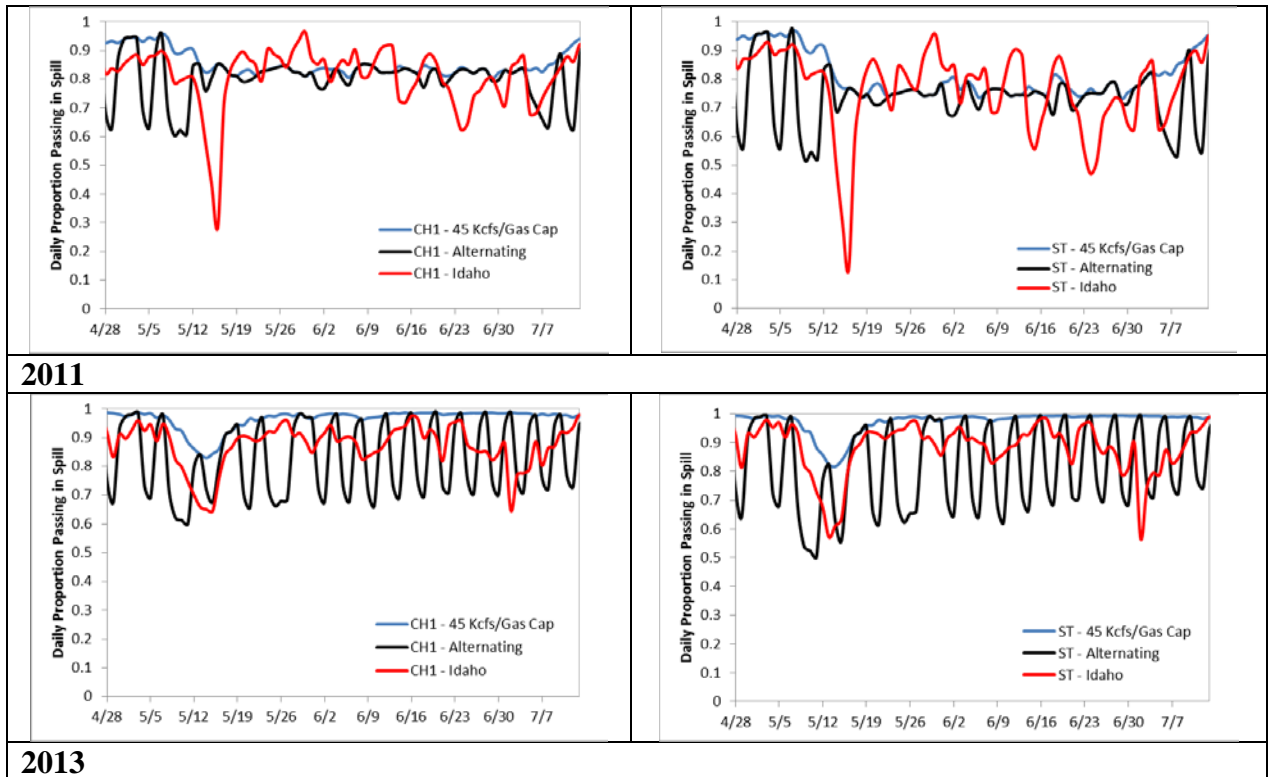
To estimate SPE under the three different operations, we relied on our modeled estimates of hourly spill proportion and the CSS function describing SPE at IHR (Figure 2 above). To include daily passage timing, the hourly passage timing data from Axel et al. (2010) (Figure 3 above) were used. We assumed a constant daily passage of 1,000 fish per day in order to estimate how many fish were expected to pass the project in any given hour. With this estimate of the number of fish expected to pass per hour, we then estimated the proportion that were expected to pass in spill, based on the hourly SPE estimate. Hourly data were then summarized into daily averages for presentation. Since the three operations differ only during the April 28<sup>th</sup> to July 13<sup>th</sup> period, we only present results from this period.

## Results

Under all three operational scenarios, estimates of daily proportion of yearling Chinook and steelhead passing in spill at IHR were variable throughout the season (Figure 4). However, this variability was most pronounced under the alternating 30%/30% and 45 Kcfs/Gas Cap operation than the 45 Kcfs/Gas Cap and the Idaho proposal, particularly in the low flow year (2013) (Figure 4). The difference between years is likely due to the fact that spill at IHR in 2011 was uncontrolled for much of the April 28<sup>th</sup> to July 13<sup>th</sup> period due to high flows and, therefore, the

variability in spill between the 30%/30% and 45 Kcfs/Gas Cap “treatments” was not as pronounced during this time.

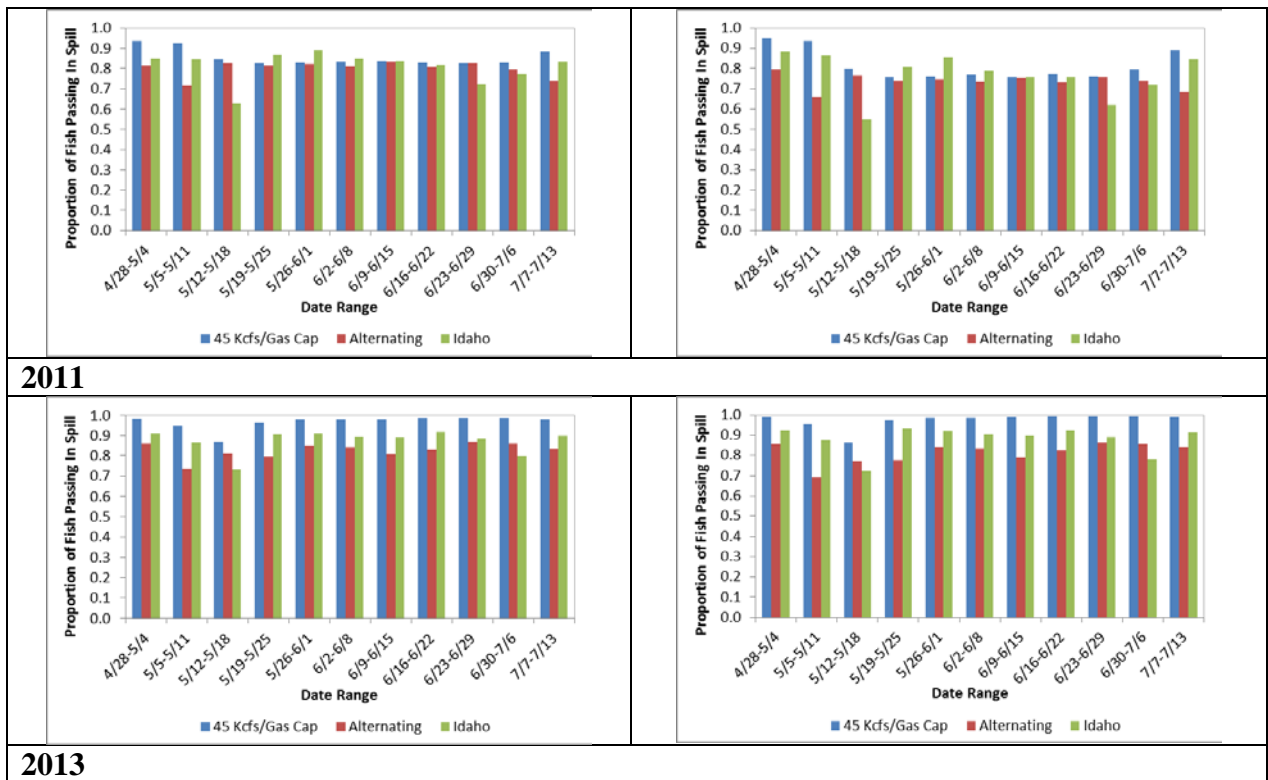
When summarized over the entire period (April 28–July 13), the average proportion of yearling Chinook and steelhead passing in spill was generally lower under the alternating 30%/30% and 45 Kcfs/Gas Cap than the proposed Idaho Change Form, but always highest under the 45 Kcfs/Gas Cap operation (Table 1). In a high flow year (2011) the differences between the three operations were relatively small (Table 1). In a low flow year (2013) these differences were larger, particularly for the 45 Kcfs/Gas Cap operation (Table 1). However, when summarized over weekly periods the proportion of fish passing in spill is not always higher under the Idaho proposal, as there were at least a few weeks in both years and for both species when the alternating 30%/30% and 45 Kcfs/Gas Cap operation had higher estimates of proportion passing in spill (Figure 5).



**Figure 4.** Estimates of the daily proportion of the hatchery and wild yearling Chinook (left) and steelhead (right) population passing IHR in spill under three operational scenarios: 45 Kcfs/Gas Cap; Alternating 30%/30% and 45 Kcfs/Gas Cap; and the proposed Idaho Change Form.

**Table 1.** Average proportion of yearling Chinook and steelhead passing in spill under three operational scenarios: 45 Kcfs/Gas Cap; Alternating 30%/30% and 45 Kcfs/Gas Cap; and the proposed Idaho Change Form for the period of April 28<sup>th</sup> to July 13<sup>th</sup>.

Year	Species	45 Kcfs/Gas Cap	Alternating	Idaho Change Form
2011	CH1	0.85	0.80	0.81
	ST	0.81	0.74	0.77
2013	CH1	0.97	0.83	0.87
	ST	0.97	0.81	0.88



**Figure 5.** Average weekly proportion of yearling Chinook and steelhead passing in spill under three operational scenarios: 45 Kcfs/Gas Cap; Alternating 30%/30% and 45 Kcfs/Gas Cap; and the proposed Idaho Change Form. (Note: In 2011 the SPE for the Idaho proposal exceeded the 45 Kcfs/Gas Cap scenario. However, this should not be interpreted as providing an improvement over the 45 Kcfs/Gas Cap scenario. The higher SPE results from the weekly forecasted ESP flows used in the Idaho scenario being consistently higher than the actual flows modeled for the other two scenarios. In actual implementation these changes from the ESP flows would cause a reduction in the proportion spilled under the Idaho scenario and SPE would be lower.)

## Discussion

The Idaho proposal does not suggest a change in the volume spill from the status quo. It rearranges the volume to provide a flatter level of spill over a daily period. When summarized over the entire period (April 28–July 13), SPE was either the same or lower under the alternating 30%/30% and 45 Kcfs/Gas Cap than the proposed Idaho Change Form, but always highest under the 45 Kcfs/Gas Cap operation. These differences were generally small in the high flow year (2011) but larger in the low flow year (2013). The assumptions made in the analysis should be considered when interpreting these results. The Idaho proposal was modeled for only two years and is very sensitive to changes in actual flows from forecasted flows in the ESP. (These deviations from the ESP forecasted flows can cause changes in spill passage efficiency.) From these modeled results, within the described constraints of the assumptions made in this analysis, the Idaho proposal can be described as not likely to adversely affect average SPE for the season. However, the preferred operation of the project is the 45 Kcfs/gas cap operation, since it provides a higher SPE, higher survival, and decreased forebay residence time.

## Literature Cited

- Axel, G.A., E.E. Hockersmith, B.J. Burke, K. Frick, B.P. Sanford, W.D. Muir, R.F. Absolon, N. Dumdei, J.J. Lamb, and M.G. Nesbit. 2010. Passage behavior of radio-tagged yearling and subyearling Chinook salmon and juvenile steelhead at Ice Harbor Dam, 2009.
- Hall, A. and D. Marmorek. 2013 Comparative Survival Study (CSS) 2013 Workshop Report Prepared by ESSA Technologies Ltd. Vancouver B.C. for the Fish Passage Center (Portland, OR) and U.S. Fish and Wildlife Service (Vancouver, WA.) 47 pp. + Appendices.