FISH PASSAGE CENTER

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MEMORANDUM

TO: Tucker Jones, ODFW

FROM: Michele DeHart, FPC

DATE: August 16, 2017

RE: Review of NOAA evaluation of 2017 Little Goose spill for fish passage manipulations

In response to your request the Fish Passage Center (FPC) staff reviewed the NOAA evaluation of the 2017 spill for adult fish passage operational manipulations at Little Goose Dam (LGS). This NOAA analysis was circulated for discussion at the June 20, 2017 FPAC meeting and is attached for your reference. The operational manipulations resulted in decreased spill during the morning hours for a period of 11 days. Reducing spill in 2017 likely led to more juvenile spring migrants passing through the powerhouse, which has been shown to result in lower adult return rates (McCann et al. 2016, Chapter 7). In addition to reviewing the NOAA analysis, FPC staff reviewed historic evaluations of adult passage at LGS.

Our overall conclusion is that the factors affecting adult and juvenile passage at LGS are complex and interrelated and, to date, have not been thoroughly evaluated. The NOAA 2017 evaluation does not address these complexities, including: the actual physical configuration of the project, the specific combination of turbine units operating, the flow through operating turbines, specific combination of spill bay openings, amount of spill through each spill bay, operation of the temporary spillway weir (TSW), conditions at fishway entrances, conditions at fishway exits, fishway water temperatures, temperature differentials in fishways, and route of passage during the juvenile downstream migration. These LGS adult and juvenile passage issues should be thoroughly evaluated in a comprehensive analysis beginning with hydraulic modelling evaluations. Our conclusions are listed below followed by a discussion of each point.

- The NOAA evaluation of the 2017 operation at LGS is not adequate to establish a long term spill operation for fish passage at the project.
- Historical evaluations of spill levels at LGS have indicated that spill levels above 30% had no effect on adult conversion rates in the Snake River while spill above 40% results in increases in adult travel time. However, spill levels above 40% generally only occur when flows are in excess of powerhouse capacity and the estimated spill cap at LGS.
- Historical operational evaluations at LGS were like the NOAA evaluation for 2017, incomplete, and led to flawed operational decisions. One example of this is the 2005 decision to reduce spill to 30% without considering the effect of turbine unit operations. Subsequently, modifications in unit operations were determined to have affected adult passage.
- Past evaluations have shown that spill patterns, unit operations, and TSW operations at low flows may have more effect on adult passage than spill percent.
- Adult passage issues at LGS have not been thoroughly evaluated. Reducing spill for juvenile fish passage is the only option that has been considered. Other potential actions that could maintain spill for fish passage at tailrace gas cap limits have not been considered. Examples of other options include: TSW operations and its contribution to adverse tailrace conditions and streamlining the peninsula which is directly downstream of units 1 and 2 on the south side of the powerhouse. These factors and their effect on tailrace conditions could be evaluated in hydraulic model studies.

Overview of the 2017 Operational Modifications

Due to a disparity in cumulative adult counts between Lower Monumental Dam (LMN) and LGS, managers decided to implement modified spill operations at LGS, in an effort to improve adult passage conditions at the project. Three different special operations were conducted: 1) reducing spill to 40% from 0400 to 1000 (June 3-5), 2) reducing spill to 30% from 0400 to 1000 (June 6-8), and 3) reducing spill to 30% from 0400 to 1200 (June 9-14). Due to these decreases in spill volumes, and limited powerhouse capacity, all three of these operations resulted in filling the LGS pool to ~1 foot above MOP. Therefore, all three operations included increases in spill in the afternoon and/or evening to draft the LGS pool back to MOP by the next morning. By June 15th, flows in the Snake River had decreased to a level where spill of 30% was possible 24-hours a day without changes in the pool elevation. These operations, and corresponding adult counts are summarized in Figure 1 and Table 1 below.

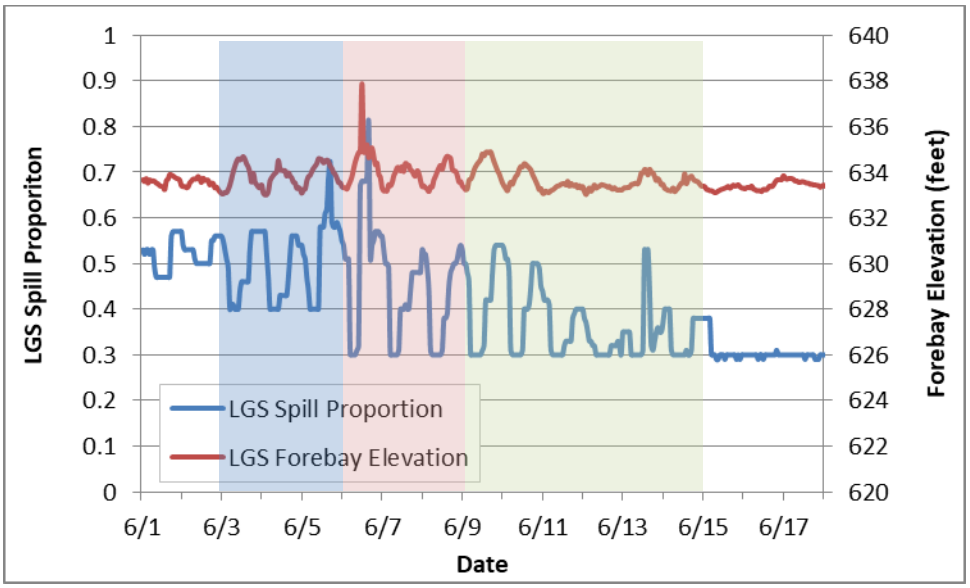

Figure 1. Little Goose Dam hourly spill proportion and forebay elevation (feet) just before, during, and after special operations to improve adult counts in 2017. Filled areas correspond to three operations conducted in 2017: 1) 40% spill from 0400-1000 (blue), 2) 30% spill from 0400-1000 (red), and 3) 30% spill from 0400-1200 (green).

Table 1. Flow and spill volumes, forebay temperatures, and adult counts at Little Goose Dam just before, during, and after special operations to improve adult counts in 2017. Filled areas correspond to three operations conducted in 2017: 1) 40% spill from 0400-1000 (blue), 2) 30% spill from 0400-1000 (red), and 3) 30% spill from 0400-1200 (green).

Date	Time Period	Average Flow (Kcfs)	Average Spill Volume (Kcfs)	Average Spill Proportion	Daily Average Forebay Temp. (°F)	Daily Chinook Adult Count
1-Jun	0100-0400	170.5	89.8	0.53		
	0500-1000	171.5	86.0	0.50	56.4	780
	1100-2400	178.0	92.6	0.52		
2-Jun	0100-0400	172.2	92.1	0.53		
	0500-1000	174.5	90.0	0.52	56.8	762
	1100-2400	182.5	96.8	0.53		
3-Jun	0100-0400	171.3	89.7	0.52		
	0500-1000	141.6	56.9	0.40	56.9	793
	1100-2400	180.2	94.2	0.52		
4-Jun	0100-0400	175.6	94.0	0.53		
	0500-1000	140.4	55.8	0.40	56.6	578
	1100-2400	172.9	87.2	0.50		
5-Jun	0100-0400	156.8	76.3	0.49		
	0500-1000	140.5	56.0	0.40	56.0	390
	1100-2400	183.2	110.2	0.60		

Table 1 cont'd. Flow and spill volumes, forebay temperatures, and adult counts at Little Goose Dam just before, during, and after special operations to improve adult counts in 2017. Filled areas correspond to three operations conducted in 2017: 1) 40% spill from 0400-1000 (blue), 2) 30% spill from 0400-1000 (red), and 3) 30% spill from 0400-1200 (green).

Date	Time Period	Average Flow (Kcfs)	Average Spill Volume (Kcfs)	Average Spill Proportion	Daily Average Forebay Temp. (°F)	Daily Chinook Adult Count
6-Jun	0100-0400	169.7	87.9	0.52	56.6	1,542
	0500-1000	129.0	39.4	0.31		
	1100-2400	172.3	105.1	0.62		
7-Jun	0100-0400	163.5	83.0	0.51	57.0	1,384
	0500-1000	129.3	39.1	0.30		
	1100-2400	154.5	69.3	0.45		
8-Jun	0100-0400	162.7	80.4	0.49	57.7	1,398
	0500-1000	129.0	39.0	0.30		
	1100-2400	156.8	71.7	0.45		
9-Jun	0100-0400	156.3	75.7	0.49	57.9	948
	0500-1200	128.7	39.0	0.30		
	1300-2400	163.0	78.2	0.48		
10-Jun	0100-0400	162.6	82.3	0.51	58.2	1,338
	0500-1200	128.7	39.1	0.30		
	1300-2400	154.1	70.0	0.45		
11-Jun	0100-0400	138.3	57.8	0.42	58.2	1,520
	0500-1200	128.7	38.8	0.30		
	1300-2400	133.5	48.7	0.37		
12-Jun	0100-0400	125.4	44.8	0.36	58.3	1,242
	0500-1200	121.2	37.3	0.31		
	1300-2400	119.2	37.5	0.32		
13-Jun	0100-0400	110.5	38.5	0.35	57.9	907
	0500-1200	100.9	30.6	0.30		
	1300-2400	119.3	46.9	0.40		
14-Jun	0100-0400	135.3	54.2	0.40	57.7	772
	0500-1200	128.2	38.6	0.30		
	1300-2400	129.3	45.2	0.35		
15-Jun	0100-0400	130.4	49.7	0.38	57.5	446
	0500-1200	125.0	37.1	0.30		
	1300-2400	121.7	36.0	0.30		
16-Jun	0100-0400	115.5	34.5	0.30	58.0	1,186
	0500-1200	117.1	34.7	0.30		
	1300-2400	110.8	33.3	0.30		

Review of Past FPC Memos

Over the years, the FPC has addressed the issue of the 30% spill limit LGS in five separate memos (FPC 2005, FPC 2006, FPC 2009, FPC 2011a, FPC 2011b). The first of these memos summarized conditions in June of 2005 when adult delays and declining adult counts were observed at LGS coincident with the initiation of summer spill on June 20th. As a result, spill patterns were changed and daytime spill percentages were reduced, eventually to 30% of river flow. In our July 7, 2005 memo (FPC 2005), the FPC concluded that the delay in adult passage at LGS due to the high volume of spill at the project did not impact conversion rates in the Snake River. In 2006, the FPC was asked to review historic adult passage data (including the 2005 delay event) to assess whether there was information to suggest that a 30% spill limit would be warranted in the spring. In our July 26, 2006 memo (FPC 2006), the FPC noted that: 1) the 2005 event did not affect total passage timing, 2) the successful passage of adults in 2005 was due, in part, to an effective management process where fishery managers and project operators responded to the progress of adult passage, and 3) the 10-year analysis conducted indicated that adult passage responds minimally to spill conditions during the spring migration, suggesting that a 30% spill limit was unwarranted.

For a period in August of 2009, voluntary spill at LGS exceeded the 30% level that was specified in the Fish Operations Plan. During this period, spill at LGS was as high as 36.5%. Given this, FPAC asked the FPC to review the travel time and conversion rate data for Chinook and steelhead passing between Ice Harbor and Lower Granite dams during this time to see if there was evidence of an impact of the higher spill levels at LGS. In our November 6, 2009 memo (FPC 2009), the FPC concluded: 1) spill levels greater than 30% (up to 36.5%) had no effect on travel times or conversion rates of adult Chinook or steelhead and 2) regression analyses showed no significant relationship between travel times (or conversion rates) of adult Chinook and steelhead and average spill percent, average flow, or average temperature.

High flows in 2011 and project outages at LGS resulted in daily average spill operations that ranged from 30% to 97% of instantaneous flows. As a result of these conditions, the FPC was requested to review the 2011 passage data to determine if the 30% spill limit was a documentable threshold. In our December 9, 2011 (FPC 2011a) and December 14, 2011 (FPC 2011b) memos, the FPC concluded: 1) spill levels of greater than 30% had no effect on conversion rates of adult Chinook in 2011, 2) travel times increased slightly at spill levels above 40% but these spill levels generally exceeded the estimated gas caps at LGS, and 3) spill to the gas cap at LGS is unlikely to affect adult passage, specifically conversion rates. In addition, the FPC reviewed other studies and concluded that LGS spill patterns and TSW operations at low flows may have a more significant effect on adult Chinook passage than spill proportions. For example, drogue tests in 2008 revealed that a uniform spill pattern resulted in fewer eddies in the LGS tailrace (Jepson et al. 2009). Furthermore, adult radio-tag studies suggested that adult spring/summer Chinook passed more quickly through LGS under uniform spill than under bulk (Jepson et al. 2009). It is worth noting that both of these tests were conducted before the Temporary Spillway Weir (TSW) was installed at LGS. With the TSW in place, the spill pattern at LGS is more similar to a bulk pattern (particularly at low flows), as spill is prioritized through the TSW in spillbay 1. Finally, a review of 2009 and 2010 special operations revealed that the operation of the TSW at low flows, which result in a bulk spill pattern, may have a larger impact on adult Chinook passage than spill percent at LGS.

The multiple analyses that the FPC has conducted over the years on this topic highlight the complexity of the matter. However, all of the FPC analyses have indicated that spill above 30% at LGS is unlikely to affect Chinook conversion rates in the Snake River. Furthermore, while spill above 40% may result in increased travel times, these spill levels generally only occur when flows are in excess of powerhouse capacity and the estimated spill cap.

Review of NOAA Analysis

At your request, we have reviewed the retrospective analysis provided by NOAA on modified LGS operations to reduce spill with the intent to assist adult passage. Based on our review of the NOAA retrospective analysis, we have several concerns which we highlight below. These concerns include: 1) the analysis provided by NOAA lacks a clear, testable hypothesis, as well as biologically based metrics of "success", 2) there is no discussion of how the criteria that NOAA chose to identify a "substantial change" in adult passage (i.e., 200% from previous day with minimum 200 adult passage) may affect results, 3) there is no clear definition as to what is considered a significant reduction in spill, 4) passage timing, including substantial increases in adult passage at LMN, is not considered in this analysis, and 5) by only looking at changes in spill at times when adult passage increased, the NOAA review is subject to a confirmation bias.

With this in mind, the FPC staff conducted the same analysis as NOAA, only over a longer time frame. Including a longer time frame allowed for the inclusion of more variability in operational conditions, particularly in spill proportions. Furthermore, we will address many of the concerns outlined above to demonstrate why the NOAA analysis is not rigorous enough to make solid conclusions on LGS operations or to establish a long term spill operation for fish passage at the project. Our original intent was to review adult counts and operations data at LGS and LMN dams over the last 30 years. However, there was no adult counting at LGS between 1982 and 1990. Therefore, our analysis covered the last 27-years (1991-2017).

To demonstrate our point that the number of instances of "substantial changes" in adult counts is likely influences by the adult count and percent change thresholds that are chosen, we identified the number of instances of "substantial changes" in adult counts under several different adult count thresholds (range: 50-200) and minimum percent change thresholds (range: 100%-450%) over the last 27-years (1991-2017). The NOAA analysis relied on a minimum adult count threshold of 200 fish and a percent change threshold of 200%. Table 2 provides a summary of the number of "substantial changes" under these different scenarios. Under the original NOAA criteria, we found 26 instances of "substantial changes" in adult counts at LGS over the last 27-years. However, if one were to reduce the adult count threshold to 100 fish, the number of instances increases to 34. Likewise, if you leave the adult count threshold at 200 fish but reduce the percent change threshold to 150%, the number of instances increases to 44. As is illustrated by this sensitivity analysis, the decision to use a 200% increase in adult counts from one day to the next, with a threshold of 200 adults per day, has a significant impact on the number of instances that were considered "substantial changes" and, therefore, are considered for further review of operational changes.

Table 2: The number of instances of "substantial change" in adult passage at LGS under different adult count and percent change thresholds.

		Adult Count Threshold						
		50	75	100	125	150	175	200
Threshold for Percent Change in Adult Count	100	133	119	105	101	92	84	78
	150	72	66	57	54	49	46	44
	200	45	41	34	32	30	27	26
	250	27	26	20	18	16	13	13
	300	15	14	12	12	10	7	7
	350	15	14	12	12	10	7	7
	400	11	10	8	8	6	3	3
	450	9	8	6	6	5	2	2

As mentioned above, under the NOAA thresholds of 200 adults at LGS and a percent change of 200%, we found 26 instances of "substantial changes" in adult counts at LGS. Each of these instances is summarized below (Table 3). Based on our review of the last 27-years, we found that only seven (27%) of the instances of "substantial changes" in adult counts at LGS coincided with reductions in spill (Table 3, grey shading). Of these seven, five (71%) coincided with reductions in spill from the 37-50% range to the 30-32% range (Table 3). The other two coincided with reductions in spill from 96% to 73% (June 1, 2011) and 47% to 42% (May 18, 2017). The instance on May 18, 2017 was noted by the NOAA analysis but the spill proportion attributed to this date was misidentified as being 32% instead of 42%. We used the COE website (http://www.nwd-wc.usace.army.mil/ftppub/water_quality/spill/201705.html) to verify that the spill proportion on this date was 42%.

Furthermore, of the 26 total instances of "substantial change" in adult counts at LGS, we found six (23%) that occurred when spill at LGS was 5% or less (Table 3, blue shading). These primarily occurred in the years prior to voluntary spring spill. This illustrates the importance of looking at a larger dataset when assessing this issue, as the NOAA analysis only included two years where no voluntary spill occurred at LGS (2004 and 2005). Finally, we identified 13 (50%) total instances of "substantial changes" in adult passage that coincided with no change in spill proportion at LGS (Table 3, yellow shading). In all but two of these instances, daily average spill at LGS ranged from 23-30%. The two exceptions to this were in 2017 when daily average spill was 39% (May 28th) and 53% (June 6th). These two dates coincide with the modified operations at LGS. Two other instances (May 13, 2010 and May 18, 2010) where a "substantial change" in adult counts occurred with no change in spill operations are worth noting because they coincide with a period when the TSW was taken out of service for at least a portion of the day. These instances are noted in the NOAA analysis and are documented on the COE website (http://www.nwd-wc.usace.army.mil/tmt/documents/ops/spillbay/LGS_2010_05_f.html).

This breakdown of the various instances where "substantial changes" in adult counts over the last 27-years illustrates the complicated nature of the events that likely lead to adult passage issues at LGS. It is clear from this review that reducing spill of 30% is not the only thing that has led to "substantial changes" in adult counts at LGS.

Table 3: Instances of "substantial changes" in adult passage at Little Goose Dam and other relevant operational data for these dates (1991-2017). "Substantial changes" in adult passage were based on the NOAA adult count threshold of 200 fish and percent change threshold of 200% on consecutive days. A spill change of less than 5% (absolute) on consecutive days was considered "no change".

Date	Adult Count	Percent Change in Adult Count	Percent Spill	Change in Spill	Notes
5/8/1992	1,447	205.92	0.0%	No Change	
4/30/1993	950	211.48	0.8%	No Change	
4/13/2001	1,717	219.74	0.0%	No Change	
5/4/2001	3,139	265.85	0.0%	No Change	
6/3/2002	967	285.26	29.1%	Spill reduction 50% to 30%	
4/15/2003	1,597	242.7	22.7%	No Change	
4/19/2003	4,069	218.14	28.6%	No Change	
5/15/2003	895	230.26	22.9%	No Change	
6/10/2004	1,228	221.47	0.0%	No Change	
5/5/2005	1,252	270.41	0.0%	No Change	Instance missed in NOAA analysis
5/3/2010	3,272	257.21	30.0%	No Change	
5/11/2010	2,406	219.1	30.0%	No Change	
5/13/2010	9,572	490.14	29.9%	No Change	TSW removed
5/18/2010	9,863	438.67	29.9%	No Change	TSW removed
6/1/2011	4,393	475.75	73.6%	Spill reduction 96% to 73%	Spill averaged 94% from 10AM to 4PM
5/14/2012	1,098	205	29.8%	No Change	
5/18/2012	10,621	360.18	31.9%	Spill reduction 37% to 32%	
6/11/2012	2,315	225.14	34.9%	Spill reduction 43% to 35%	
6/14/2012	1,079	386.04	33.4%	Spill reduction 54% to 34%	
4/30/2014	856	298.14	29.8%	No Change	
5/4/2014	2,188	384.07	30.2%	Spill reduction 37% to 30%	
5/17/2016	2,804	239.47	30.0%	No Change	
6/11/2016	857	201.76	29.9%	No Change	
5/18/2017	796	208.53	42.0%	Spill reduction 47% to 42%	NOAA analysis misidentified spill reduction from 35% to 32%
5/28/2017	1,070	367.25	39.2%	No Change	Spill averaged 30% from 10AM to 4PM
6/6/2017	1,542	295.38	52.6%	No Change	Spill averaged 30% from 5AM to 10AM

Run Timing and Conversion Rate Threshold:

It is clear that run timing plays a substantial role in adult counts from day to day and project to project. The NOAA review did not consider run timing or increases in passage at the downstream site (i.e., LMN). From our review above, 10 of the 26 instances of "substantial changes" in adult passage at LGS were preceded by an adult passage increases at LMN of more than 150% two days prior to the "substantial change" event at LGS. This illustrates that many of the "substantial changes" in adult passage at LGS may also be related to run timing and not necessarily just spill operations at LGS.

One tool managers have used to evaluate whether there is a passage problem at LGS is the estimation of conversion rates between LMN and LGS. For example, low conversion rates between these two dams was a contributing factor to the decision to change operations at Little Goose Dam in 2017 to assist in adult passage. However, considering adult counts at two sites on the same day ignores the travel time between the projects. In recognition of this travel time, the COE uses a two-day lag when separating spring, summer, and fall Chinook counts between Lower Monumental and Little Goose dams. For example, the start date for summer Chinook at LMN is June 14, whereas that at LGS is June 16.

To investigate the impact of this two-day lag on conversion rates, we estimated conversion rates between LMN and LGS using a two day lag (i.e., total count at LGS divided by total count at LMN two days prior), versus comparing counts from the same day (i.e., total count at LGS divided by total count at LMN on same day). This analysis focused on three separate periods during the spring Chinook passage season, May 1-May 15, May 16-May 31, and June 1-June 15. Conversion rates using the two day lag were always higher than the same-day methodology (Table 4). In general, the difference between the two methodologies tended to decrease as time went on. For example, in 2010, the differential in average conversion rate between the two methodologies went from 11% for the May 1-15 period to 4% for the May 16-31 period to 2% from June 1-15 period (Table 4, Figure 2). To further illustrate this effect, we plotted the conversion rates over time (May 1-June 15) for three years (2010, 2012, and 2017) (Figure 2). These three years were chosen because they had the largest number of instances of "substantial changes" in adult passage at LGS (Table 3).

Table 4. Conversion rates between LMN and LGS based on a two day lag in cumulative counts versus same day cumulative counts for return years 1991-2017.

Return Year	May 1-15		May 16-May 31		June 1-15	
	Two Day Lag	Same Day	Two Day Lag	Same Day	Two Day Lag	Same Day
1991	0.71	0.58	0.72	0.68	0.78	0.75
1992	0.88	0.82	0.90	0.88	0.91	0.89
1993	0.90	0.75	0.94	0.91	0.96	0.93
1994	0.73	0.62	0.86	0.82	0.89	0.87
1995	0.55	0.47	0.68	0.62	0.77	0.74
1996	0.86	0.56	0.84	0.74	0.89	0.85
1997	1.01	0.72	0.90	0.84	1.00	0.97
1998	0.98	0.83	0.94	0.92	0.97	0.95
1999	0.88	0.64	0.88	0.78	0.87	0.82
2000	1.00	0.88	0.98	0.95	0.97	0.96
2001	0.97	0.93	0.97	0.95	0.97	0.95
2002	1.08	0.78	0.98	0.94	0.99	0.97
2003	1.00	0.95	0.98	0.96	0.97	0.95
2004	0.88	0.81	0.86	0.84	0.87	0.85
2005	1.06	0.73	0.91	0.87	0.93	0.89
2006	1.44	0.62	0.91	0.77	0.89	0.86
2007	0.85	0.64	0.72	0.68	0.85	0.83
2008	0.89	0.67	0.90	0.81	0.93	0.89
2009	0.85	0.51	0.74	0.66	0.75	0.72
2010	0.81	0.70	0.92	0.88	0.94	0.93
2011	1.25	0.61	0.80	0.74	0.95	0.93
2012	0.88	0.49	0.98	0.82	0.98	0.96
2013	0.98	0.65	0.92	0.89	0.95	0.93
2014	0.94	0.67	0.99	0.95	0.99	0.97
2015	0.98	0.84	0.96	0.94	0.95	0.94
2016	1.02	0.67	0.94	0.89	0.95	0.93
2017	0.54	0.38	0.76	0.56	0.81	0.77

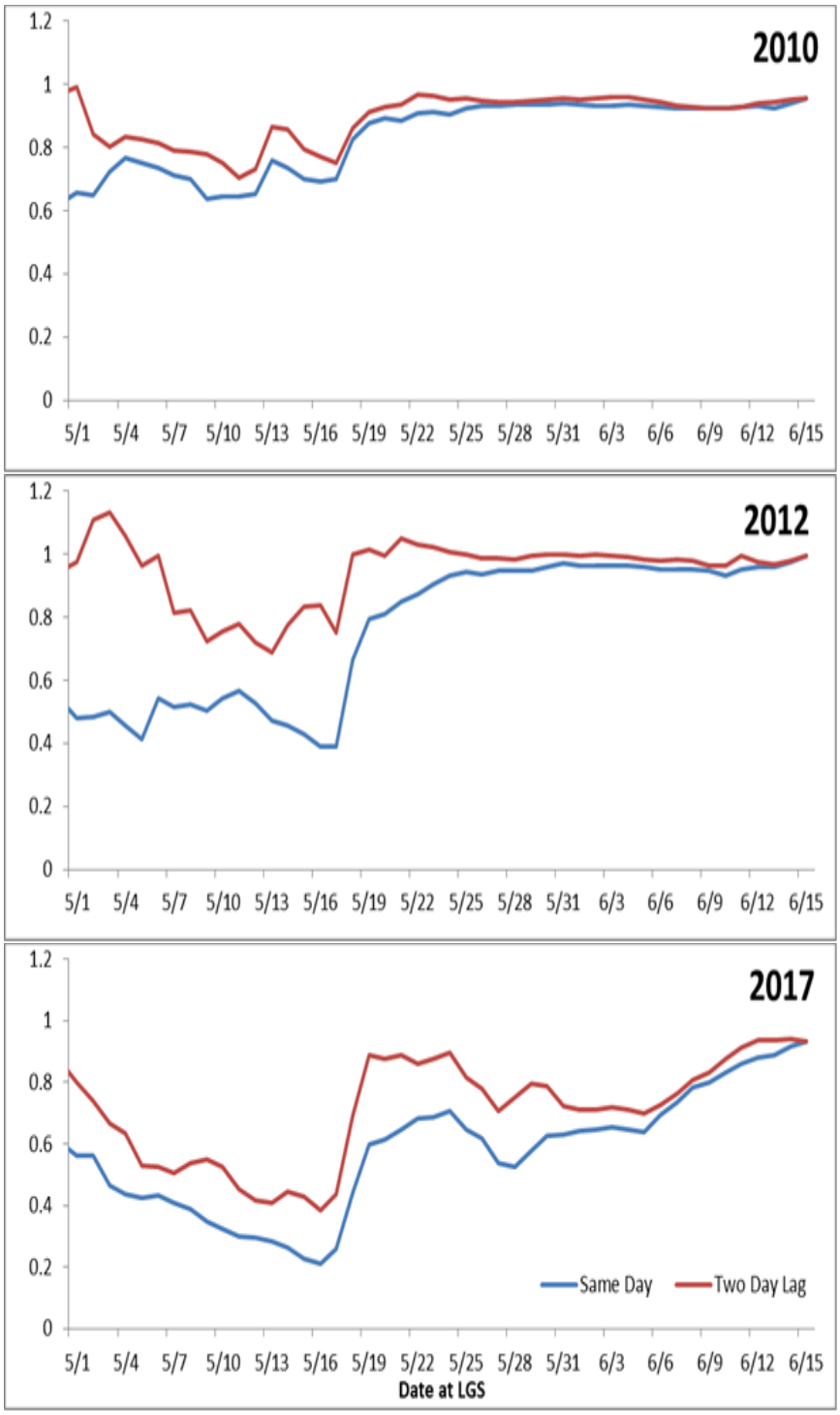

Figure 2: Adult conversion rates between Lower Monumental and Little Goose Dams in 2010, 2012, and 2017 (May 1-June 15) based on two methodologies: two day lag versus same day.

Recently, there has been discussion in FPAC about what level of conversion between LMN and LGS can be considered a problem. While our analysis does not suggest a conversion rate "threshold", it does highlight the importance of accounting for run-timing when estimating

and evaluating conversion rates, particularly when deciding if there is a passage issue at LGS and when making in-season management decisions.

Discussion

Spill is one of many factors which affects adult passage, including turbine operations, surface passage flow, temperatures, and overall flow. A full analysis of the impacts of spill will include river conditions, dam operations, and run timing. Both historical data and hydrodynamic modeling can provide data on a wide range of flow, spill, and operations at LGS. Future opportunities to change operations for adult passage should include model results as well as an a priori study design to evaluate the success of the operation.

Literature Cited:

Fish Passage Center. 2005. Adult passage in the Snake River (July 7, 2005). http://www.fpc.org/documents/memos/112-05.pdf

Fish Passage Center. 2006. Spill and adult passage at Little Goose during summer 2005 (July 26, 2006). http://www.fpc.org/documents/memos/104-06.pdf

Fish Passage Center. 2009. Greater than 30% spill at Little Goose Dam and adult travel times and conversion rates (November 6, 2009). http://www.fpc.org/documents/memos/173-09.pdf.

Fish Passage Center. 2011a. 2011 Little Goose Dam spill operations and adult travel times and conversion rates (December 9, 2011). http://www.fpc.org/documents/memos/177-11.pdf

Fish Passage Center. 2011b. Clarification of December 9, 2011 memo regarding Little Goose spill operations and adult Chinook conversion rates and travel times (December 14, 2011). http://www.fpc.org/documents/memos/179-11.pdf

Jepson, M.A., C.C. Caudill, T.S. Clabough, C.A. Peery, J.W. Beeman, S. Fielding. 2009. Adult Chinook salmon passage at Little Goose Dam in relation to spill operations – 2008. Technical Report for the U.S. Army Corps of Engineers, Walla Walla. (Technical Report 2009-6).

McCann, J., B. Chockley, E. Cooper, T. Garrison, H. Schaller, S. Haeseker, R. Lessard, C. Petrosky, T. Copeland, E. Tinus, E. Van Dyke, and R. Ehlke. 2016. Comparative survival study of PIT-tagged spring/summer/fall Chinook, summer steelhead, and sockeye, 2016 Annual Report. Project No. 19960200.

Little Goose adult passage and spill retrospective

Introduction

An analysis was conducted to address the question of whether a change in spill to a 30% operation during selected hours of the day was "successful" or was merely a matter of chance and could not be differentiated from natural variation in adult passage that occurs at the Little Goose project. The motivation to change the operation was a discrepancy in adult passage between the Lower Monumental and Little Goose projects. Ladder counts indicated that approximately 28,000 adults had passed Lower Monumental Dam but only 20,000 had passed Little Goose Dam. The conditions in which this discrepancy occurred was during a high flow condition in the range of 180,000 cfs. The Little Goose project had only 5 of its 6 turbines operational which resulted in the project spilling up to 90,000 cfs or 50% of the project's flow. While it was not possible to reduce the spill to less than 50% during the day it was possible to shape the spill into blocks of time, during which spill would be less than 50% and at other times when spill would be in excess of 50%. The method of accomplishing this task was to use the Little Goose Reservoir to store the water during the time when a lower spill was desired and then release the water into a later period which would have a higher period of spill.

Operation

An unscheduled TMT meeting was held on June 2, to adopt a special project operation to provide a block of 40% spill during the hours of 4:00 AM to 10:00 AM. This caused the pool to raise about 1 foot above Minimum Operating Pool (MOP). This water was drafted later in the day and during nighttime hours which returned the pool to its MOP level the next morning. This procedure was repeated for three days. No change in adult passage was observed at the end of day 3.

A second unscheduled TMT meeting was held on June 5 to review the passage data and consider an alternative operation. The TMT agreed to operate the project at a level of 30% spill during the hours of 4:00 AM until 10:00 AM. The results of this operation were reviewed at the June 7, TMT meeting and an increase in adult returns was noted. The TMT elected to slightly modify the operation by changing the hours of the 30% spill operation to run from 4:00 AM until noon, an increase of 2 hours.

Methods

While the objective of increasing adult passage at the project occurred, the question remains whether this change in passage was the result of the change to 30% spill or whether this was just a random event. This question is difficult to answer without a formal study methodology. The method I adopted was to look at the frequency of sudden changes in adult passage at the Little Goose project and review adult passage during the years 2004 – 2017 to assess how frequent substantial changes in adult passage occurs and assess whether changes in spill are associated with these changes. The threshold for a change in adult passage was set at 200% and the threshold for the base number of adults was set at 200. These base numbers were selected because a "substantial" change was sought and when low numbers of adults pass (<200) variation in the percent change (<200%) can be large. Daily change in adult passage was set for the period April 15 – June 15.

Results

The results indicate that the criteria of a 200% change in adult passage did happen in 50% of the years (Table 1). Each year when the established criteria was met is summarized to assess the adult passage and spill condition that occurred when the 200% criteria was met. The spill conditions that were in place during the years when the 200% criteria was met are yellow highlighted in the attached spreadsheet. This spreadsheet needs to be opened and viewed separately to understand some of the details reported in this word document.

Table 1. Frequency of times per year adult counts at Little Goose Dam met the criteria of a change in daily passage of at least 200% when the prior day's adult count was greater than 200 fish.

Year	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004
Events	3	2	0	2	0	3	1	4	0	0	0	0	0	1

- 2017 was a high flow year, 140 kcfs for the spring season average (April 3 – June 21). There were three occasions when the 200% criteria was met and each time was associated with a decrease in spill approaching the 30% level. Although the average daily spill on the May 28 occurrence is 40%, spill occurred at the 30% level for a 6 hour block during 10:00 AM until 4:00 PM. The following day another drop in spill occurred during the hours of 11:00 AM until 5:00 PM. On June 5, the TMT managed spill program was implemented and an increase in adult passage ensued.
- 2016 had average flow of 78 kcfs for the spring season, marked by a period of high flow in the early spring, followed by a sharp drop in flow in mid-May. The 200% change in adult passage occurred twice. Both were under a 30% spill operation. The change in adult passage occurred during an orderly increase in passage through the season.
- 2014 was an average flow year, 89 kcfs for the spring season. Both increases that occurred that year were preceded by spill in excess of 30% several days prior. See spreadsheet for details. Both occurrences were during a period of increasing adult passage.
- 2012 had an average flow of 103 kcfs for the spring season. Two of the three events occurred when spill levels were reduced to 32% and 35% from higher spill levels.
- 2011 was a high flow year, 131 kcfs for the spring season. During this year, the Little Goose power house was out of service for a week long period. The day the power house was returned to service an increase in passage occurred (June 1) accompanied by a several hour block of spill in the 40 – 60 kcfs (28% - 42%) range.
- 2010 had an average flow of 76 kcfs for the spring season. Spill was in the 30% range on all of the 4 days noted. However two of the four (May 13, and May 18) events were also accompanied with the TSW being taken out of service for all or part of the day. View these events at: http://www.nwd-wc.usace.army.mil/tmt/documents/ops/spillbay/LGS_2010_05_o.html
- 2004 was a low flow year with a spring seasonal average of 70 kcfs, and spill was terminated on April 20, so any spill was involuntary. The one event occurred during a no spill period.

Conclusion

The action taken on June 5, 2017 to reduce spill to a 30% level resulted in an increase in fish passage by 295% relative to the prior day's passage. An analysis of whether fish passage increases of 200%

are common was analyzed by reviewing the prior 14 years of passage at Little Goose Dam during the April 15 to June 15 timeframe. While occurrences of 200% increases were noted, most of them were associated with a reduction of spill to the 30% level.