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MEMORANDUM

TO: Jason Sweet, BPA
RIOG Spill Operations Team

Michele Dehart

FROM: Michele Dehart for Comparative Survival Study Oversight Committee

DATE: September 18, 2017

RE: Additional follow-up questions regarding evaluation of the implementation of the injunction order for spill for fish passage at the 120%/115% dissolved gas cap

The CSS Oversight Committee has discussed the follow-up questions from the RIOG Spill Operations Team, transmitted by email on August 31, 2017 from Jason Sweet, BPA. The questions are listed below, in bold font, followed by the Committee response.

The first question was regarding the dam specific spill assumptions that went into the power analysis which was sent to the ISAB. It appears that based on table 4.2 (2017 study design and response to ISAB from CSS oversight committee), spill at Bonneville was assumed to be consistent with the current spring operation of 100 kcfs rather than the 115/120 gas cap assumptions that were developed by either Oregon (~130kcfs) or the Corps' SYSTDG model (up to 200 kcfs). How would this potential increase in spill at Bonneville Dam under a spill operation up to the 115/120 TDG spill cap change the CSS estimates of detection efficiency and associated power analysis?

Response: Chapter 4 of the Response Report to the ISAB, titled "Development of Spill Scenarios for Use in Prospective Analyses", (CSSOC 2017) describes the basis and process for determining spill levels at a specific dissolved gas level. The spill levels utilized in the Response Report to the ISAB for Bonneville Dam were based upon the annual spill priority list generated by the COE for distribution of excess spill in 2012. The spill priority list was utilized for this

purpose because the COE declined to make the SYSTDG model available to the co-managers. However, the spill priority list of spill caps is based on COE SYSTDG model runs as described in the Response Report to the ISAB. The 2012 list identified 100 Kcfs as the 115%/120% spill cap at Bonneville Dam. A spill cap of 100 Kcfs has been the most frequently published SYSTDG spill cap during April-June over the last ten years (Figure 1A). Over the last five years, the SYSTDG estimated spill cap at Bonneville has generally ranged from 120-140 Kcfs (Figure 1B).

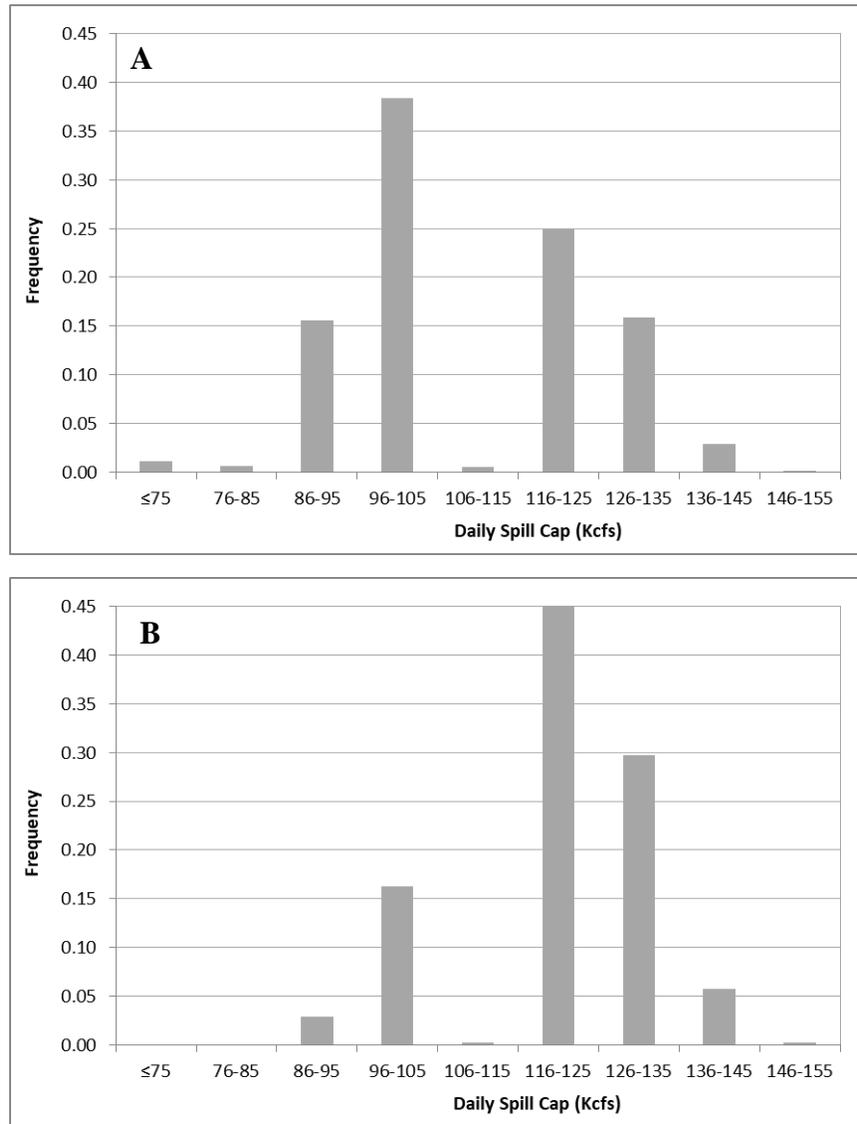


Figure 1. Histograms of published daily spill caps at Bonneville Dam over last ten years (2008-2017, April-June) (A) and five years (2013-2017, April-June) (B).

Based on historical published SYSTDG data, the maximum spill cap of 200 Kcfs at Bonneville Dam that you mention in Question #1 appears to be well outside of what has been observed over the last ten years. To illustrate this point, we reviewed the

published SYSTDG spill caps for Bonneville Dam over the last ten years (April-June, 2008-2017) (<http://pweb.crohms.org/tmt/documents/ops/spill/caps/>). Based on this review, we found that the maximum daily spill cap over this period was 150 Kcfs, which occurred on one day in May of 2017. This one day equates to approximately 0.1% of the time period that we reviewed. Over the period that we reviewed, the average spill cap at Bonneville Dam was approximately 110 Kcfs, with caps in the 96-105 Kcfs range being the most common (Figure 1A). It appears that the last five years (2013-2017) SYSTDG has generated slightly higher spill caps than the previous five (2008-2012). For example, the average spill cap at Bonneville Dam over the last five years was approximately 120 Kcfs, with caps in the 116-125 Kcfs range being the most common (Figure 1B). The actual TDG that occurs at specific spill volumes can vary based upon location of TDG monitors and spill bay patterns implemented. The elimination of the Camas-Washougal TDG monitoring site may have contributed to the trend of higher spill volume at the 120% gas cap compared to previous years. The summary of the past ten years and the summary of the past 5 years indicate that a spill cap of 200 Kcfs, referenced in your question appears to be unrealistic, based on historical SYSTDG generated spill caps.

In addition to our review of spill cap estimates generated by SYSTDG, we also reviewed actual 12-hour average tailrace TDG levels (maximum of the Oregon and Washington methodologies) and daily average spill at Bonneville Dam over the last five years (April-June, 2013-2017). Based on this review, we found that a 12-hour average tailrace TDG of 120% typically occurred at spill levels in the 100-125 Kcfs range (Figure 2). Furthermore, spill levels of 200 Kcfs have generally resulted in 12-hour average tailrace TDG levels of approximately 124%, which would only occur under conditions of uncontrolled spill due to flows in excess of hydraulic capacity or lack of market. This further illustrates that the potential of a spill cap of 200 Kcfs is unrealistic, based both on historical SYSTDG modeling that is used to generate the daily spill caps and empirical data.

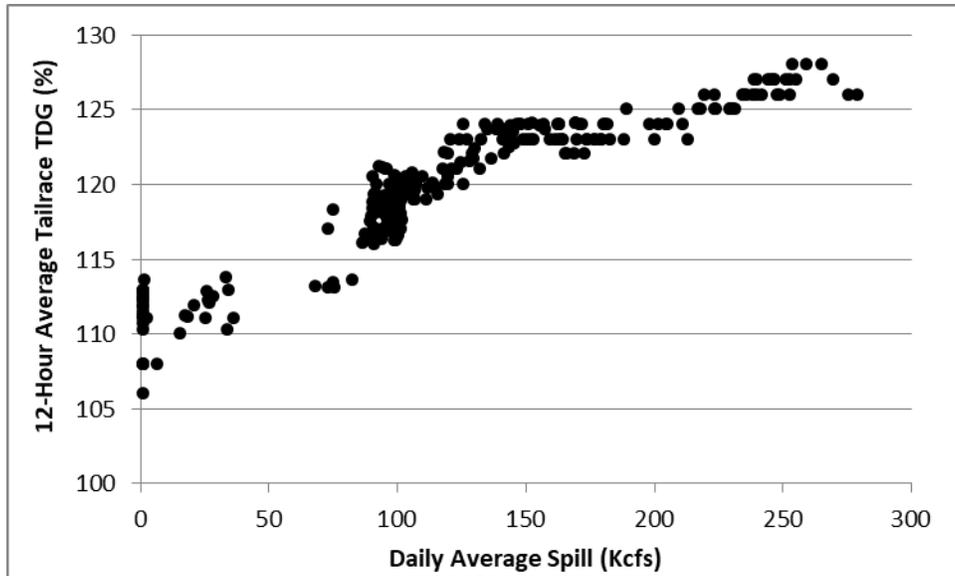


Figure 2. 12-hour average tailrace total dissolved gas (maximum of Oregon and Washington methodologies) produced as a function of daily average spill at Bonneville Dam (April-June, 2013-2017).

The review of both historical SYSTDG generated spill caps and actual empirical monitoring data indicates that the 100 Kcfs spill cap utilized in the Response Report to the ISAB is reasonable. However, if 100 Kcfs, as utilized in the Response Report to the ISAB, is an underestimate of the spill that will result in 120% tailrace TDG this would mean that the predicted juvenile survival probabilities and SARs associated with a 120% tailrace operation are underestimated. In other words, this would mean that the CSS model has underestimated the predicted survival and SAR benefits of providing spill to the 120% spill cap at Bonneville Dam. These underestimates would reduce the amount of contrast between the predicted juvenile survival and SARs at 120% tailrace TDG and the comparison group (i.e. observations under the Biological Opinion operations 1998-2016). In this regard, the predicted survival benefits and the power analyses presented in CSSOC (2017) would be conservative. Assuming higher spill levels (e.g. 130-200 Kcfs), one would expect greater contrast between the treatment and comparison groups, greater power to detect effects for a fixed study duration, and reduced duration to detect effects at a given power level. Adult PIT tagged salmon and steelhead returns to Bonneville Dam would be higher than predicted.

The most important consideration is that, the CSS project has successfully generated the evaluation metrics identified in the Response Report to the ISAB over the past 21 years which encompass the recent years in which the spill volume associated with the 120% gas cap appears to be trending upwards.

The second question that we had was related to the estimates of uncertainty surrounding the dam specific PITPH estimates (figures J.7 and J.8 in appendix J of the 2015 CSS Report). In those figures, it appears that the relative uncertainty around the PITPH estimate decreases as spill proportion increases. We assume that much of the historic PIT

based data would have been collected under lower or moderate spill levels and that the uncertainty around the PITPH estimates would be lower in the middle of the spill range and higher at high spill extremes where the data may be more sparse relative to lower spill levels.

Response: The error bounds presented in Figures J.7 and J.8 (Appendix J of the 2015 CSS Report) reflect both sampling (observation) error and process error. Sampling error is variation in detection probability due to the sampling methodology used to estimate detection probability, and the sampling error decreases with increasing sample sizes. Process error is variation in detection probability due to random biotic or abiotic factors, and this process error is present irrespective of sample sizes. The PITPH relationships were developed by first modeling the effects of spill proportions, flow, and the presence of spillway passage structures on detection probabilities. Plots of detection probability versus proportion spill (Figures 3 and 4) show that there is considerable variability in detection probability at low-to-moderate spill proportions, indicating that there is a high amount of process error at low-to-moderate spill proportions. These figures also show that at higher spill proportions (e.g., greater than 60%), although there are fewer observations, the observations that are available show that there is less variability in detection probability, indicating that there is less process error at high spill proportions. The lower levels of uncertainty in PITPH at high spill proportions are due to this apparent decrease in process error at high spill proportions, where nearly all of the fish are avoiding the powerhouses.

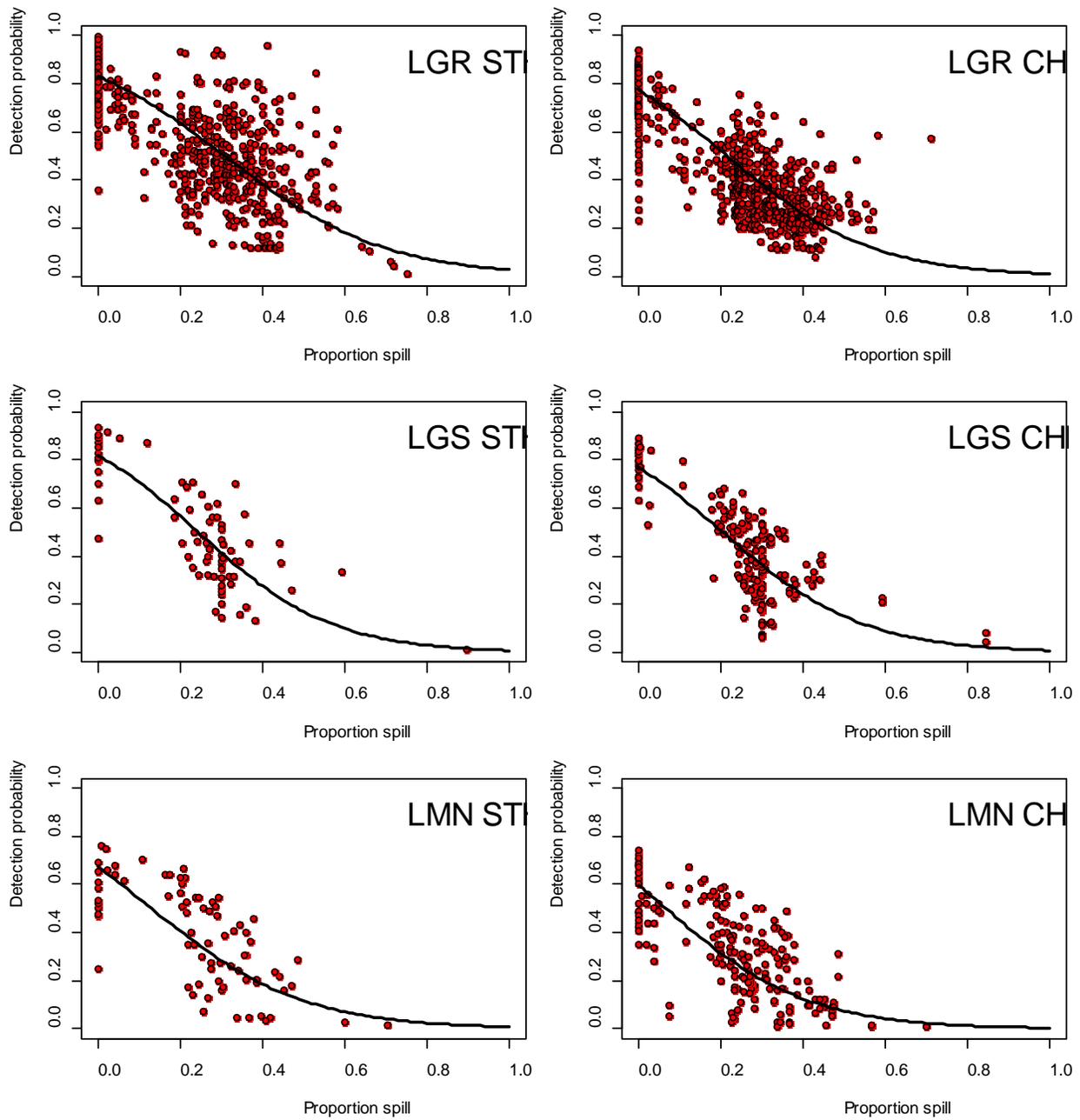


Figure 3. Estimates of detection probability versus proportion spill at Lower Granite Dam (LGR), Little Goose Dam (LGS), and Lower Monumental Dam (LMN) for hatchery and wild steelhead (STH) and yearling Chinook salmon (CHN).

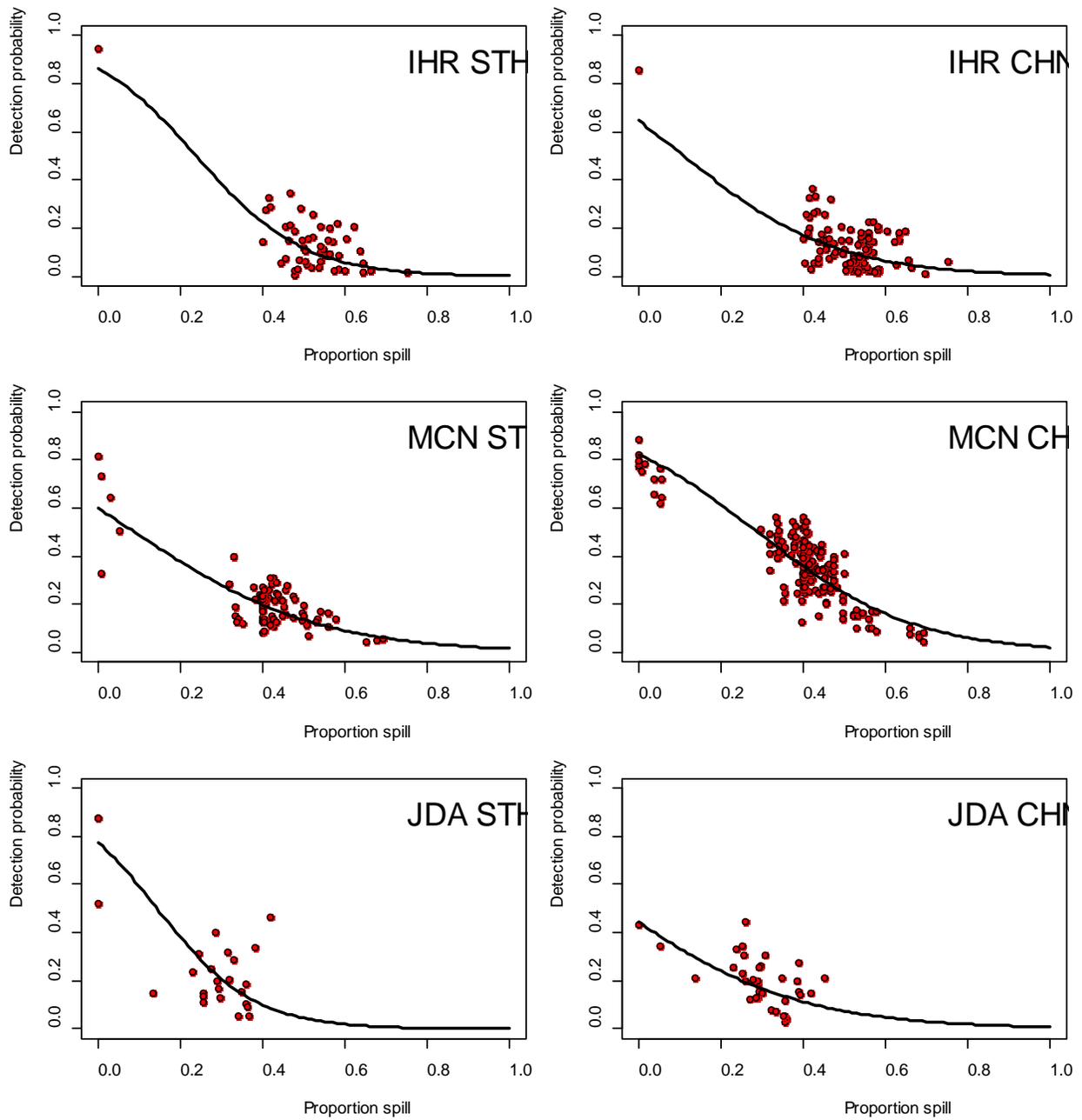


Figure 4. Estimates of detection probability versus proportion spill at Ice Harbor Dam (IHR), McNary Dam (MCN), and John Day Dam (JDA) for hatchery and wild steelhead (STH) and yearling Chinook salmon (CHN).

A third question that I had after reviewing the PITPH appendix was specific to The Dalles Dam. It appears that fish passing the Ice and Trash Sluiceway (ITS) are combined with turbine passed fish to form the total powerhouse estimate. Although the ITS doesn't have PIT detection (which makes replicating the method used to calculate efficiency at the corner collector at Bonneville impossible), this method seems to have the potential to substantially overestimate powerhouse passage at The Dalles. Treating fish passing via the ITS and the B2 corner collector in a similar manner would be justified given that both routes are surface oriented, non-screened turbine bypass routes with very high direct survival. Past data collected at The Dalles has shown that approximately 50% of fish passing via the powerhouse use the sluiceway rather than the turbines so this is not an inconsequential route of passage. If telemetry estimates of ITS efficiency were incorporated into the PITPH calculation, how would that affect the project specific estimates in figure J8 as well as system-wide estimates of PITPH?

Response:

During development of the PITPH variable for The Dalles Dam we chose to combine the Ice and Trash Sluiceway (ITS) with the turbine passage route in our estimates of total powerhouse passage. The rationale for this decision was: 1) smolts enter the ITS in a similar manner as smolts entering bypass systems at the other dams, 2) smolts exiting the ITS follow a similar route in the tailrace as smolts that pass through the turbines, 3) smolts that use the ITS have similar tailrace egress times as smolts that pass through the turbines, and these tailrace egress times are approximately double those of smolts that pass via the spillway (Johnson et al. 2007), and 4) smolts that exit the ITS pass near or through zones of high predator (northern pikeminnow and smallmouth bass) density in the tailrace (Duran et al. 2003), and this predator exposure is expected to be similar to smolts that pass through the turbines. Smolts that exit the corner collector at Bonneville Dam enter into the same area as smolts that pass through the spillways, unlike the ITS where smolts enter areas directly adjacent to the turbine outfalls. For these reasons, we believe that it is appropriate to combine the ITS route with the turbine route for quantifying total powerhouse passage at The Dalles Dam.

There is a wide range in the proportion of total powerhouse passage that occurs through the ITS. Estimates of this proportion range as low as 9% sluiceway passage (Beeman et al. 2005). These sluiceway passage rates are likely influenced by the flow and spill proportions that occur in each year. However, even if we were to assume that a fixed 50% of the fish passing via the powerhouse use the sluiceway, and we were to combine the ITS proportion with the spillway proportion, this would have very little effect on the system-wide estimates of PITPH (Figure 5). This approach would also have little-to-no effect on the projected survival estimates or the power analyses presented in CSSOC (2017), as the PITPH variable would be modified by a similar amount for both the fitting and projection data sets.

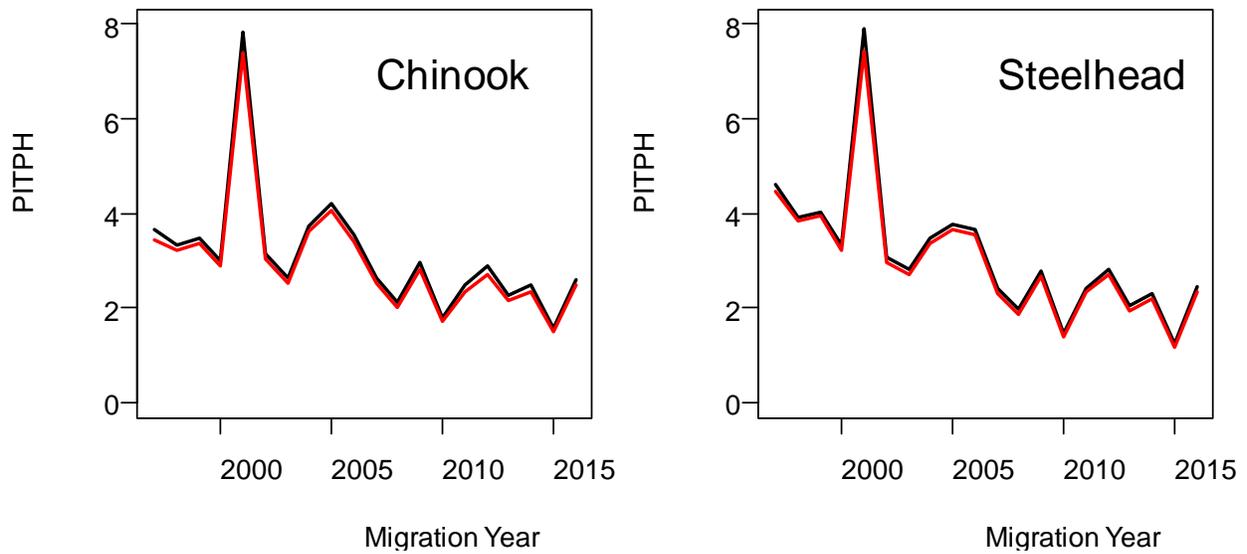


Figure 5. Estimates of PITPH (black lines) for yearling Chinook and steelhead over juvenile outmigration years 1997-2016 and estimates of PITPH with 50% of the powerhouse passage at The Dalles Dam assigned to the spillway (red lines).

References:

Beeman, J.W., H.C. Hansel, P.V. Haner, and J. Hardiman. 2005. Estimates of fish-, spill-, and sluiceway-passage efficiencies of radio-tagged juvenile steelhead and yearling Chinook salmon at The Dalles Dam, 2000. Final Report of Research during 2000. Submitted to U.S. Army Corps of Engineers, Portland District.

Duran, I.N., T.L. Liedtke, and J.H. Petersen. 2003. Predator-prey interactions in The Dalles Dam tailrace, 2002. Annual Report of Research for 2002 submitted to U.S. Army Corps of Engineers, Portland District.

Johnson, G.E., J.W. Beeman, I.N. Duran, and A.I. Puls. 2007. Synthesis of juvenile salmonid passage studies at The Dalles Dam Volume II: 2001-1005. Final Report prepared for the U.S. Army Corps of Engineers, Portland District. Contract DE-AC05-76RL01830.