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MEMORANDUM

TO: Michele DeHart

FROM: FPC Staff

DATE: March 6, 2019

RE: Juvenile salmon survivals in 2018 and river conditions

   Based on your request the Fish Passage Center (FPC) utilized Comparative Survival Study (CSS) data to develop estimates of reach survivals for 2018 for the reach Lower Granite Dam to Bonneville Dam, for aggregate hatchery and wild spring/summer Chinook, as well as for aggregate hatchery and wild steelhead originating from the Snake River above Lower Granite Dam. And, for comparison, we provide similar estimates for the years 2006 to 2017 for the same reach. We also compared CSS survival estimates to those reported by NOAA.

- We estimated 2018 survival for spring/summer Chinook in the Lower Granite Dam to Bonneville Dam reach at 0.64 which is very near the average for the estimates we provide for the years 2006 to 2017, of 0.63.
- For steelhead we estimated survival from Lower Granite Dam to Bonneville Dam at 0.68 which is above the average of 0.60, for the years 2006 to 2017.
- NOAA estimates of survival were lower in 2018 than those developed by FPC and were generally lower than those FPC developed for the years 2006 to 2017.
- NOAA seasonal reach survivals, LGR to BON, use fish detected at Lower Granite Dam and McNary Dam to develop the estimate. The CSS data set uses fish released above LGR, regardless of whether they were detected at LGR and/or MCN.
- NOAA survival estimates represent fish bypassed at a minimum of one dam and possibly two, and for 2018 those fish had detection probabilities of 0.31 at LGR, and 0.045 at MCN for steelhead. The NOAA combined reach estimate LGR to BON represents a very small percentage of the total migrating steelhead population, since they used fish detected at both of these bypasses (roughly 1.4% of in-river migrants). Similarly, for yearling Chinook, the CSS estimated that 3% of the migrating population would have been bypassed at both LGR and MCN. Given this, it appears that the NOAA estimates may only be applicable for a small portion of the population and do not necessarily pertain to the run-at-large.

- Differences in estimates of LGR to BON survival between FPC and NOAA methodologies may indicate the effect of the bypasses, as the NOAA estimates are generally lower than those generated by FPC and NOAA estimates are based on fish that experienced a minimum of two bypasses (LGR and MCN).

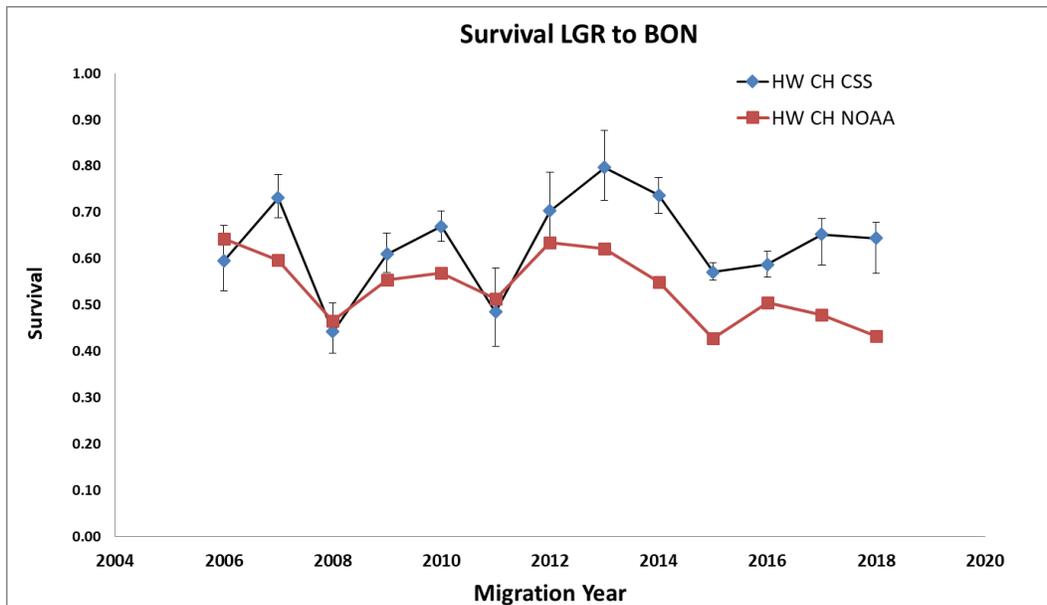**Lower Granite to Bonneville Dam seasonal reach survivals**

This an update of a previous memo http://www.fpc.org/documents/memos/7-18.pdf that reported reach survivals using CSS tags for yearling Chinook and steelhead that migrated from hatcheries as well as from wild populations originating above Lower Granite Dam. Here we added estimated survival from Lower Granite Dam to Bonneville Dam for 2018 (Table 1). To provide some context, we also estimated survival for the same groups in the year 2006 to 2017 (see Table 1). To improve fit, we included detections in the NOAA estuary trawl, recoveries of PIT-tag mortalities collected at estuary islands during the winter, and adults detected at Bonneville Dam (as available). In addition, we plotted those survivals along with reach survival estimates from NOAA (see Figures 1 and 2) (NOAA 2018). The NOAA estimates for the same reach followed a similar pattern year after year but tended, on average, to be about 7% lower than those estimated by the FPC.

The difference in survival reported by FPC and NOAA may be due to differences in the populations included in the estimates. FPC includes all hatchery and wild PIT-tagged fish from releases above Lower Granite Dam and then estimates survival through the hydrosystem to Bonneville Dam. Whereas NOAA estimates survivals in sub-reaches from Lower Granite Dam to McNary Dam and then again from McNary Dam to Bonneville Dam. NOAA then combines those estimates to provide the LGR to BON estimates. Their method uses fish detected at Lower Granite Dam to estimate the first reach. And then again requires fish detections at McNary Dam to estimate the reach for McNary Dam to Bonneville Dam. Based on estimates of detection probability at these locations the NOAA estimates likely represent a small portion of the overall in-river population. And, that population segment are fish that experienced a minimum of one bypass (and possibly two) in their migration through the reach.

The CSS estimates of detection probability at Lower Granite Dam for yearling Chinook and steelhead were 0.26 and 0.31 in 2018; while estimates of detection probability at McNary Dam were 0.12 and 0.04 in 2018 for yearling Chinook and steelhead (respectively). Based on those detection probabilities, the proportion of the migrating populations of Snake River steelhead and yearling Chinook that would have encountered the Lower Granite bypass and the McNary Dam bypass would be quite small. We estimated that the proportion of migrant juvenile Chinook that were bypassed at both Lower Granite Dam and McNary Dam would have been about 3% while for steelhead that number would have been about 1.5%. Based on this alone it appears the NOAA estimates are representing only a small fraction of the migrant populations. And those populations would encounter more powerhouses than the run-at-large. This difference may explain why the NOAA estimates are on average, lower than the CSS estimates, since powerhouse encounters are known to cause delayed mortality in juvenile migrants that can be measured in reach survivals (McCann et al. 2017).

Table 1. Reach survivals from Lower Granite Dam to Bonneville Dam, for combined hatchery and wild yearling Chinook and hatchery and wild steelhead from populations originating above Lower Granite Dam. PIT-tag estimates for the years 2006 to 2018 and the average of the years 2006 to 2017 reported for comparison to 2018.

| Migration year	Hatchery and Wild Chinook survival LGR to BON	Hatchery and Wild Steelhead survival LGR to BON
2006	0.59	0.60
2007	0.73	0.44
2008	0.44	0.43
2009	0.61	0.69
2010	0.67	0.57
2011	0.48	0.52
2012	0.70	0.83
2013	0.80	0.72
2014	0.74	0.69
2015	0.57	0.54
2016	0.59	0.53
2017	0.65	0.67
2018	0.64	0.68
Average (2006 to 2017)	0.63	0.60

Figure 1. Estimated survival from Lower Granite Dam to Bonneville Dam for hatchery and wild spring/summer Chinook of Snake River origin. CSS spring/summer Chinook included only fish marked above Lower Granite Dam, while NOAA reach estimates include fish either detected or marked at Lower Granite Dam (for survival LGR to MCN), combined with fish detected at McNary Dam (for survival MCN to BON); the two reaches were then combined to generate the LGR to BON estimates. Error bars represent 95% confidence intervals (non-parametric).
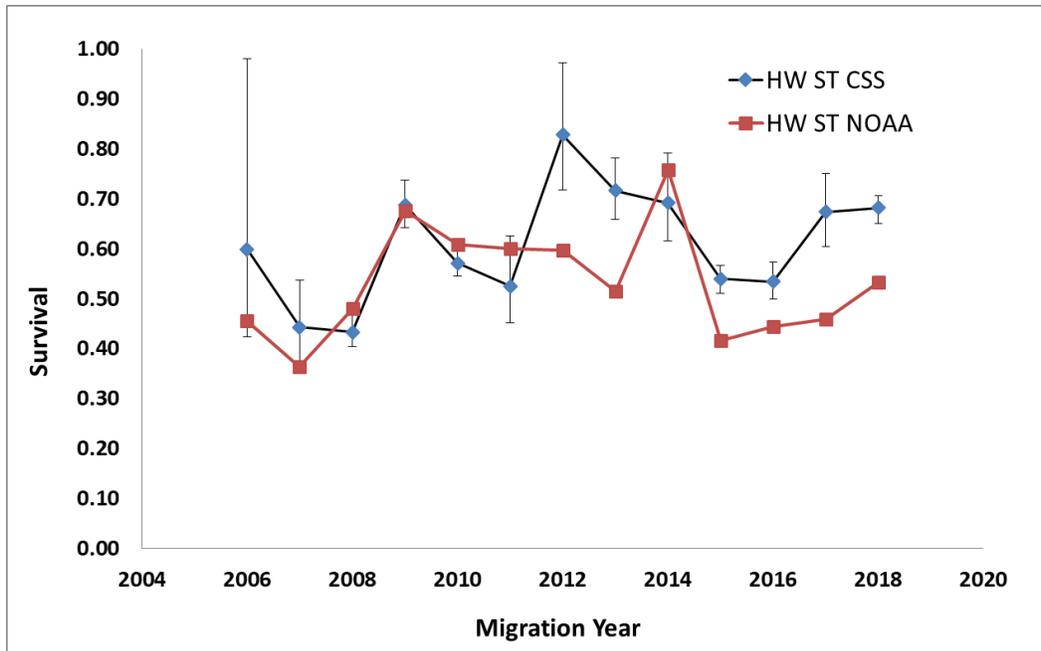
Figure 2. Estimated survival from Lower Granite Dam to Bonneville Dam of hatchery and wild steelhead from the Snake River. CSS steelhead included only fish marked above Lower Granite Dam, while NOAA reach estimates include fish either detected or marked at Lower Granite Dam (for survival LGR to MCN), combined with fish detected at McNary Dam (for survival MCN to BON); the two reaches were then combined to generate the LGR to BON estimates. Error bars represent 95% confidence intervals (non-parametric).

2018 Flow and Spill Conditions

In 2018, flows in the Snake River were near the ten-year average for spring migrant smolts. In the Middle Columbia River flows were sufficiently high throughout May and into early June that uncontrolled spill events occurred at all of the Mid-Columbia (McNary down to Bonneville dams) projects from late April through early June. In addition, based on a U.S. District Court of the District of Oregon order, dams were all operated to the 115%/120% standard for TDGS. The combination of high flows and court ordered spill resulted in relatively high spill volumes for spring migrant salmon. May flows in the Snake River were above the ten-year average. Runoff in the Middle Columbia was much higher than the ten-year average with a sustained peak from about May 10 to May 28 (Figure 3). During this time, total dissolved gas (TDG) levels were well above waiver levels, sometimes as high as 130% at some forebay monitors and just above 134% at some tailrace monitors.
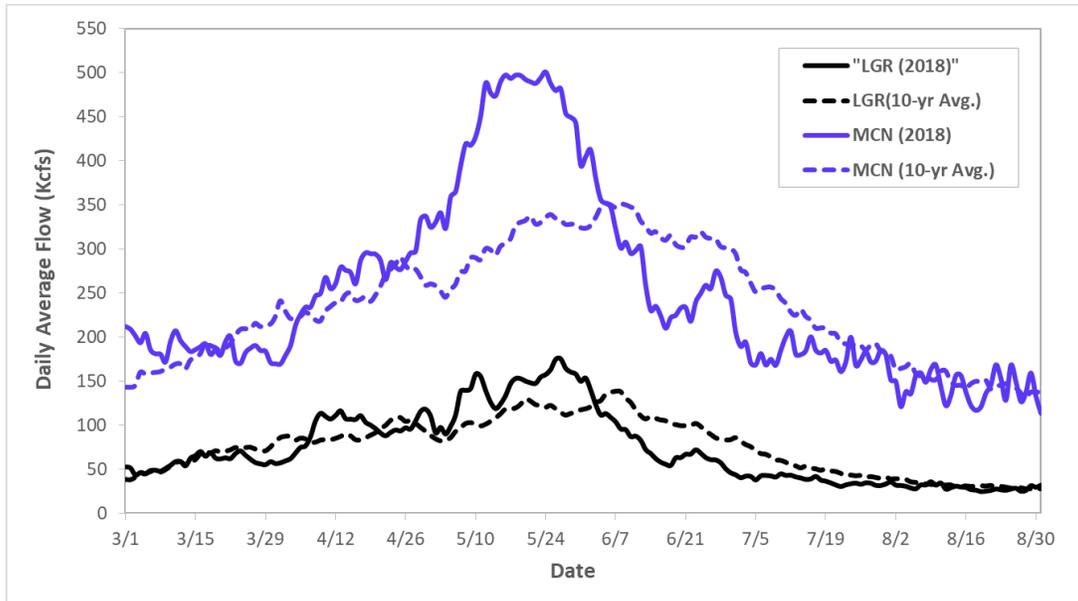
Figure 3. Daily average flow at Lower Granite and McNary dams in 2018 compared to 10-year average (2008-2017)

Literature Cited

McCann, J., B. Chockley, E. Cooper, B. Hsu, S. Haeseker, R. Lessard, C. Petrosky, T. Copeland, E. Tinus, A. Storch, and D. Rawding. 2018. Comparative Survival Study (CSS) of PIT tagged Spring/Summer Chinook and Summer Steelhead. 2018 Annual Report. Project No. 199602000. http://fpc.org/documents/CSS/2018_Final_CSS.pdf (December 2018).

NOAA. 2018. Preliminary survival estimates for the passage of spring-migrating juvenile salmonids through Snake and Columbia River dams and reservoirs, 2018. September 19, 2018.