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MEMORANDUM

TO: Charlie Morrill (WDFW),
Tom Lorz (CRITFC)

FROM: Michele DeHart

DATE: August 18, 2014

RE: Evaluation of spill proposals for Ice Harbor Dam in 2015

We have received both of your requests relative to proposals for a single operation at Ice Harbor Dam (IHR) and the potential effects of some proposed operations on juvenile passage using existing data from radio- and PIT-tag studies. Because these requests contained significant overlap, we have combined them into a single response.

Current operations at IHR alternate in 2-day blocks between 45 Kcfs during the daytime and gas cap at night versus 30% spill for 24 hours/day. To simplify performance testing at IHR, which is planned for 2015, the action agencies and fisheries managers have expressed an interest in ending current alternating operations and determining a single operation. For this data request, the FPC staff has reviewed the 2006–2009 radio-tag studies that are being used in these discussions. In addition, FPC staff modeled three different spill scenarios that are currently under discussion for future operations at IHR. These scenarios include: (1) the BPA Proposal of 30%/30%, (2) the NOAA Proposal of 50%/Gas Cap, and (3) the ODFW Proposal of Gas Cap/Gas Cap. For historical perspective, we also modeled a fourth scenario, the 2004 Biological Opinion (2004 BiOp) of 45 Kcfs/Gas Cap. Below is a brief summary of our findings followed by a more detailed discussion of the review and methods and results from the modeling work.

- Past studies at IHR using radio tags do not provide representative survival estimates for the run at large, have low statistical power for comparing survival differences between operations, and should not be used to inform the decision-making process moving forward.

- An operation of 30% spill, as in the BPA Proposal, will result in greatly reduced spill levels and spill passage efficiency (SPE) from the current conditions. A growing body of information indicates that spillway passage has relatively high project survival and decreases the effects of latent mortality due to bypass or turbine passage.
- The 50% daytime spill/gas cap at night proposal will reduce spill and spill passage efficiency in low flow periods when spill is the only mitigation available for fish passage. Past studies have shown that spill provides some mitigation for the adverse impacts of low flows. This is particularly important in low flow periods such as summer months when Biological Opinion flow targets are rarely met. The 2004 BiOp operation of 45 Kcfs/Gas Cap provides better protection in these low flow periods than the NOAA or BPA proposed option.
- The Gas Cap/Gas Cap proposal will result in the highest spill and spill passage efficiencies.
- There is no indication that reducing spill at IHR is necessary. Rather, increasing spill will be likely to increase survivals and adult returns.

You specifically requested that the FPC staff review and update a May 21, 2009, memorandum which examined whether there were measurable differences in SARs between individuals that were detected at IHR (i.e., powerhouse bypassed) versus those that were undetected at IHR (i.e., spill or turbine passage). The FPC staff reviewed the subject memorandum and concluded:

- The analysis in the May 21, 2009, memorandum introduces a downward bias in SARs for the non-bypassed group.
    - The non-bypassed group includes smolts that passed via turbines, which has a higher mortality than other passage routes.
    - The non-bypassed group also includes smolts that may have died between Lower Monumental (LMN) and IHR while the detected group includes only those smolts alive at both projects.
- Chapter Seven of the 2010 CSS Annual Report (Tuomikoski et.al. 2010), "Bypass Effects," assesses the effect of powerhouse route of passage on SARs. This analysis avoids the downward biases included in the May 21, 2009, memorandum. This method has been reviewed by the ISAB and the region (ISAB 2011, ISAB 2012).
    - Significant migration delay is associated with bypassed smolts when compared to undetected smolts.
    - Bypass history is important for characterizing variation on post-BON SARs.
    - For Yearling Chinook, post-BON SARs were reduced by 10% per bypass at upriver dams.
    - For Steelhead, post-BON SARs were reduced 6% for each bypass at Snake River projects and 22% for Columbia River projects.

- To avoid biases in estimates of the impacts of passage route at IHR, the methods used in the 2010 CSS analysis are preferable. Unfortunately, time constraints and other reporting deadlines do not allow an update of the analyses presented in this chapter at this time. We will update the "Bypass Effects" analyses in the upcoming months.

Review of 2006–2009 Radio-Tag Studies from Ice Harbor and data from JSATS Tagging

- More juveniles migrate through the spillway during the current 45 Kcfs/gas cap operations than during reduced spill of 30%.
- Previous studies have lacked the statistical power to distinguish between survival estimates at different operations. These studies are not sufficient to evaluate survival and these data should not be used in the decision-making process.
- Even with sufficient statistical power, the radio-tag studies conducted from 2006–2009 at IHR have limited relevance to actual survivals of the run-at-large under proposed operations and cannot provide predictions for the results of performance testing. Reasons for this inapplicability include:
    - Samples are not representative of the run-at-large. Rejection rates are not included in reports. However, because radio tags are considerably larger than the JSATS tags used in performance testing and the current criteria were not in use, we can surmise that rejection rates were significantly higher than current performance testing allows. These results cannot be applied to a large portion of migrating juveniles.
    - The study design inflates survival estimates with a single release above the dam and a single release in the tailrace. Increased tailrace mortality due to predation or other unrelated factors will artificially increase the survival estimate of dam passage.
    - The tag burden for the radio tags used in these studies is much higher than for the JSATS tags currently in use. Tag burdens of this magnitude may have a significant impact on swimming behavior, which will affect the choice of passage route and overall dam survival estimates. Smolts with large tag burdens may also be less able to avoid predators, which will disproportionately affect smolts released directly into the tailrace as a "control group."
- Data from incidental JSATS tagging (provided by PNNL) indicate that there is a strong benefit to gas cap spill for juvenile survival from the forebay to tailrace, particularly for Steelhead.

Methods for Modeling Spill and Spill Passage Efficiency at Ice Harbor

Modeled Spill Proportions

The FPC staff modeled three different spill scenarios that are currently under discussion in the SRWG for future operations at IHR. These scenarios include: (1) the BPA Proposal of 30%/30%, (2) the NOAA Proposal of 50%/Gas Cap, and (3) the ODFW Proposal of Gas Cap/Gas Cap. For historical perspective, we also modeled a fourth scenario: the 2004 BiOp of

45 Kcfs/Gas Cap. All four scenarios were modeled over the last five years (2009–2013). Under all four scenarios, the following assumptions were made when modeling spill: (1) hydraulic capacity of 83.8 Kcfs (based on actual capacity in 2011), (2) powerhouse minimum of 10.5 Kcfs, and (3) a 115/120% total dissolved gas spill cap of 92 Kcfs (when not limited by flows).

For perspective, Table 1 is provided below to illustrate the observed runoff volume (April–August) at Lower Granite Dam (LGR) over the five years that were used for SPE modeling efforts. In general, 2010 and 2013 are considered low flow years, 2009 and 2012 are considered average to slightly above average flow years, and 2011 is considered a high flow year. Figure 1 is provided below to illustrate how daily average flows at IHR have varied over these same five years.

Table 1. Observed runoff volume at Lower Granite Dam (April–August) for each of the five modeled years. Each year's rank is in terms of the 53-year record between 1961 and 2013 (lower rank = higher water year).

Water Year	Runoff Volume (MAF)	Rank
2009	24.7	18
2010	19.5	34
2011	35.0	4
2012	23.7	23
2013	14.7	44

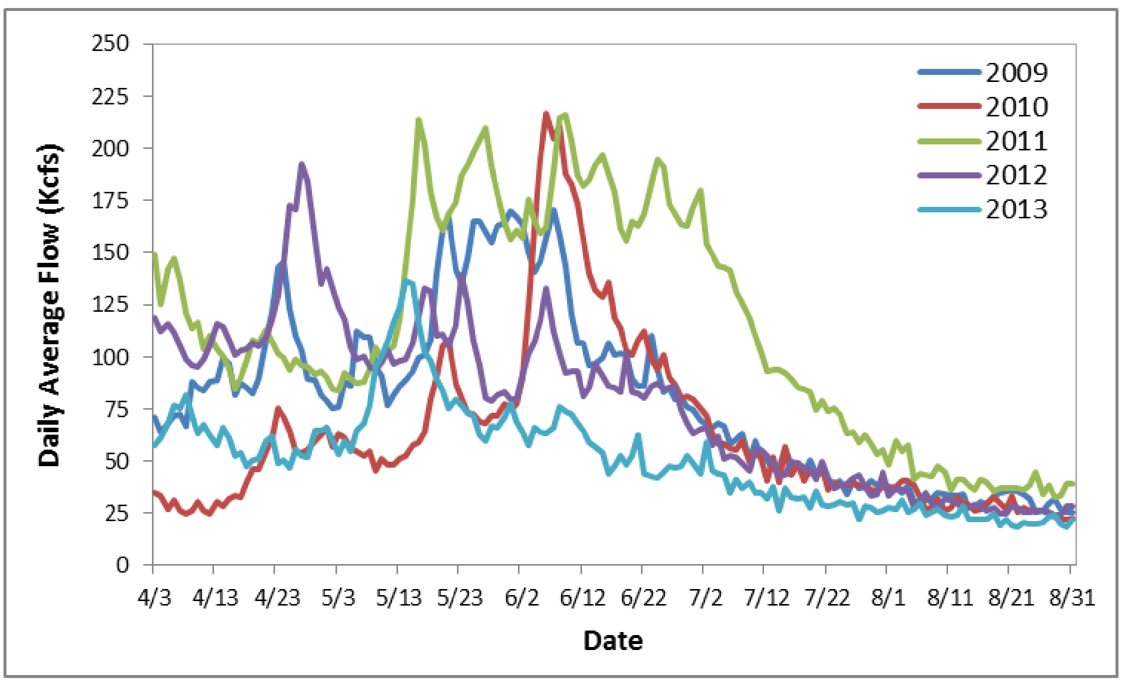

Figure 1. Average daily flow (Kcfs) at Ice Harbor Dam in 2009–2013 (April 3-August 31).

Modeled Spill Passage Efficiency

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. The Experimental Spill Management modeling efforts did not include subyearling Chinook. For this analysis, we assumed the yearling Chinook SPE curves for subyearling Chinook.

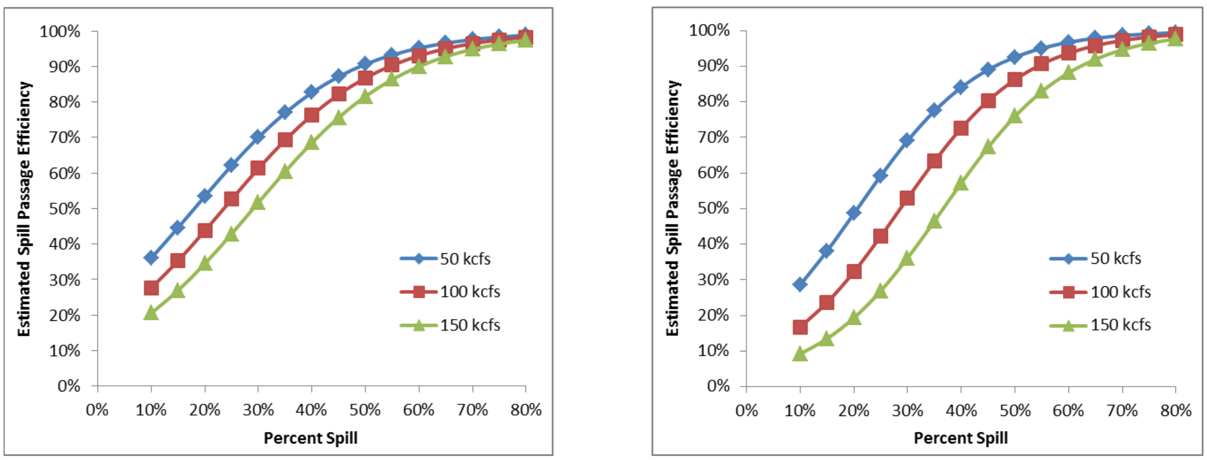

Figure 2. Estimated spillway passage efficiency of hatchery and wild yearling Chinook (left) and steelhead (right) at IHR under various flow conditions and spill proportions. Curves are based on CSS modeling efforts for Experimental Spill Management (Hall and Marmorek 2013) and assume the presence of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

To estimate hourly SPE under the four different operational scenarios, we relied on our modeled estimates of hourly spill proportion, actual hourly flows, and the CSS SPE curves for IHR (Figure 2). Estimates of hourly SPE were then summarized into a daily average SPE, for each of the four spill scenarios. For presentation purposes, SPE results from these modeling efforts will be presented for the period of April 3–June 30 for yearling Chinook and steelhead and June 1–August 31 for subyearling Chinook.

Results

Modeled Spill Proportions

In the 5 years that were modeled for this data request, the BPA Proposal (30%/30%) consistently resulted in the lowest spill proportions while the ODFW Proposal (Gas Cap/Gas Cap) consistently resulted in the highest spill proportions (Figure 3). Spill proportions from the

NOAA Proposal (50%/Gas Cap) and 2004 BiOp (45 Kcfs/Gas Cap) were generally lower than those under the ODFW Proposal, but much higher than under the BPA Proposal (Figure 3).

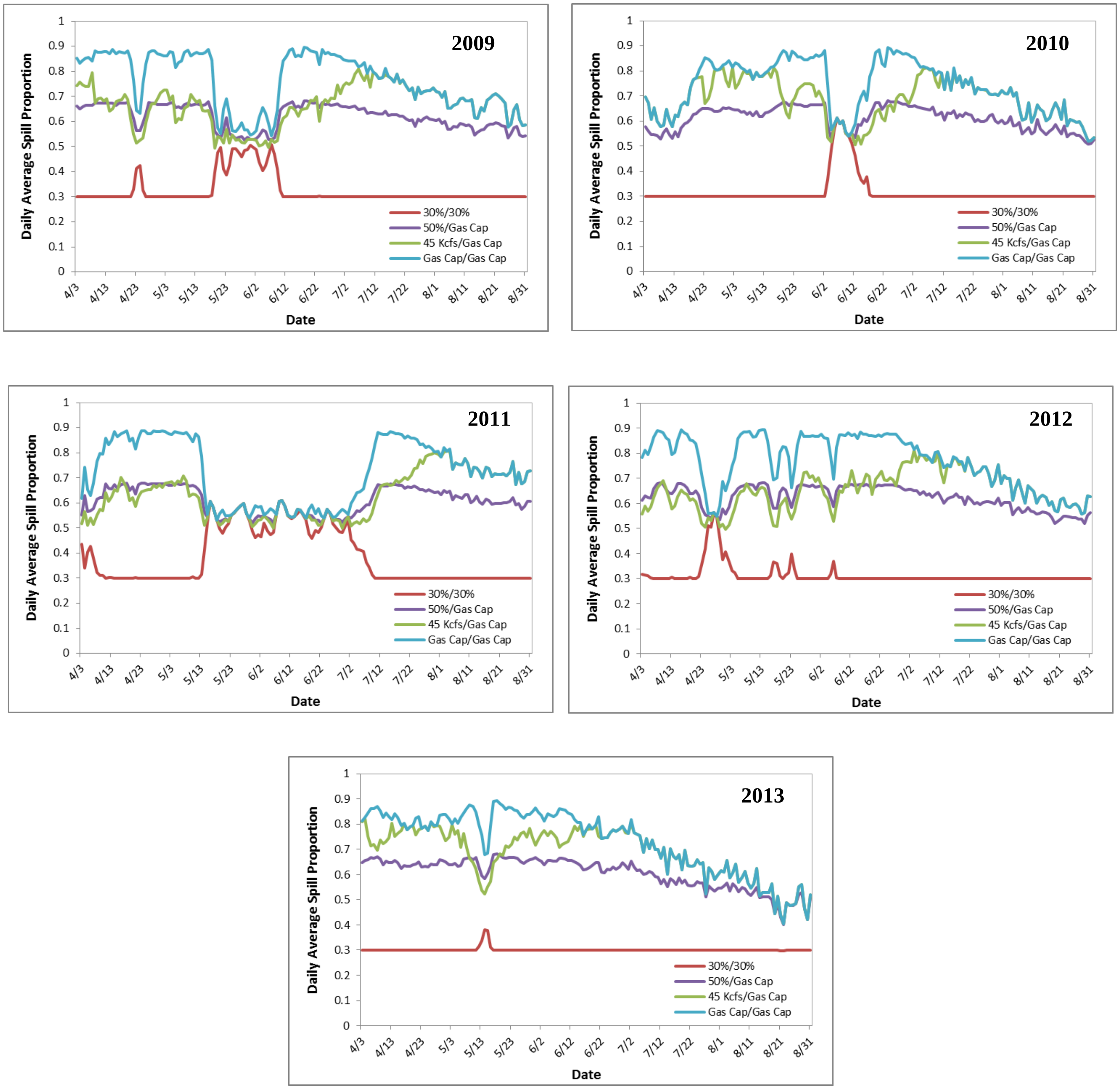

Figure 3. Modeled daily average spill proportion from four operational scenarios: (1) BPA Proposal (30%/30%), (2) NOAA Proposal (50%/Gas Cap), (3) 2004 BiOp (45 Kcfs/Gas Cap), and (4) ODFW Proposal (Gas Cap/Gas Cap) in 2009–2013 (April 3-August 31).

When comparing the spill proportions, both within years and between years, a few patterns become evident. First, in mid- to late May, when flows typically increase from the freshet, the spill proportions from the four scenarios often begin to converge (e.g., 2010 from Figure 3). This convergence between scenarios occurs because flows are typically so high during these periods that IHR is spilling all flow in excess of hydraulic capacity. The degree and duration of this convergence is typically dependent on how high flows get and the duration of the freshet. For example, 2011 was a high flow year that resulted in flows in excess of hydraulic capacity from about May 10th through early July. During this time, the four scenarios resulted in spill proportions what were very similar (Figure 3). On the other hand, 2013 was a low flow year that had only a brief period in mid-May when flows exceeded hydraulic capacity at IHR. Even though flows exceeded hydraulic capacity during this brief period, it was not by much. Therefore, the level of convergence between the four scenarios was to a much lesser degree than other higher flow years (Figure 3).

Second, differences in spill proportion between the NOAA Proposal (50%/Gas Cap) and 2004 BiOp (45 Kcfs/Gas Cap) seem to be dependent on flows. At low flows (i.e., less than 90 Kcfs), the 2004 BiOp scenario typically resulted in higher spill proportions than the NOAA Proposal. This pattern was evident during the summer period in all the years modeled (Figure 3). In addition, except during periods of peak flows, spill proportions were consistently higher under the 2004 BiOp in the two low flow years (2010 and 2013) than under the NOAA Proposal (Figure 3).

Finally, at flows of less than about 55.5 Kcfs, spill proportions under the 2004 BiOp and ODFW Proposal (Gas Cap/Gas Cap) scenarios are virtually the same. This is because the 45 Kcfs daytime spill levels in the 2004 BiOp cannot be maintained at flows of less than 55.5 Kcfs. Therefore, spill under these flow conditions will be everything in excess of powerhouse minimum. However, regardless of how low flows are, spill levels of 30% (as prescribed by the BPA Proposal) or 50% (as prescribed by the NOAA Proposal during daytime hours) are generally obtainable. This is why the BPA Proposal and NOAA Proposal resulted in lower spill proportions in the summer period when flows are generally lower (Figure 3 and Table 2).

When summarized over the migration periods (April 3–June 30 for yearling Chinook and steelhead, and June 1–August 31 for subyearling Chinook), average spill proportion was consistently the lowest under the BPA Proposal (30%/30%) and consistently highest under the ODFW Proposal (Gas Cap/Gas Cap) (Table 2). This was true in all five flow years that were modeled and for all three species. Over the five years that were modeled, average spill proportions under the BPA Proposal were in the 0.30–0.43 range for the yearling Chinook and steelhead period (April 3–June 30) and 0.30–0.38 for the subyearling Chinook period (June 1–Aug 31) (Table 2). Average spill proportions under the ODFW Proposal ranged from 0.69–0.82 for the yearling Chinook and steelhead period (April 3–June 30) and 0.67–0.75 for the subyearling Chinook period (June 1–August 31) (Table 2).

Average spill proportions under the NOAA Proposal (50%/Gas Cap) and the 2004 BiOp scenario (45 Kcfs/Gas Cap) were generally similar to one another. For the spring Chinook and steelhead period (April 3–June 30), average spill proportions were generally higher or the same under the NOAA Proposal in average to high flow years (2009, 2011, and 2012). However, in low flow years (2010 and 2013), average spill proportions were higher under the 2004 BiOp scenario than the NOAA Proposal (Table 2). For the subyearling Chinook period (June 1–August 31), average spill proportions were always higher under the 2004 BiOp scenario than the NOAA Proposal (Table 2). Finally, estimates of seasonal average spill proportions under the NOAA Proposal and 2004 BiOp scenario were generally lower than those from the ODFW Proposal but much higher than those under the BPA Proposal (Table 2).

Table 2. Average spill proportion at Ice Harbor Dam during the yearling Chinook and steelhead migration period (4/3–6/30) and subyearling Chinook migration period (6/1–8/31) under four modeled spill scenarios: BPA Proposal (30%/30%), NOAA Proposal (50%/Gas Cap), 2004 BiOp (45 Kcfs/Gas Cap), and ODFW Proposal (Gas Cap/Gas Cap).

Species	Year	BPA Proposal (30%/30%)	NOAA Proposal (50%/Gas Cap)	2004 BiOp (45 Kcfs/Gas Cap)	ODFW Proposal (Gas Cap/Gas Cap)
CH1 & ST	2009	0.34	0.63	0.63	0.79
	2010	0.33	0.62	0.68	0.77
	2011	0.43	0.60	0.58	0.69
	2012	0.32	0.65	0.63	0.82
	2013	0.30	0.65	0.74	0.82
CH0	2009	0.32	0.61	0.68	0.74
	2010	0.33	0.60	0.66	0.71
	2011	0.38	0.60	0.65	0.70
	2012	0.30	0.62	0.68	0.75
	2013	0.30	0.58	0.66	0.67

Modeled Spill Passage Efficiency

Plots of the estimated daily average spill passage efficiencies (SPE) under each of the four modeled spill scenarios are provided in Appendix A. These plots are broken down by species (CH1, ST, and CH0) and year (2009–2013) (Appendix A). Under all four operational scenarios, estimates of daily spill passage efficiency (SPE) at IHR were variable. This was true for all three species. Because spill proportion was one of the variables used in estimating SPE, variations in SPE generally followed variations in spill proportions. For example, as spill proportions increased, SPE also increased.

When summarized over the entire migration period (April 3–June 30 for yearling Chinook and steelhead, and June 1–August 31 for subyearling Chinook), average SPE under the BPA Proposal (30%/30%) was always lowest, when compared to the other three scenarios (Table 3). This was true in all five flow years that were modeled and for all three species. Over the five years we modeled, seasonal average SPE under the BPA Proposal was in the 0.64–0.72 range for yearling Chinook, 0.56–0.65 for steelhead, and 0.69–0.73 for subyearling Chinook (Table 3).

The ODFW Proposal (Gas Cap/Gas Cap) always resulted in the highest estimates of seasonal average SPE (Table 3), when compared to the other three scenarios (Table 3). This was consistent over all five years modeled and all three species. Over the five years, seasonal average SPE under the ODFW Proposal ranged from 0.91–0.99 for yearling Chinook, 0.88–0.99 for steelhead, and 0.93–0.98 for subyearling Chinook (Table 3).

Estimates of seasonal average SPE under the NOAA Proposal (50%/Gas Cap) and the 2004 BiOp (45 Kcfs/Gas Cap) were generally similar to one another. In fact, seasonal average SPE under these two scenarios never differed by more than 0.04 (Table 3). For yearling Chinook and steelhead, seasonal average SPE was higher under the 2004 BiOp scenario than under the NOAA Proposal in low flow years (2010 and 2013) (Table 3). In average to high flow years (2009, 2011, and 2012) the NOAA Proposal resulted in higher estimates of seasonal average SPE than the 2004 BiOp scenario (Table 3). For subyearling Chinook, seasonal average SPE was always higher under the 2004 BiOp scenario than under the NOAA Proposal, but generally by no more than 0.02 (Table 3). Finally, estimates of seasonal average SPE under the NOAA Proposal and 2004 BiOp scenario were generally lower than those from the ODFW Proposal but much higher than those under the BPA Proposal (Table 3).

Table 3. Average spill passage efficiency of yearling Chinook (CH1, 4/3–6/30), steelhead (ST, 4/3–6/30), and subyearling Chinook (CH0, 6/1–8/31) under four modeled spill scenarios: BPA Proposal (30%/30%), NOAA Proposal (50%/Gas Cap), 2004 BiOp (45 Kcfs/Gas Cap), and ODFW Proposal (Gas Cap/Gas Cap).

Species	Year	BPA Proposal (30%/30%)	NOAA Proposal (50%/Gas Cap)	2004 BiOp (45 Kcfs/Gas Cap)	ODFW Proposal (Gas Cap/Gas Cap)
CH1	2009	0.66	0.91	0.89	0.96
	2010	0.69	0.92	0.93	0.97
	2011	0.72	0.87	0.85	0.91
	2012	0.64	0.91	0.89	0.97
	2013	0.68	0.94	0.96	0.99
ST	2009	0.59	0.89	0.87	0.96
	2010	0.65	0.92	0.93	0.97
	2011	0.64	0.83	0.81	0.88
	2012	0.56	0.91	0.87	0.97
	2013	0.64	0.94	0.97	0.99
CH0	2009	0.70	0.93	0.95	0.97
	2010	0.71	0.93	0.94	0.96
	2011	0.73	0.90	0.91	0.93
	2012	0.69	0.94	0.96	0.98
	2013	0.72	0.93	0.96	0.96

Literature Cited

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Tuomikoski J, J McCann, T Berggren, H Schaller, P Wilson, S Haeseker, J Fryer, C Petrosky, E Tinus, T Dalton, R Ehlke. 2010. Comparative Survival Study (CSS) of PIT-tagged Spring/Summer Chinook and Summer Steelhead 2010 Annual Report.

Appendix A

Estimates of daily spill passage efficiency (SPE) for yearling Chinook, steelhead, and subyearling Chinook at Ice Harbor Dam under each of four modeled spill scenarios, 2009–2013.

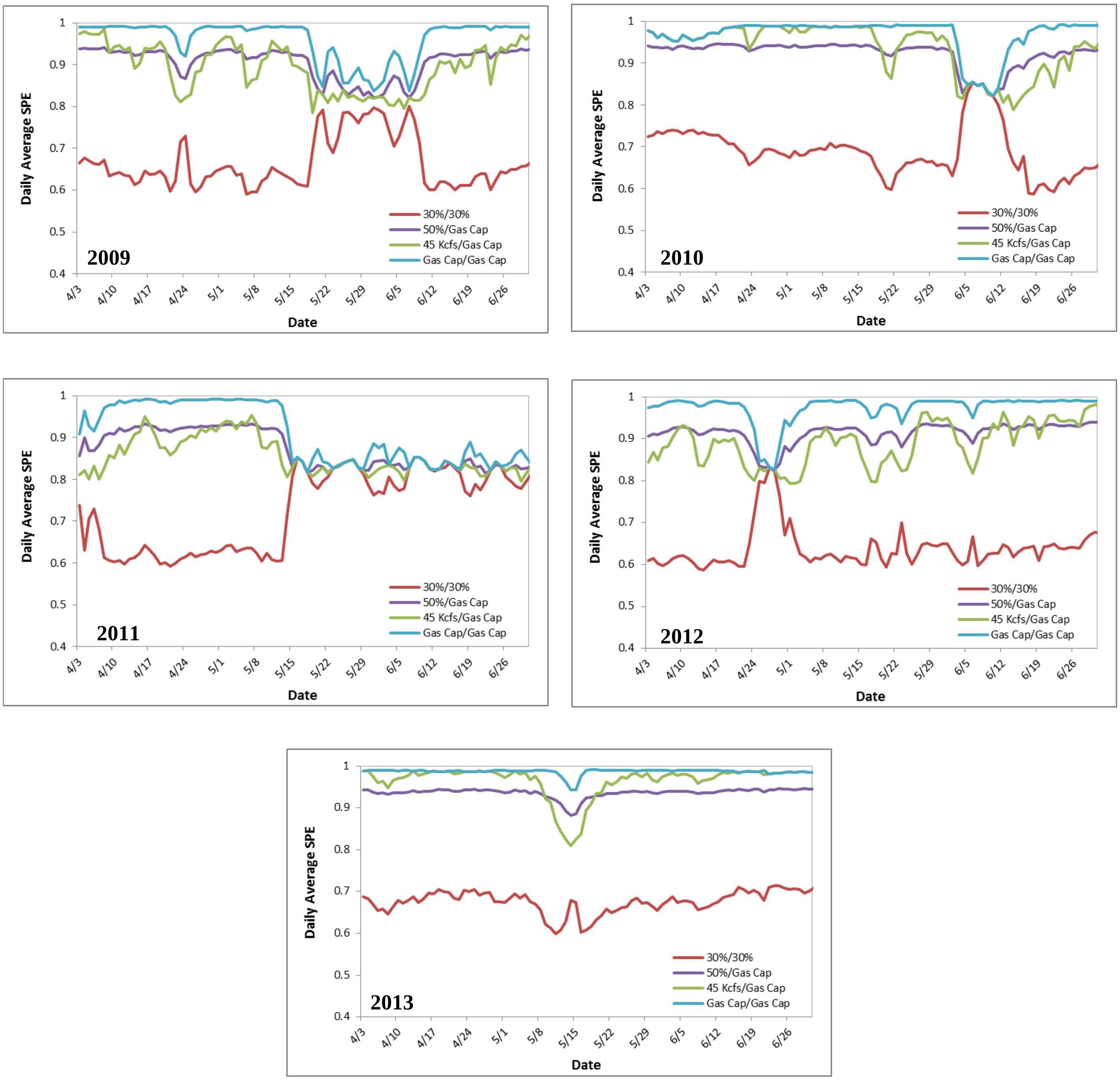

Figure A.1. Estimated daily spill passage efficiency (SPE) for yearling Chinook (April 3–June 30) at Ice Harbor Dam under each of four modeled spill scenarios, 2009–2013.

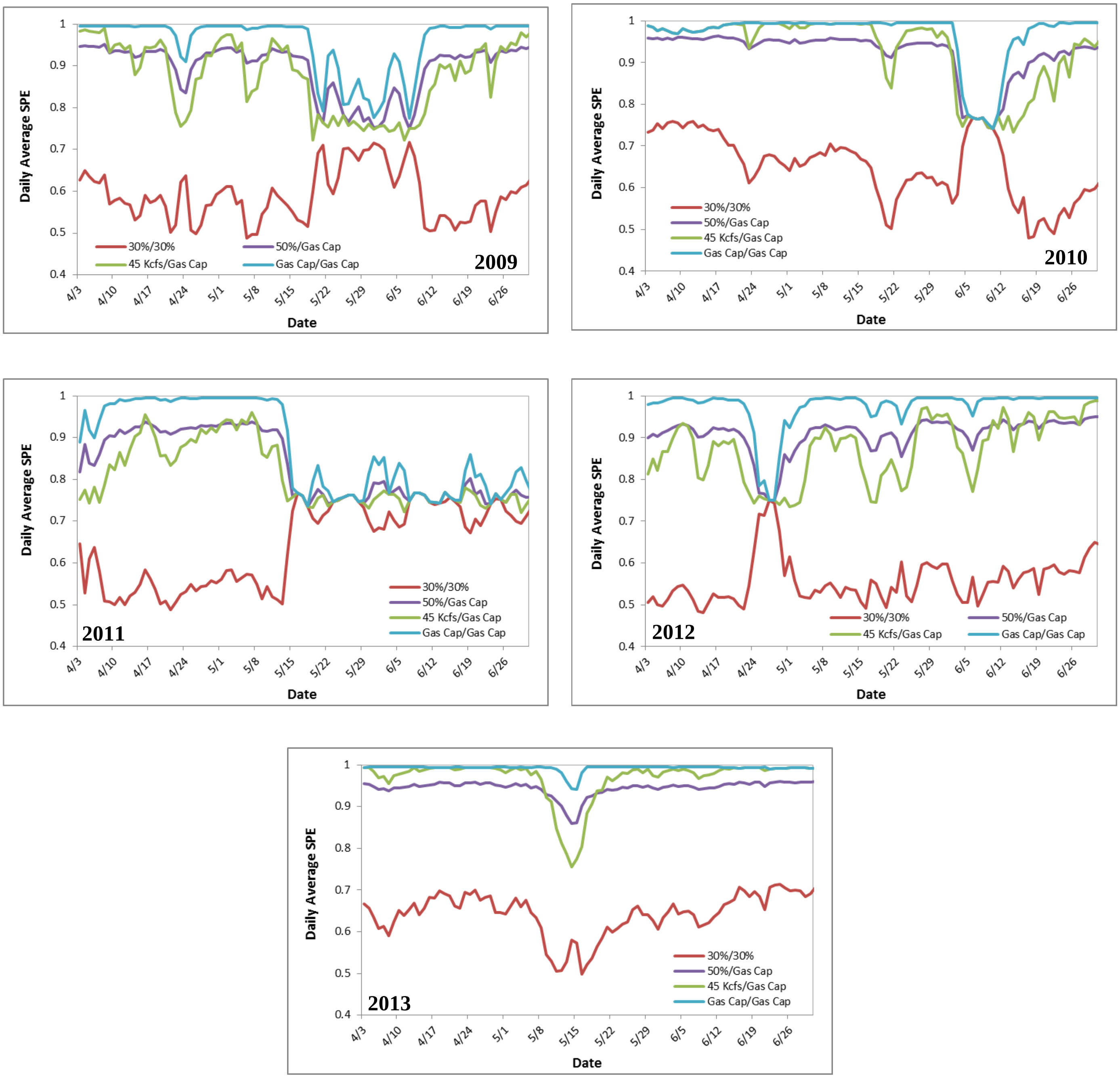

Figure A.2. Estimated daily spill passage efficiency (SPE) for steelhead (April 3–June 30) at Ice Harbor Dam under each of four modeled spill scenarios, 2009–2013.

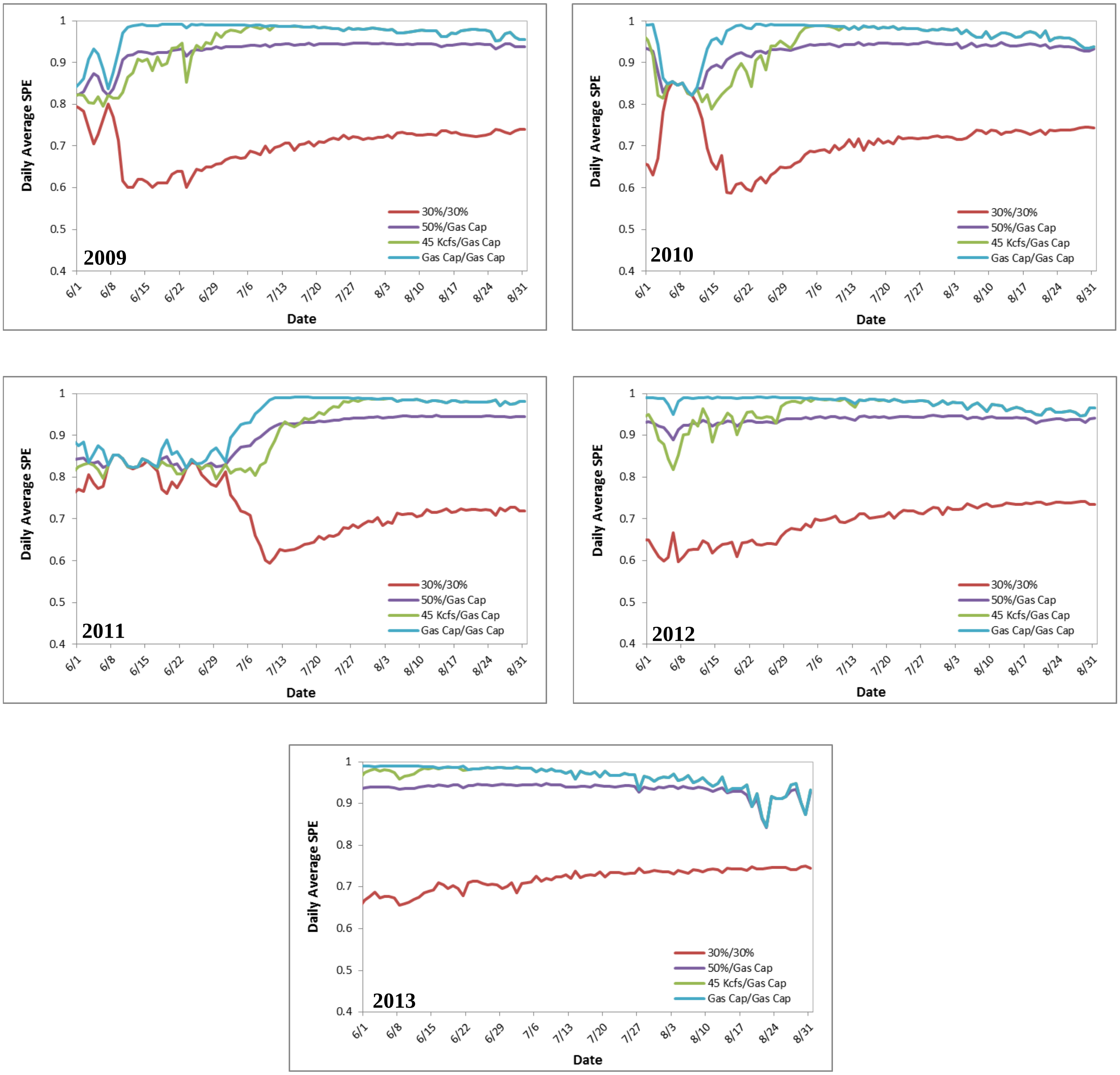

Figure A.3. Estimated daily spill passage efficiency (SPE) for subyearling Chinook (June 1–August 31) at Ice Harbor Dam under each of four modeled spill scenarios, 2009–2013.