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MEMORANDUM

TO: Charlie Morrill

FROM: Michele Dehart

DATE: February 5, 2018

SUBJECT: IDFG Little Goose Delay Spreadsheet Review

In response to your request the Fish Passage Center (FPC) staff has reviewed the spreadsheet provided to FPAC in June 2017, by Idaho Fish and Game (IDFG). The IDFG spreadsheet analyses was circulated to FPAC for consideration in application to the question of whether or not delay of adult spring Chinook passage was occurring at Little Goose Dam. The following review was conducted within this context. Prior to beginning the review, FPC contacted IDFG and requested documentation of this analysis that would explain the methodology, purpose, and assumptions underlying this estimation method. IDFG advised that there was no written documentation of the methodology. FPC staff evaluated the spreadsheet methodology to understand the underlying assumptions, methods, and to determine how estimates of both spring Chinook run size and timing at Lower Granite Dam were determined with this spreadsheet analysis. **Our overall conclusion after review is that this methodology does not have the precision necessary to accurately diagnose adult delay in the Lower Snake River**. Without accounting for variability in all of the subject passage metrics, this method would not be an appropriate tool for diagnosing the incidence of adult passage problems at Little Goose Dam for in-season operations management. We identified some of the primary assumptions that will limit its scope of inference in this matter:

- Variability in travel times between Ice Harbor and Lower Granite Dam is not accounted for when calculating expected counts at Lower Granite Dam.
- Variability in conversion rates between Ice Harbor and Lower Granite Dam is not accounted for when calculating expected counts at Lower Granite Dam.
- Deviations in travel time from expected values would not be directly attributable to operations at Little Goose Dam. All travel time related output metrics

incorporate variability in seasonal timing, in-river environmental conditions, conversion rates, and any delay related to the passage of two additional dams (Lower Monumental and Lower Granite).

- Inference on passage problems between Ice Harbor and Lower Granite would be lagged by a minimum of four days, and as much as two weeks, making actionable criteria for systems operations nominally responsive to in-season conditions.
- Consideration of parameter uncertainty, biological impact of delay, and the full range of expected responses must be taken into account when considering how to define potential adult passage delay, particularly when response actions may present negative impacts on other life stages.

Spreadsheet Summary:

Methods:

This spreadsheet uses adult counts at Ice Harbor Dam (ICH) to calculate expected numbers at Lower Granite Dam (LGR) that are corrected by a constant conversion rate (0.9354), and adjusted for average travel times between the two projects. Travel times are based on distributions for years 2010-2016 (Table 1), although no documentation on how these were determined has been provided. The resulting lagged ICH count numbers are summed for each day to compute an "expected" count at LGR. The expected count is then compared with the corresponding observed count at LGR for each day. Output metrics display graphs of daily and cumulative adult passage counts at ICH, LMO, LGS, and LGR dams, as well as daily and cumulative comparisons of observed versus "expected" counts at LGR (Figures 1, 2, and 3).

Table 1: *Travel time (days) from ICH to LGR and % of ICH passage by travel time assumed by IDFG spreadsheet model.*

Travel time (days) from ICH to LGR and % of ICH passage by travel time											
Days	3	4	5	6	7	8	9	10	11	12	13
Daily Passage	19.9%	26.5%	19.4%	11.5%	7.7%	4.6%	3.5%	2.2%	2.0%	1.5%	1.2%
Cumulative Passage	19.9%	46.4%	65.8%	77.3%	85.0%	89.6%	93.1%	95.3%	97.2%	98.8%	100.0%

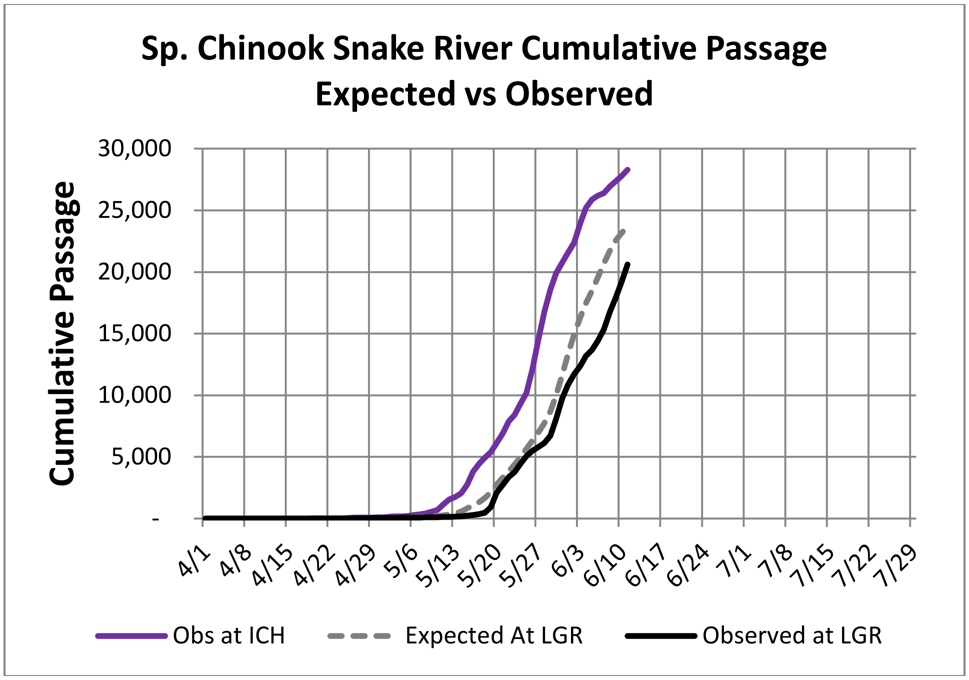

Figure 1: *Output graph from IDFG spreadsheet depicting expected passage vs. observed passage at Lower Granite Dam for spring 2017 (through June 12)*

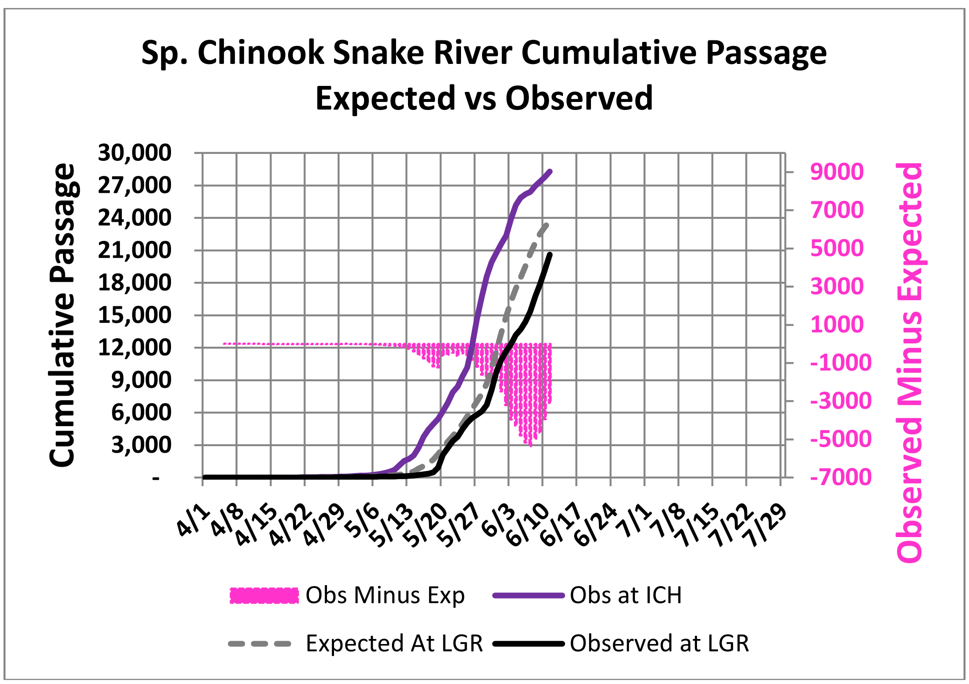

Figure 2: *Output graph from IDFG spreadsheet depicting divergence between observed vs expected passage at LGR by date for spring 2017 (through June 12)*

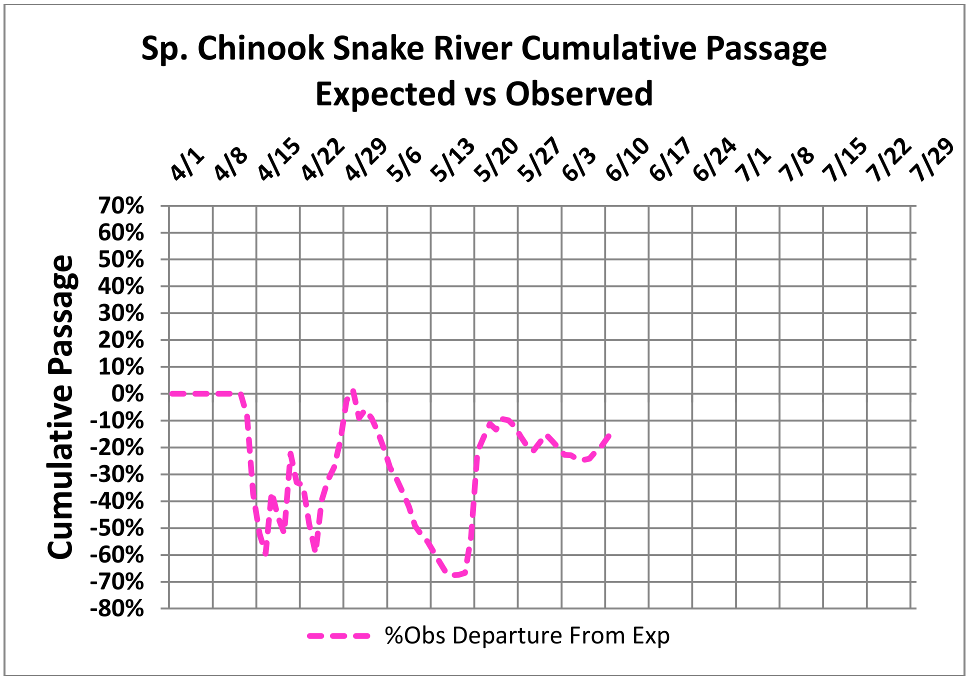

Figure 3: *Output graph from IDFG spreadsheet depicting departures by date of observed vs expected passage at LGR for spring 2017 (through June 12)*

Summary:

In its current formulation, this spreadsheet may introduce some significant bias in calculating expected counts at LGR that would make accurate diagnosis of adult passage problems at LGS difficult to identify. Variability in travel times, conversion rates, and lagged output metrics all introduce considerable uncertainty in actionable criteria produced by this spreadsheet.

Analysis of Adult Fish Travel Time:

To determine travel times of spring Chinook originating in the Snake River basin from 2005-2017, FPC staff used PIT-tag detections of known spring Chinook adults at both ICH and LGR. We observed a wide range of travel time distributions for adult spring Chinook for 2005-2017. Averages for individual years ranged from 5.0 days (2009) to 8.1 days (2011), with distributions of individual fish travel times varying considerably by year (Figures 4 and 5). Given this spreadsheet only uses an average distribution of travel times, deviations from the expected count at LGR could be misinterpreted as delay when these deviations may just be the result of natural variability in travel times between IHR and LGR.

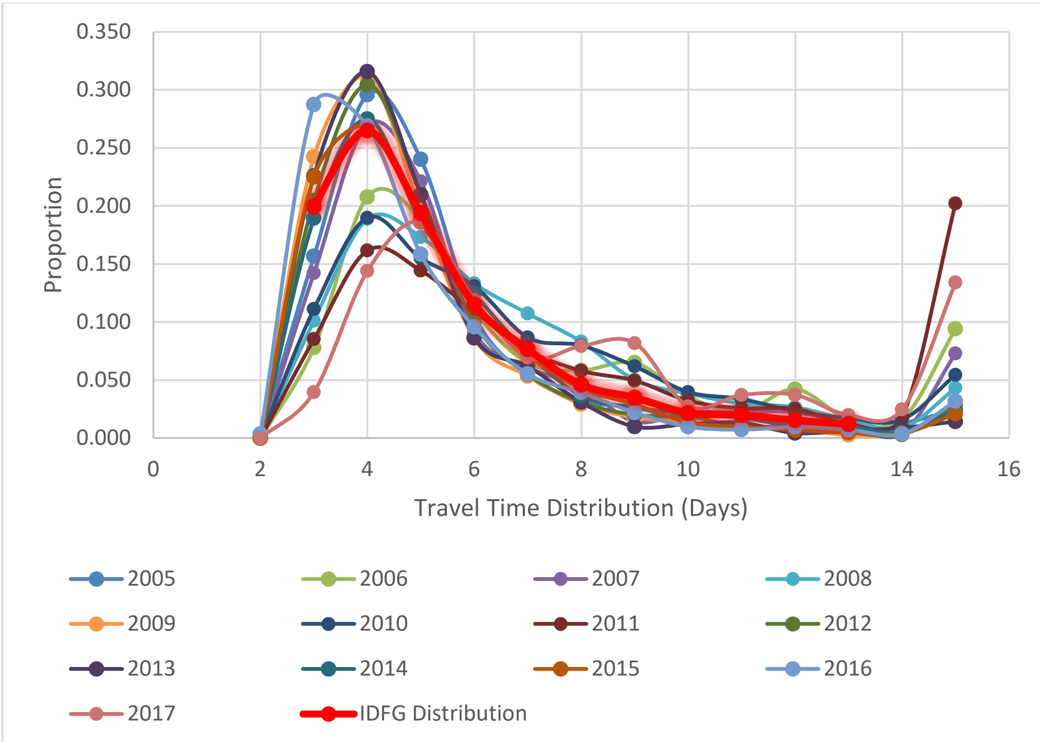

Figure 4: *Variability in interannual distributions of travel times (ICH-LGR) for spring Chinook passing Ice Harbor Dam in years 2005-2017. Points at 15 days represent cumulative proportions of individuals with travel times of 15 days or longer*

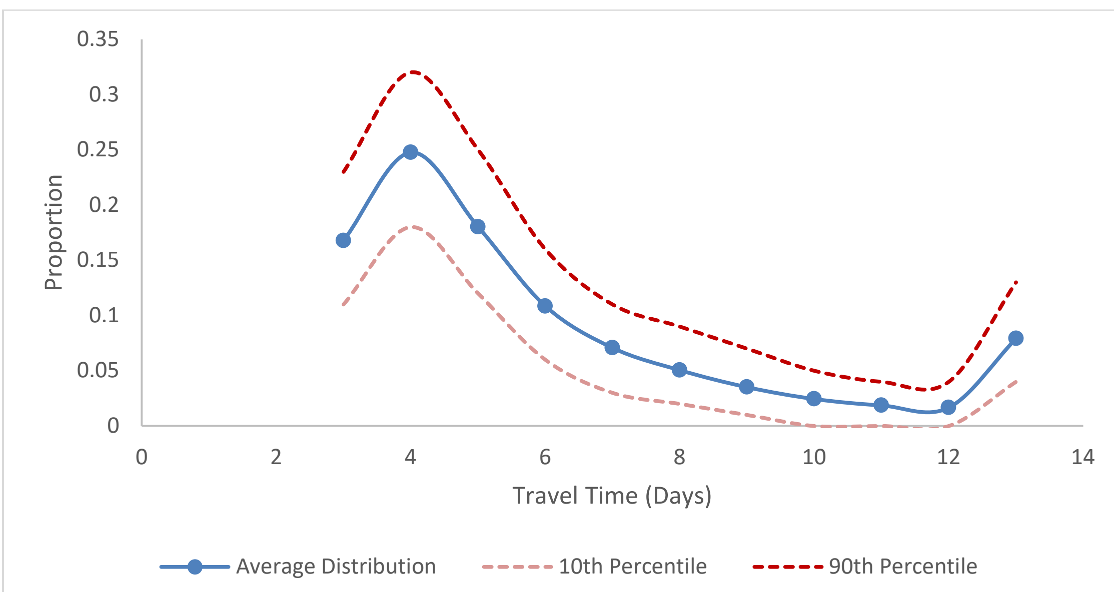

Figure 5: *Average travel time (ICH-LGR) distribution for years 2005-2017 with 10th and 90th percentiles. Points at 15 days represent cumulative proportions of individuals that took 15 days or longer to traverse the reach (ICH-LGR).*

Similarly, PIT-tag detections show notably longer travel times than are used in the IDFG spreadsheet, which assumed 100% passage at LGR by 13 days (Table 1). From 2005 to 2017, between 2% and 22% of individuals exceeded travel times of 13 days for the ICH-LGR reach, with a yearly average of 7% (Table 2). Without accounting for the continuous distribution of individual travel times when calculating "expected" numbers at LGR, significant skew would be expected in the outputs of this model. Given that truncated distributions of travel time is an assumption that is violated in every year of available data, it is likely adding considerable uncertainty into the output metrics. Therefore, this approach may have trouble distinguishing natural variability in travel times from project specific passage problems, especially if action criteria for delay is on the order of a few days or less.

Finally, with average travel times of more than 5 days between ICH and LGR, significant lag in the diagnosis of passage problems would be inherent in this methodology. In combination with the other identified sources of uncertainty surrounding travel times, this lag would make actionable criteria difficult to assess given the time sensitive nature of the perceived problem.

***Table 2**: Yearly proportion of run exceeding travel times of 13 days from Ice Harbor to Little Granite Dam, 2005-2017.*

Proportion of Individuals Exceeding Travel Times of 13 Days													
Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Proportion	0.04	0.11	0.08	0.05	0.03	0.07	0.22	0.03	0.02	0.03	0.03	0.04	0.16

Analysis of Conversion Rates (ICH-LGR):

Conversion rates between ICH and LGR varied considerably from 2005-2017 (Figure 6). Major factors affecting variability include natural fluctuations in environmental conditions, size of Tucannon River adult spring Chinook run, fish condition, hydrosystem operations at three Snake River Dams (LMN, LGS, and LGR), and harvest. The IDFG spreadsheet uses a constant conversion rate of 0.9354 to adjust expected counts at LGR. As with the distribution of travel times, it is unclear how this constant conversion rate was estimated. Without accounting for the multiple drivers of variability in this parameter, the uncertainty in distinguishing normal fluctuations in conversion rate from legitimate passage delays would be substantial.

We also identified some differences in expected results based on which methodology is used to calculate conversion rates. We found a significant difference in estimates obtained using adult counts at ICH and LGR versus estimates calculated using PIT-tag detections of known spring Chinook. This could significantly alter the interpretation of this models outputs depending on which metric is used. On average, the conversion rate calculated with PIT-tag data was 0.79 (95% CI: 0.73-0.84), an absolute difference of 13% (lower) from the average conversion rate calculated with count data; 0.91 (95%CI: 0.88-0.94) (Figures 6 and 7).

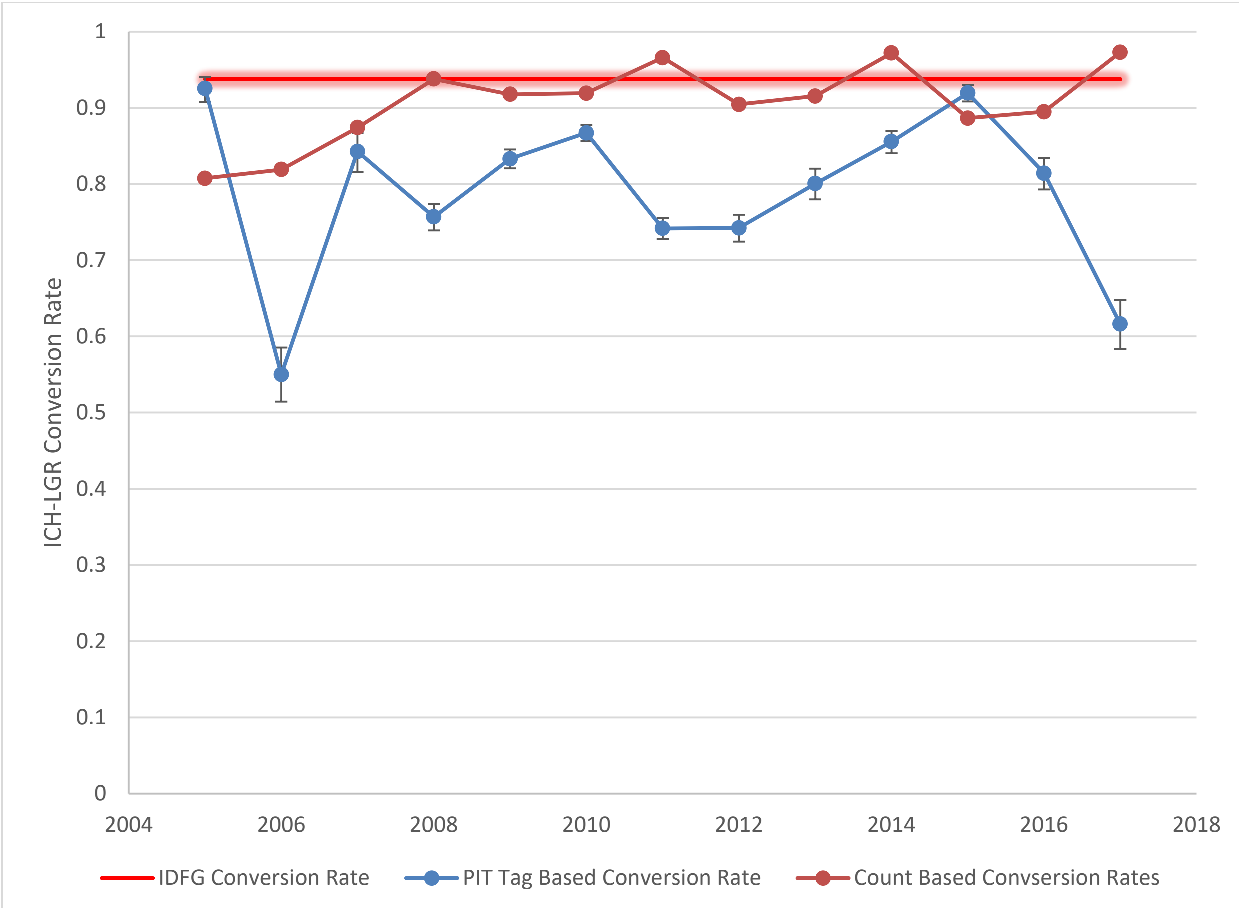

Figure 6: *Annual conversion rates and 95% confidence intervals as calculated by adult counts at Ice Harbor and Lower Granite Dams versus, PIT tag detections at Ice Harbor and Lower Granite Dams, 2005-2017.*

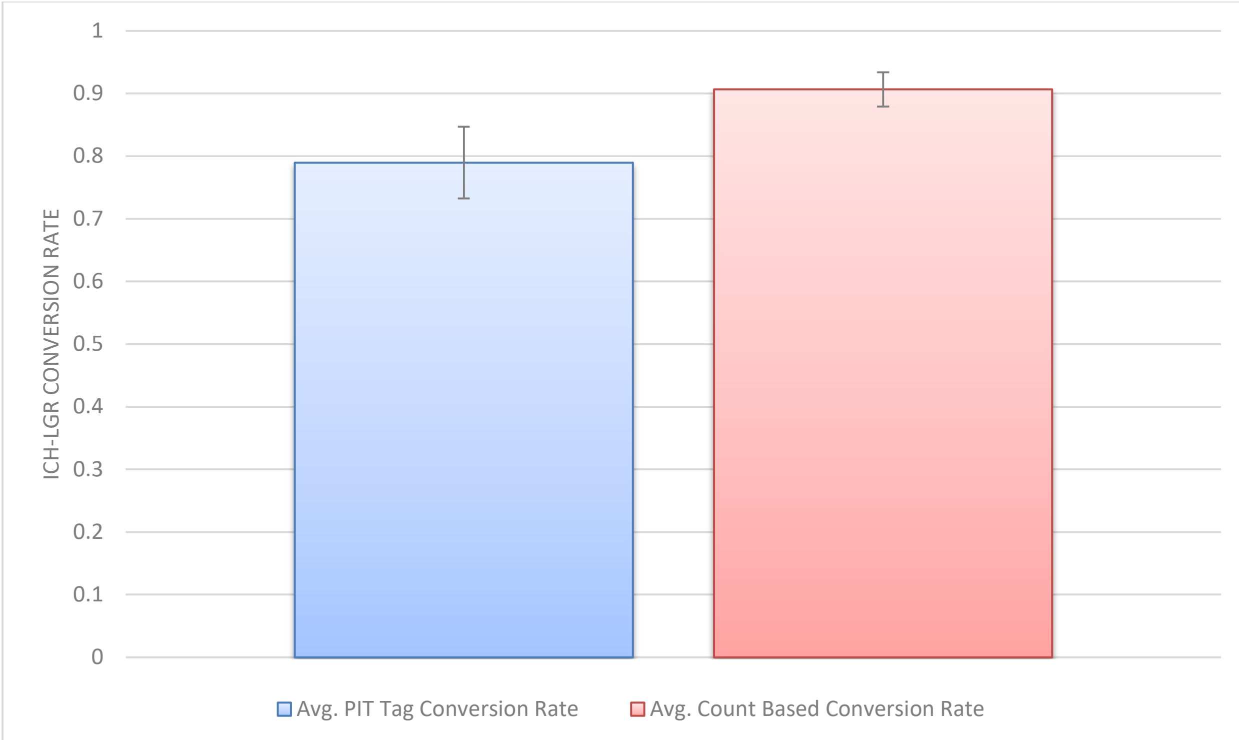

Figure 7: *Average conversion rate and associated 95% confidence interval when calculated with PIT tag detections vs counts at Ice Harbor and Lower Granite Dams.*

One contributing factor to this discrepancy is the presence of re-ascensions at both dams. FPC staff utilized a modified algorithm to identify and evaluate the proportion of individuals re-ascending at ICH and LGR (FPC 2017). From 2011-2017, non-unique passage events in proportion to dam counts ranged from 3.0-9.0% at ICH, and 3.2-16.9% at LGR (Table 3). This year to year variability, as well as disproportionality between ICH and LGR would add significant uncertainty to identifying a passage delay signal at an intermediary hydro project. Without adjusting for fish that are ascending more than once, the incidence of multiple ascensions at either project would add substantial bias to any "expected" or observed estimates.

Table 3: *Summary of seasonal comparisons between estimates of unique adult passage proportions at Ice Harbor and Lower Granite Dams for spring Chinook between 2011 and 2017*

Return Year	Proportion of Counts Classified as Re-Ascensions		Proportion of Fish with Multiple Ascensions	
	ICH	LGR	Transported	Overall
2017	0.09	0.169	0.22	0.20
2016	0.065	0.035	0.06	0.04
2015	0.05	0.032	0.02	0.03
2014	0.03	0.085	0.22	0.09
2013	0.055	0.067	0.15	0.07
2012	0.059	0.068	0.11	0.07
2011	0.075	0.136	0.05	0.16

Incorporation of Variability:

Based on the timeframe for action criteria (days) as well as the number and precision of parameters involved in this methodology, we would not recommend using this spreadsheet as a basis for determining passage problems at LGS. In its current formulation, this spreadsheet introduces some significant biases in calculating expected counts at LGR that would make accurate diagnosis of adult passage problems at LGS difficult to identify. This is particularly important because resulting operations actions could result in more juvenile migrants experiencing powerhouse passage.

Incorporation of the known sources of uncertainty that we have identified only addresses one component of the question of identifying adult passage delay at Little Goose. To illustrate this point, we incorporated variation in travel time distributions and conversion rates (PIT-tag methodology) that have been observed over the 2005-2017 period into the IDFG spreadsheet model to estimate a range of expected populations at LGR. We accounted for variability in travel times by assuming an upper limit as the fastest observed distribution (2009 – with an average of 5.0 days) and a lower limit as the slowest observed distribution (2011 – with an average of 8.1 days) (Figure 4). Variability in conversion rates assumed the upper and lower confidence interval limits for the PIT-tag based methodology (Figure 7). After accounting for these sources of variability, it appears that the observed counts at LGR in 2017 would not be outside the range of expected counts (Figure 8b). As illustrated in Figure 8, even accounting for variability, any counts falling outside of the range of expected counts can still only be interpretable as falling outside of the range of variability seen since 2005. Attributing a deviation to delay at LGS would also rely on the assumption that neither LMN, nor LGR, was contributing to delay in any way, in addition to the assumption that no other parameters such as flow, harvest, fish condition, stock composition, environmental conditions, or travel time distributions were significantly outside the norms seen since 2005. With this in mind, it is unlikely that using ICH-LGR counts would be an accurate or timely way to deduce problems with passage at a specific hydro project (i.e., LGS).

When considering potential adult passage delay, particularly since response actions present negative impacts to other life stages, accounting for uncertainty in parameter estimates, biological impact of delay, and a full range of responses must be taken into account. Solely considering observed versus expected counts does not determine whether a legitimate passage problem, or simply the observation of natural variation in travel times, composition, and/or survival parameters is occurring.

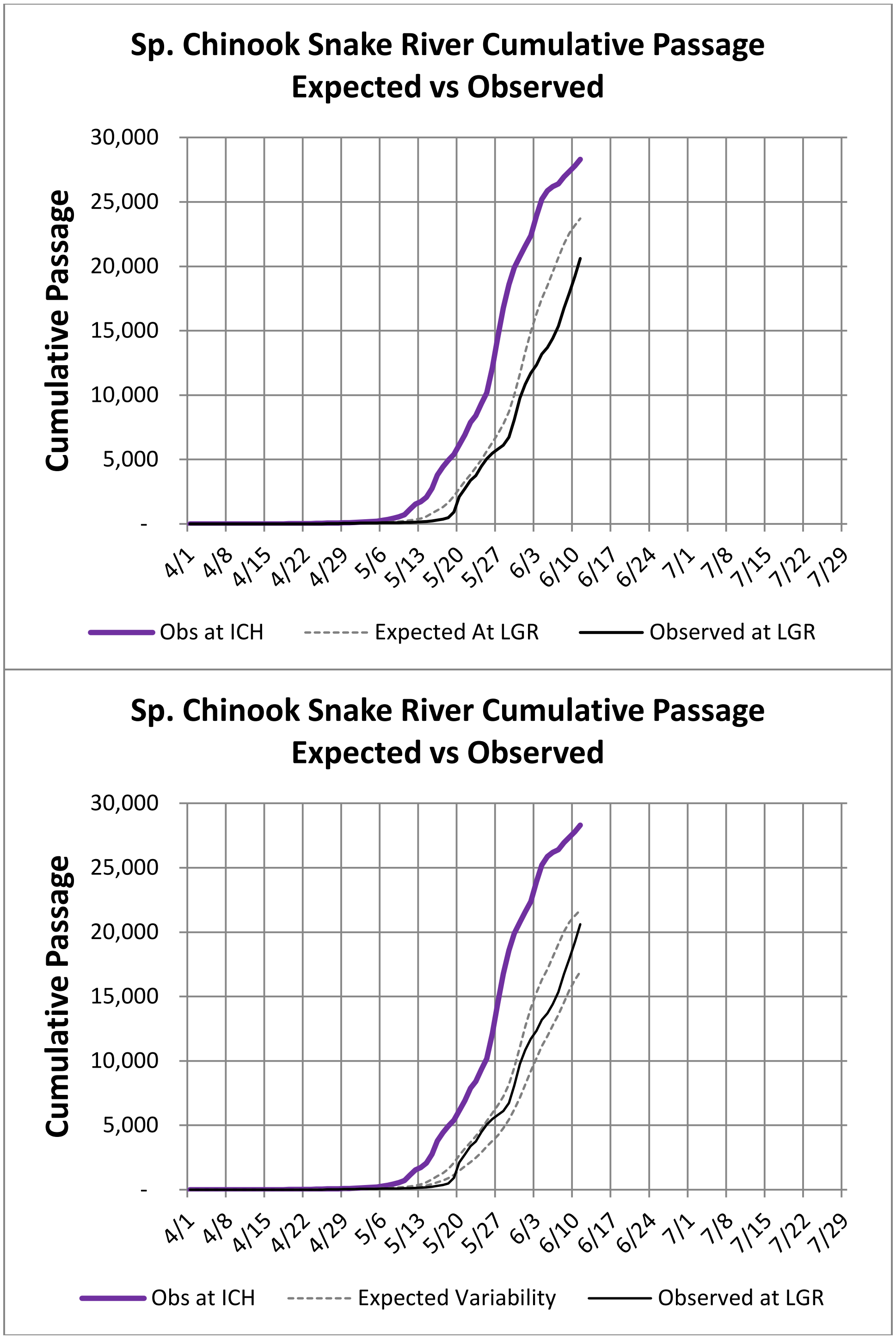

Figure 8: *(a.) Output from IDFG spreadsheet analysis, showing counts at Ice Harbor, Lower Granite, and "expected" counts at Lower Granite dam. (b.) Output from a modified spreadsheet approach defining the observed count at Lower Granite Dam and the expected variability around that count. Count numbers outside of the envelope would indicate a departure in travel times or conversion rates that are outside the expected variability observed in years 2005-2017.*

Citations:

Fish Passage Center. 2017. McNary Dam spring Chinook ladder re-ascension analysis. July 7, 2017. http://www.fpc.org/documents/memos/34-17.pdf