FISH PASSAGE CENTER

847 NE 19th Ave., Suite 250, Portland, OR 97213

Phone: (503) 833-3900 Fax: (503) 232-1259

http://www.fpc.org/

e-mail us at fpcstaff@fpc.org

MEMORANDUM

TO: Ed Bowles (ODFW)

FROM: FPC Staff

DATE: February 22, 2018

RE: Juvenile salmon survivals in 2017 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 aggregate hatchery and wild spring/summer Chinook, as well as for hatchery and wild steelhead originating from the Snake River for 2017. And, for comparison, we provide similar estimates for the years 2006 to 2016 for the same reach.

- We estimated survival for spring/summer Chinook in the Lower Granite Dam to Bonneville Dam reach at 0.61 which is very near the average for the estimates we provide for the years 2006 to 2016, of 0.62.
- For steelhead we estimated survival from Lower Granite Dam to Bonneville Dam at 0.67 which is above the average of 0.60, for the years 2006 to 2016.
- NOAA estimates of survival were lower in 2017 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.
- NOAA survival estimates represent fish bypassed at two dams, with detection probabilities of 0.28 at LGR, and 0.06 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 2% of in-river migrants). Similarly, for yearling Chinook, the CSS estimated that 2% of the migrating population would have been bypassed at both LGR and MCN.
- Cohort reach survivals were also estimated for yearling spring/summer Chinook and steelhead in the Lower Granite Dam to McNary Dam and McNary Dam to Bonneville Dam reaches.

- In all cases the observed estimates were very similar to CSS model predicted survivals based on flow and spill conditions in 2017.
- Cohort reach survivals were near or above average for all cohorts.
- High survivals and rapid fish travel times reflected the relatively good river conditions in 2017. Water transit times were very short in 2017 while dam encounter rates were well below average for Snake River cohorts.

2017 Flow and Spill Conditions

Flows in the Snake and Middle Columbia rivers were sufficiently high throughout most of the spring that uncontrolled spill events occurred at all projects for at least some period. As a result of the high runoff volumes in the Snake and Middle Columbia rivers, spill levels in the spring were generally above those prescribed by the Biological Opinion (BiOp). Runoff in the Snake River was early, with three peak flow periods; one in mid- to late March at about 180-190 Kcfs, one in early May at about 170-180 Kcfs, and one in early June at about 160-180 Kcfs (Figure 1). Late spring and early summer flows (mid-June through July 1st) in the Snake River were above the ten-year average. Runoff in the Middle Columbia was also early, with two peak flow periods; one in mid- to late March at about 380-460 Kcfs and one in mid-May to mid-June also at about 380-460 Kcfs (Figure 1). Late spring flows were above the ten-year average. During this time, total dissolved gas (TDG) levels were above waiver levels, sometimes as high as 130% at some forebay monitors and just above 135% at some tailrace monitors.

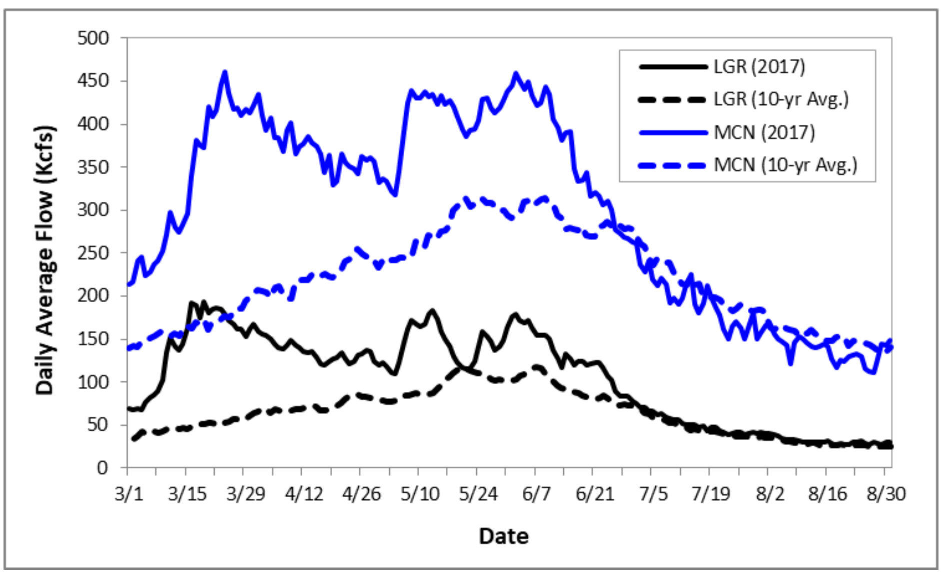

Figure 1. Daily average flow at Lower Granite and McNary dams in 2017 compared to 10-year average (2007-2016)

Effects of Spill on Gas Bubble Trauma

In all, 11,670 juvenile salmonids were examined for GBT between April and August of 2017 at FCRPS projects (Table 1). Fin signs were found in 161 (1.38%) of the total fish examined at FCRPS sites. Of the 161 fish that exhibited signs of fin GBT in 2017, 139 (86.3%) had a maximum fin ranking of 1, where less than 5% of a fin area was covered with bubbles. A total of five fish (3.1%) had signs of severe GBT (Rank 3 or 4), where >26% of a fin area was covered with bubbles. The five fish with severe GBT were encountered at Bonneville (two) and Lower Monumental (three) dams.

Table 1. Number of juveniles examined for and number of juveniles found with signs of fin GBT between April and August of 2017 at FCRPS projects, as part of the Smolt Monitoring Program.

Species	BON	MCN	LMN	LGS	LGR	Total
Total Examined	3,124	3,300	1,699	1,951	1,596	11,670
Total with Signs of Fin GBT	72	4	44	21	20	161

The action criteria for GBT is established as 15% of fish showing any signs of fin GBT, or 5% of the fish sampled showing signs of fin GBT greater than or equal to rank 3 (>26% of fin area covered with bubbles). When the action criteria is met, fisheries managers are required to take measures to reduce TDG by reducing spill. Despite very high flows and spill in 2017 gas bubble trauma incidence only exceeded the action criteria once in 2017. On May 11 over 20% of the smolts examined for GBT at Lower Monumental Dam showed signs. During the occurrence at Lower Monumental Dam, flows in the Snake River exceeded hydraulic capacities at all projects and voluntary spill could not be curtailed. The criterion of 5% severe GBT was never met in 2017.

Over the last twenty-three years, the GBT Monitoring Program has collected data over a wide range of TDG conditions, particularly given the amount of time that involuntary spill has been provided. In fact, over the historic record, observations have occurred at tailwater TDG levels as high as 140%. This has allowed for an assessment of the impacts of TDG on the salmonid population over a wide range of tailwater TDG conditions at FCRPS projects. The FPC recently assessed these historic GBT data in our 2017 Annual Report to the Oregon Department of Environmental Quality (FPC 2017).

Over the last twenty-three years, 2,771 GBT samples met our criterion of ≥75 fish examined for this assessment. Of these 2,771 GBT samples, there have been only 35 instances when the 15% GBT action criterion was met or exceeded (Figure 2). Of those 35 instances, five (open circles in Figure 2) (14.3%) can be attributed to late migrating steelhead smolts in 2002 and 2007. At the time these steelhead smolts were collected at Little Goose Dam approximately 98% of the juvenile steelhead migrating that year had already passed this project. These late migrating fish were observed in the forebay of the dam on the surface, had prolonged migration times, and were likely residualizing (FPC 2007a, FPC 2007b). These fish may be considered anomalous, and were likely present due to the very low flow conditions that occurred those years. In addition, three of the 35 instances (8.6%) where the 15% GBT action criterion was met or exceeded occurred when tailrace TDG was between 120% and 125%. Finally, 27 of the 35 instances

(77.1%) where the 15% GBT action criterion was met or exceeded occurred when tailrace TDG were greater than 125%.

It is also worth noting that, of the 2,771 GBT samples that met our sample size criterion for this assessment, 303 (11%) had corresponding tailrace TDG levels of ≥125% (Figure 2). Of these 303 samples where associated tailrace TDG levels were ≥125%, only 27 (8.9%) had GBT incidence rates of ≥15%. This indicates that the 15% GBT action criterion is generally not triggered at tailrace TDG levels of less than 120% and rarely triggered at tailrace TDG levels above 125%.

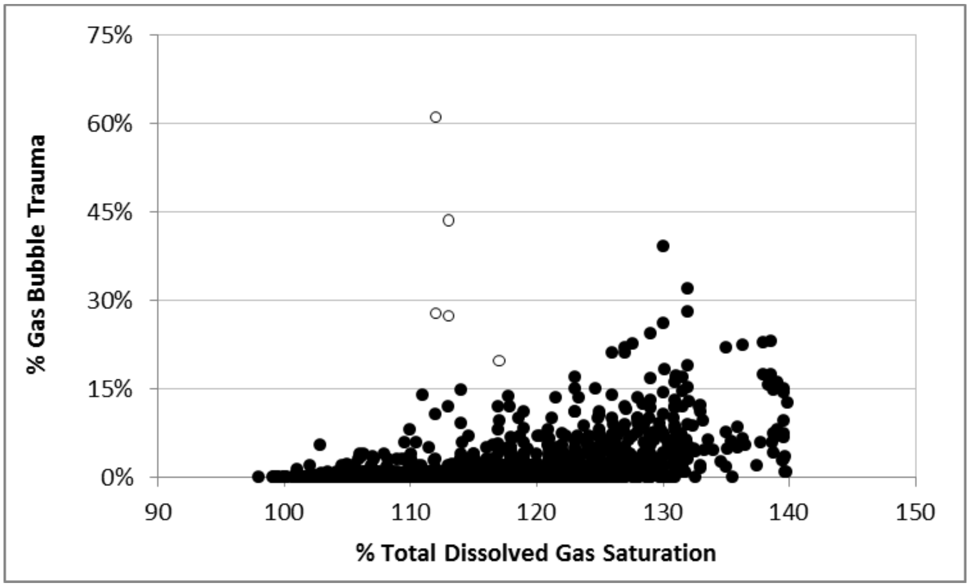

Figure 2. Fin GBT incidence rate (%) at FCRPS projects as a function of the 12-hour average TDG from the upstream tailrace monitor. Tailrace TDG is offset by estimates water transit time from upstream project to project where GBT sample was conducted.

Lower Granite to Bonneville Dam seasonal reach survivals

Using CSS tags for yearling Chinook and steelhead that migrated from hatcheries as well as from wild populations of above Lower Granite Dam, we estimated survival from Lower Granite Dam to Bonneville Dam for 2017. To provide some context for the 2017 estimates, we also estimated survival for the same groups in the year 2006 to 2016. In addition, we plotted those survivals along with similar estimates from NOAA (see Figures 3 and 4). The NOAA estimates for the same reach followed a similar pattern year after year but tended, on average, to be about 6% lower than those estimated by the FPC.

For hatchery and wild yearling Chinook, NOAA estimated LGR to BON survival in 2017 to be 0.48 compared to the FPC estimate of 0.61. Similarly, the NOAA estimate for steelhead reach survival (LGR to BON) in 2017, was 0.46 compared to the FPC estimate of 0.67. In both cases the NOAA estimates were well below the FPC estimates.

By comparison, NOAA combines LGR to MCN reach estimates with MCN to BON estimates to obtain LGR to BON seasonal reach survival estimates. The NOAA method requires fish to be bypassed at LGR and/or MCN to be part of the full reach survival. Since bypass proportions at these dams are low, the population included in their estimates represent a low proportion of the overall population. Caution should be used in making inference to the full population seasonal survival from the combination of these component reach estimates. The FPC used fish released above Lower Granite Dam to produce our annual estimates of LGR to BON survival. From those estimates, the FPC estimated detection probabilities at LGR to be 0.21 for yearling Chinook and 0.28 for steelhead. At McNary the FPC estimated detection probability to be 0.10 for yearling Chinook and 0.06 for steelhead. Since the NOAA estimates condition fish being seen at the upper dam in each reach, the effective proportion of the population their models represent are very low. Their combined seasonal estimates would represent only about 2% of the total population passing LGR to BON.

Lower Granite Dam to Bonneville Dam survival estimates in 2017 were difficult to obtain for steelhead by using the standard methods used by FPC, likely due to low sample sizes and low detection probability at Bonneville Dam and at the estuary PIT-tag detecting trawl. To improve survival fit for 2017 cohorts, we increased the sample of fish detected below Bonneville Dam by including PIT-tag mortalities collected at estuary islands during the winter. Using the estuary PIT-tag mortalities allowed us to estimate survival in the final segment of the reach (from John Day to Bonneville Dam).

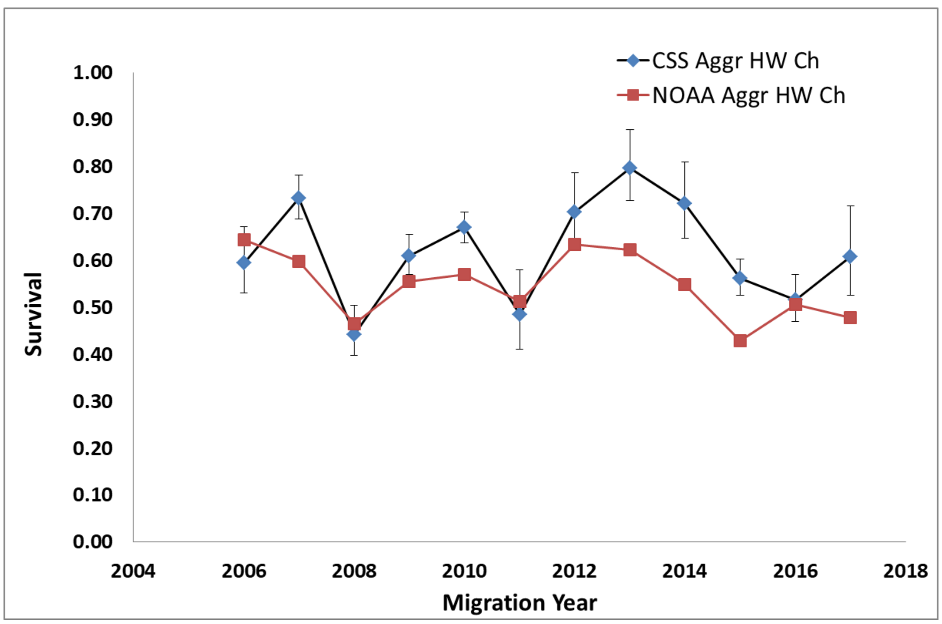

Figure 3. Estimated survival from Lower Granite Dam to Bonneville Dam for hatchery and wild spring/summer Chinook of Snake River origin. CSS spring/summer Chinook included only fish marked above Lower Granite Dam, while NOAA reach estimates include fish either detected or marked at Lower Granite Dam (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.

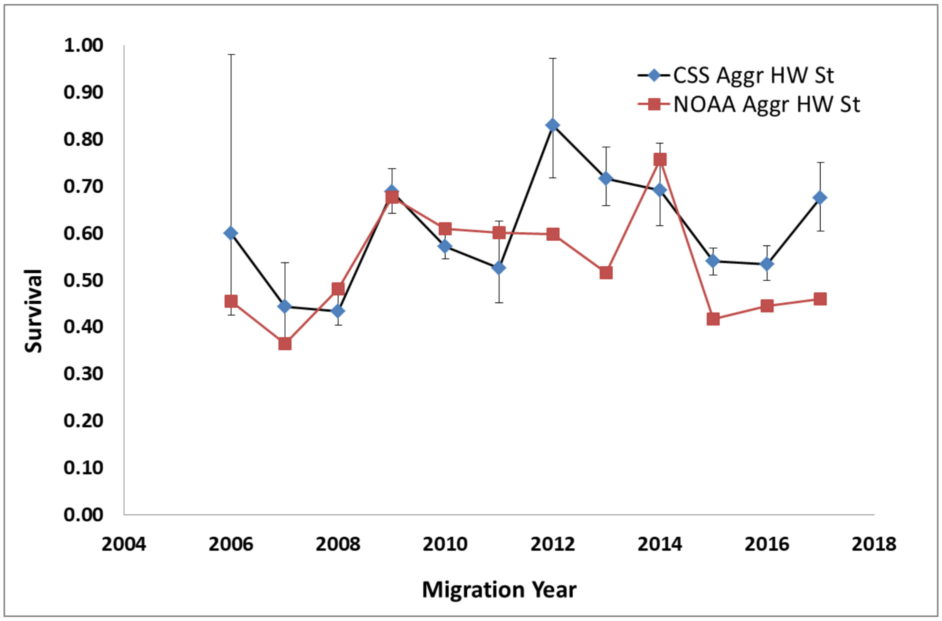

Figure 4. Estimated survival from Lower Granite Dam to Bonneville Dam of hatchery and wild steelhead from the Snake River. CSS steelhead included only fish marked above Lower Granite Dam, while NOAA reach estimates include fish either detected or marked at Lower Granite Dam (for survival LGR to MCN), 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.

Lower Granite Dam to McNary Dam Reach Cohort Survivals

Cohort reach survivals were also estimated for yearling Chinook and steelhead detected at the upper dam in each reach. The methods used for these estimates are consistent with the methods used in the FPC and CSS Annual reports. Cohorts are based on PIT-tag fish detected at the upstream dam in the reach. Estimated survival for the cohorts can then be paired with environmental variables, based on cohort fish travel time, to evaluate effects of environmental factors, such as flow and dam operations. The CSS has developed a dam encounter rate indicator variable called PITPH that has been used to evaluate the relative number of powerhouse encounters that cohorts encounter while passing through a reach. Also, flow through the reservoirs is represented by water transit time (WTT), the time it takes the average water particle to pass through a series of reservoirs. We present those variables in this analysis to provide an indication of the river conditions in 2017 relative to other years analyzed for cohorts. The combination of WTT and PITPH, along with other environmental variables, has been used by CSS to predict survival for these cohorts (see CSS Annual Report 2017). Those two metrics, WTT and PITPH, have been found to be important in explaining the variability in reach survivals for juvenile salmon.

Steelhead

Reach survivals for hatchery and wild steelhead in the LGR to MCN reach ranged between 0.69 and 0.82 (Table 2). Fish travel times (FTT) for steelhead averaged between

7.8 and 5.4 days. Dam encounter rates, as measured by PITPH, ranged between 0.87 and 0.41.

Table 2. Cohort survival and travel time data for hatchery and wild steelhead in the Lower Granite Dam to McNary Dam reach in 2017.

Cohort Dates at LGR	Survival	Fish Travel Time	Water Transit Time	PITPH
4/17-4/23	0.81	7.8	6.9	0.87
4/24-4/30	0.82	7.6	7.1	0.73
5/1-5/7	0.76	7.5	5.9	0.41
5/8-5/14	0.82	5.7	5.4	0.49
5/15-5/21	0.72	6.3	6.8	0.74
5/22-5/28	0.69	5.4	5.9	0.82

Survivals for steelhead in the LGR to MCN reach were relatively high in 2017, and fish travel times were relatively rapid compared to other recent years (Figure 5). The upper left corner position of 2017 estimates of FTT by survival data points (indicated by yellow boxes) in Figure 5 indicates relatively high survival combined with relatively rapid travel times in 2017 compared to other years.

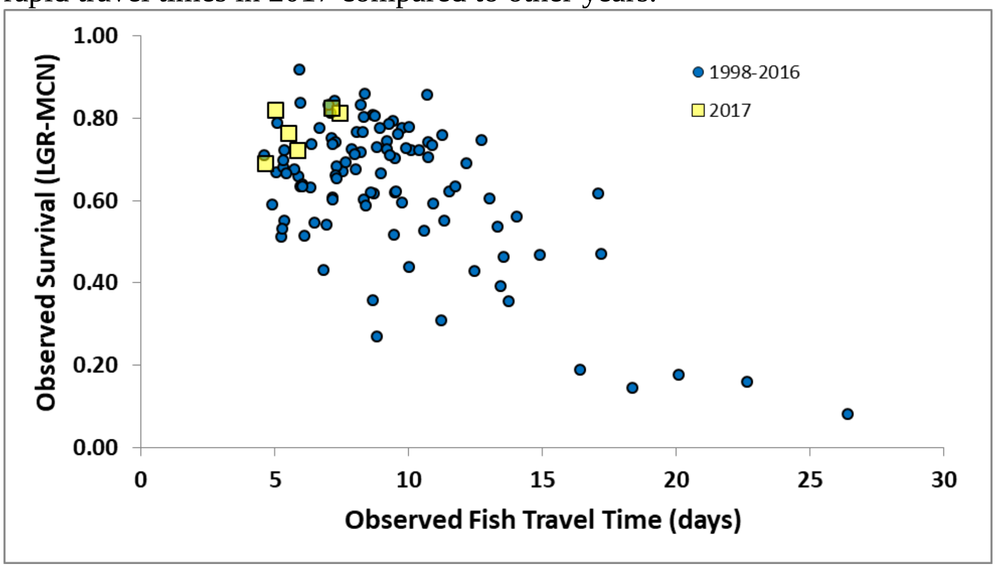

Figure 5. Observed survival and fish travel time for steelhead in the LGR to MCN reach. Estimates for 2017 are the yellow boxes.

Using the indicator variables PITPH and WTT (as well as other environmental factors) the FPC predicted survival and travel time for steelhead in the LGR to MCN reach in 2017, using the CSS steelhead survival model (Figures 6 and 7). As can be seen from the figures, estimated survivals for the cohorts were very similar to the predicted values (Figure 6). Similarly, estimated FTT in the reach were very similar to what was predicted by the CSS model (Figure 7).

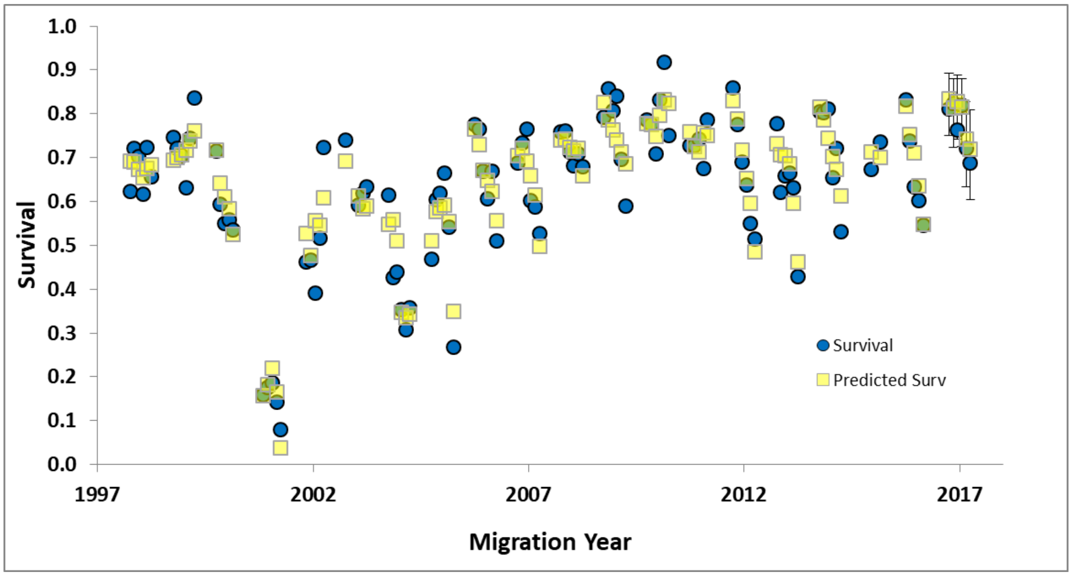

Figure 6. Predicted compared to observed survival for steelhead in the LGR to MCN reach in the years 1998 to 2017. Blue circles indicate observed survival estimates while yellow boxes indicate predicted survivals.

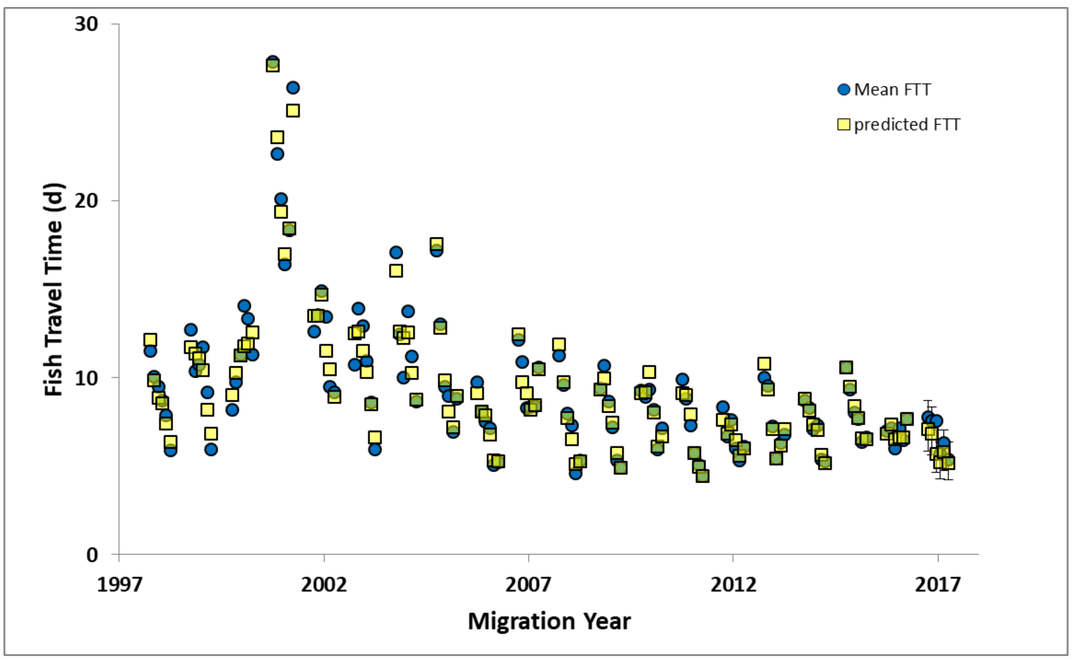

Figure 7. Predicted compared to observed fish travel times (in days) for steelhead, in the LGR to MCN reach in the years 1998 to 2017. Blue circles indicate observed FTT estimates while yellow boxes indicate predicted FTT.

A plot of the WTT and PITPH that steelhead encountered in 2017 compared to the years 1998 to 2016 is shown in Figure 8. As can be seen in the figure, both WTT and PITPH values were relatively low for steelhead in 2017 indicating relatively good juvenile migration conditions.

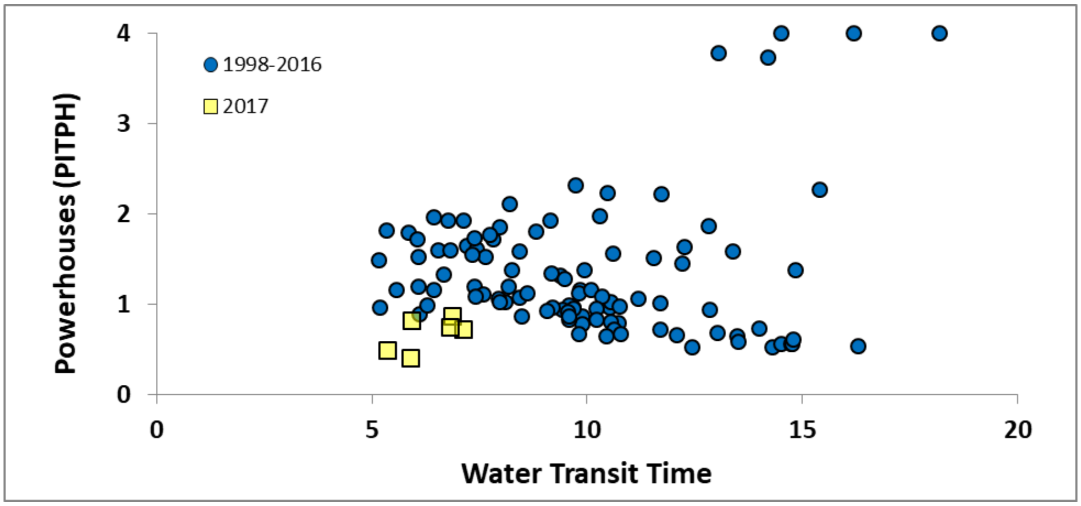

Figure 8. Water Transit Time and PITPH (Powerhouse encounter rate) estimates for steelhead cohorts in the LGR to MCN reach for the years 1998 to 2017.

Hatchery Yearling Chinook

Reach survivals for hatchery spring/summer Chinook in the LGR to MCN reach ranged between 0.57 and 0.82 (Table 3). Fish travel times for yearling Chinook averaged between 18.6 and 7.4 days. Dam encounter rates, as measured by PITPH, ranged between 1.06 and 0.56.

Table 3. Cohort survival and travel time data for hatchery and wild steelhead in the Lower Granite Dam to McNary Dam reach in 2017.

Cohort Dates at LGR	Survival	Fish Travel Time	Water Transit Time	PITPH
4/1-4/7	0.57	18.6	6.8	1.06
4/8-4/14	0.75	14.3	6.9	1.08
4/15-4/21	0.80	11.1	6.9	1.01
4/22-4/28	0.82	9.9	7.1	0.83
4/29-5/5	0.75	8.9	5.8	0.56
5/6-5/12	0.82	7.4	5.4	0.69

As with steelhead, the FPC utilized the CSS models to predict yearling Chinook reach survivals and FTT based on the indicator variables, PITPH and WTT, as well as other environmental factors. The FPC predicted survivals are compared to observed survival estimates in Figure 9. Predicted fish travel times were compared to observed FTT (Figure 10). For yearling Chinook the observed and predicted travel times were very similar.

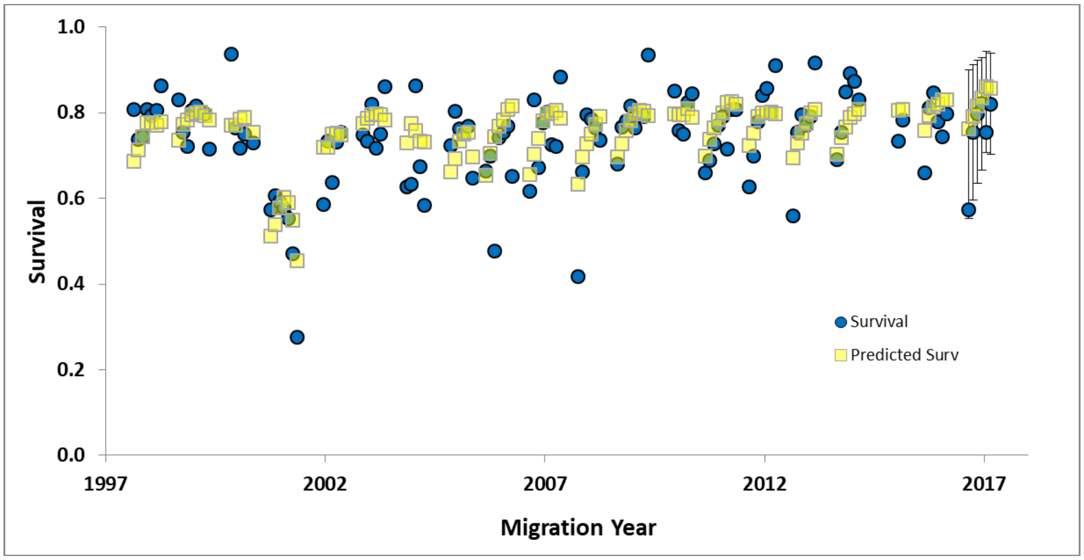

Figure 9. Predicted compared to observed survival for yearling Chinook in the LGR to MCN reach in the years 1998 to 2017. Blue circles indicate observed survival estimates while yellow boxes indicate predicted survivals.

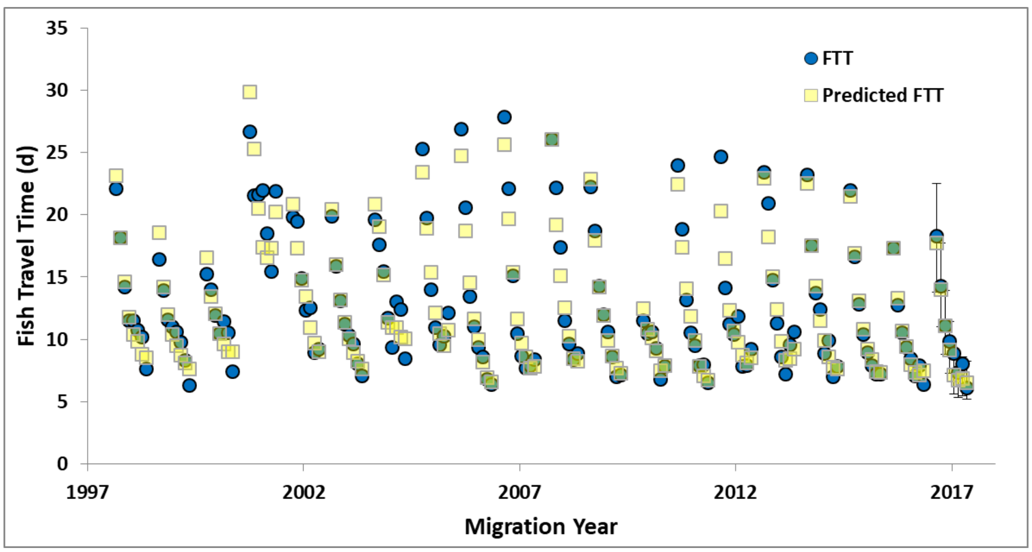

Figure 10. Predicted compared to observed fish travel times (in days) for yearling Chinook, in the LGR to MCN reach in the years 1998 to 2017. Blue circles indicate observed FTT estimates while yellow boxes indicate predicted FTT.

A plot of the WTT and PITPH that yearling Chinook encountered in 2017 compared to the years 1998 to 2016 is shown in Figure 11. As can be seen in the figure, similar to steelhead cohorts in this reach, both WTT and PITPH values were relatively low for hatchery yearling Chinook in 2017, indicating relatively good juvenile migration conditions.

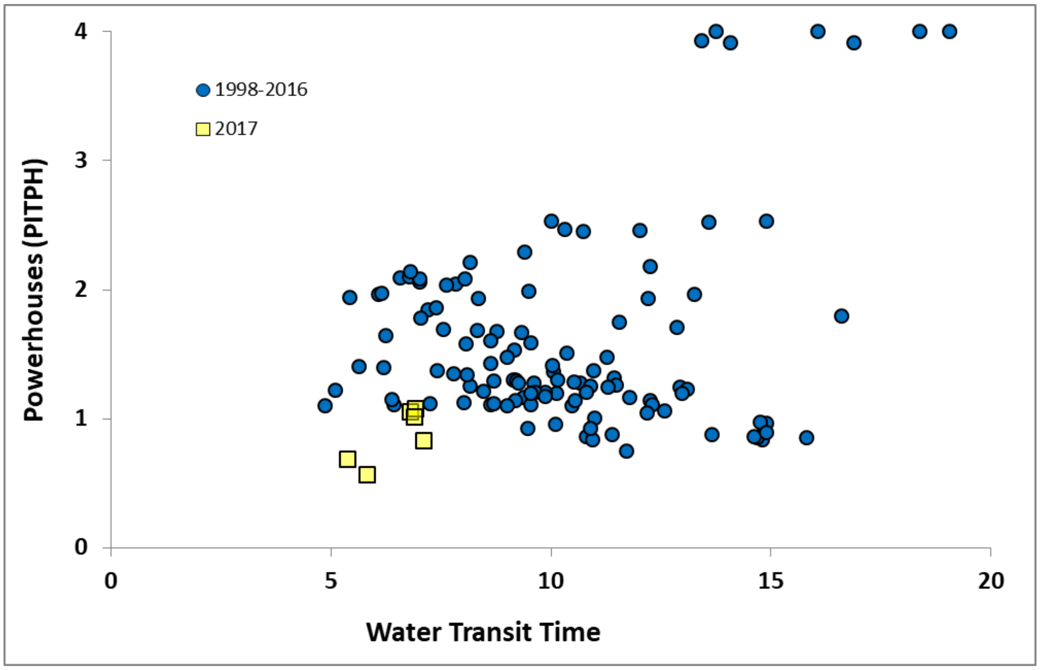

Figure 11. Water Transit Time and PITPH (Powerhouse encounter rate) estimates for yearling Chinook cohorts in the LGR to MCN reach for the years 1999 to 2017.

McNary Dam to Bonneville Dam Reach Cohort Survivals

Cohort survival estimates in 2017, in the McNary Dam to Bonneville Dam reach, were difficult to obtain by standard methods used by FPC. This was likely due to low sample sizes and low detection probability at Bonneville Dam and at the estuary PIT-tag detecting trawl. To improve survival fit for 2017 cohorts, we increased the sample of fish detected below Bonneville Dam by including PIT-tag mortalities collected at estuary islands during the winter. This allowed more data for estimating detection probability at Bonneville Dam. In the case of yearling spring/summer Chinook cohorts, estimates were still not converging. The FPC typically uses the program Mark with identity link structure in the model. This allows survivals to fluctuate freely (and in some cases go above 1) and allows variance inflation using chi-square test results. For those estimates, a logit link was used in program Mark, which limits survival estimates in individual reaches to less than 1. That method proved useful for estimating yearling Chinook cohort survivals in the McNary Dam to Bonneville Dam reach in 2017. We will continue to explore enhancing our survival methods to provide estimates in years with low detection rates at John Day Dam, Bonneville Dam, and the estuary trawl.

Steelhead

Reach survivals for hatchery and wild steelhead in the MCN to BON reach were 0.71 and 0.78 for the two survival cohorts (Table 4). Fish travel times for steelhead averaged 3.9 and 3.5 days for the two cohorts. The reach survivals estimates for steelhead in the MCN to BON are plotted in relation to FTT through the reach (Figure 12). Fish travel times were relatively rapid in 2017, as illustrated in Figure 12 and Figure 14. Steelhead survivals in 2017 were above the average for all the cohorts in the time series (Figure 13).

Dam encounter rates for the two survival cohorts, as measured by PITPH, were 0.83 and 0.79 (Table 4). Powerhouse encounters (PITPH) were near average for the two survival cohorts. Years with high flows, such as 2017, typically have high powerhouse discharge, and that increases the likelihood of fish passing via powerhouse, despite relatively high spill discharge at the dams. As a result, in high flow years, powerhouse encounter rates (PITPH values) are higher than what is observed in low flow years.

Table 4. Cohort survival and travel time data for hatchery and wild steelhead in the McNary Dam to Bonneville Dam reach in 2017.

Cohort Dates at MCN	Survival	Fish Travel Time	Water Transit Time	PITPH
4/27-5/17	0.71	3.9	4.1	0.83
5/18-6/07	0.78	3.5	3.9	0.79

Figure 13 presents observed survivals in comparison to the predicted survival in 2017 based on conditions in the reach during the cohort migration; with WTT and PITPH being two important variables in that estimate. Observed survival estimates are near the predicted values for the 2017 cohorts based on CSS models. Similarly, observed FTT values for 2017 cohorts are very similar to predicted values (Figure 14).

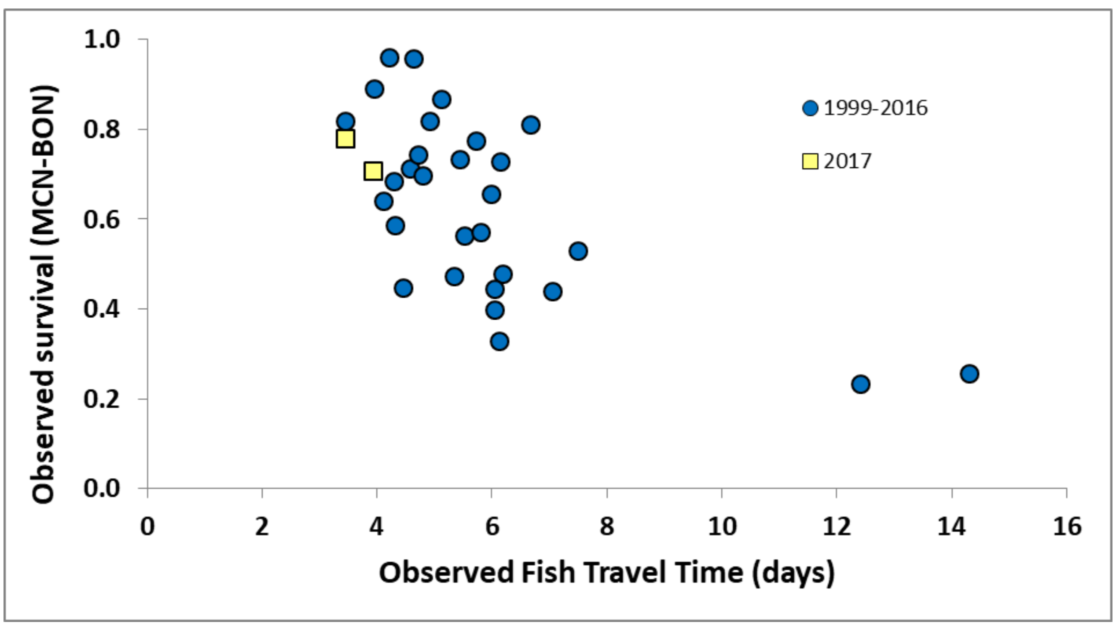

Figure 12. Observed survival and fish travel time for hatchery and wild steelhead in the MCN to BON reach. Estimates for 2017 are the yellow boxes.

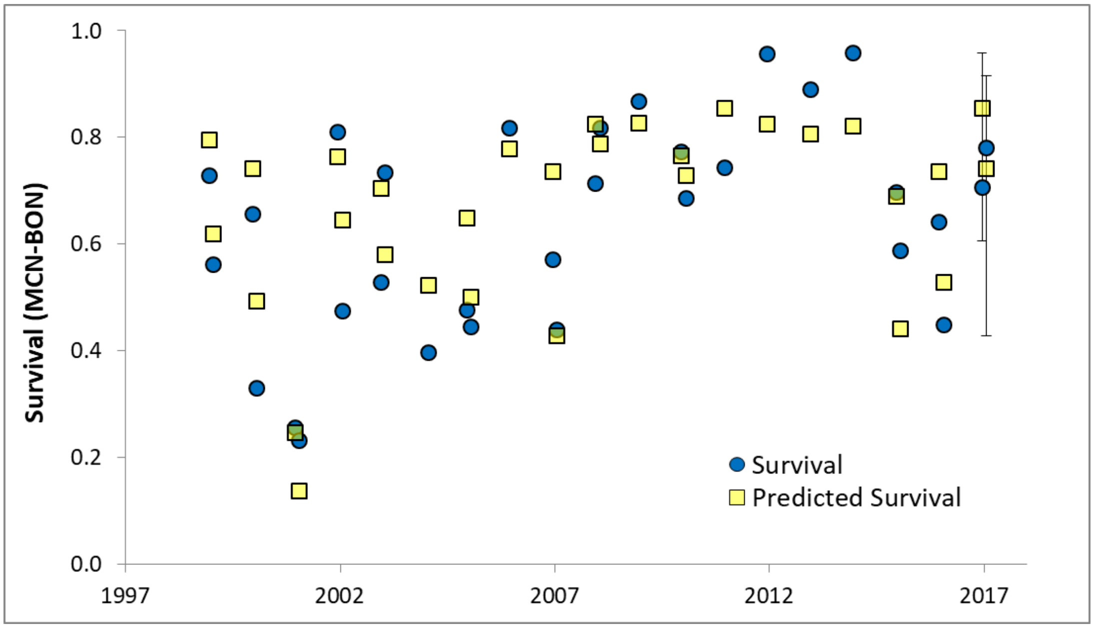

Figure 13. McNary to Bonneville Dam survival for hatchery and wild steelhead. Estimated survivals are represented by blue circles while model predicted survivals are shown as yellow squares.

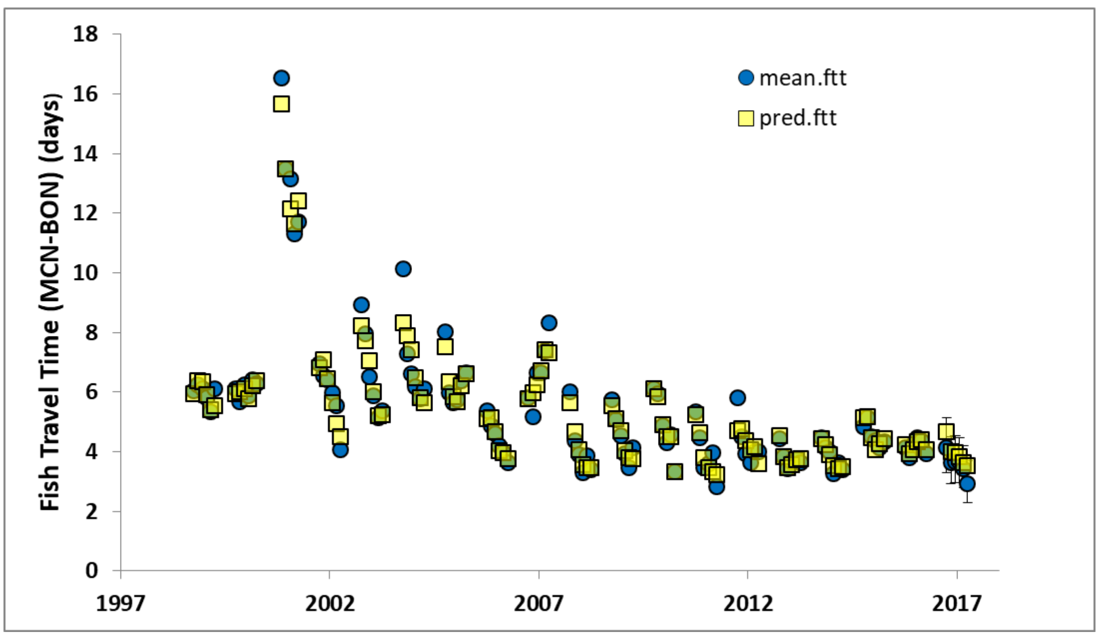

Figure 14. Travel Time in the MCN to BON reach for hatchery and wild steelhead for the years 1999 to 2017. Estimated mean travel times are represented by blue circles while model predicted travel times are shown as yellow squares.

A plot of the WTT and PITPH that steelhead cohorts encountered in 2017 compared to the years 1998 to 2016, is shown in Figure 15. As can be seen in the figure, WTT values were relatively rapid for steelhead in 2017 indicating relatively good juvenile migration conditions.

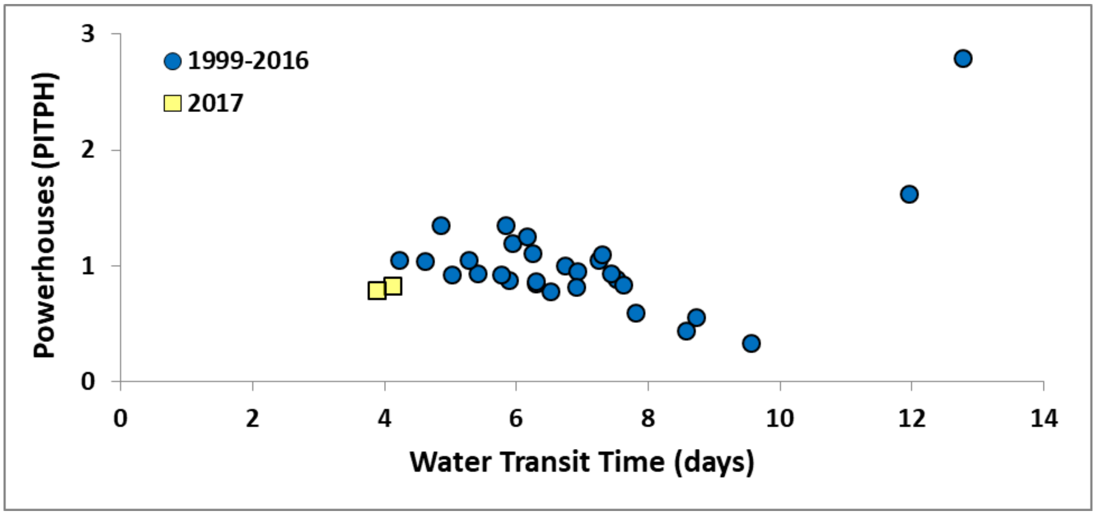

Figure 15. Water Transit Time and PITPH estimates for steelhead cohorts in the MCN to BON reach for the years 1999 to 2017.

Yearling Chinook

Cohort survivals for yearling Chinook in the MCN to BON reach were estimated at 0.72 and 0.77 (Table 5). Fish travel times for the survival cohorts were 3.8 and 3.4 days. The reach survivals estimates for yearling Chinook are plotted in relation to FTT through the reach (Figure 16). As can be seen in the figure, fish travel times were relatively rapid in the high flow year whereas survivals were near average. A plot of the WTT and PITPH that yearling Chinook cohorts encountered in 2017 compared to the years 1998 to 2016, is shown in Figure 19.

Figure 17 presents observed survivals in comparison to the predicted survivals based on conditions in the reach during the cohort migration; with WTT and PITPH being two important variables in that estimate. Survival estimates were near the predicted values for these cohorts based on CSS models.

Fish travel times, were relatively rapid in 2017 as illustrated in figures 16 and 18. Travel times were 3.4 and 3.8 days for the two survival cohorts. Observed FTT were similar to predictions for 2017 (Figure 18).

Table 5. Cohort survival and travel time data for hatchery and wild yearling Chinook in the McNary Dam to Bonneville Dam reach in 2017.

Cohort Dates at MCN	Survival	Fish Travel Time	Water Transit Time	PITPH
4/25-5/08	0.72	3.8	4.0	0.84
5/09-5/22	0.77	3.4	3.8	0.83

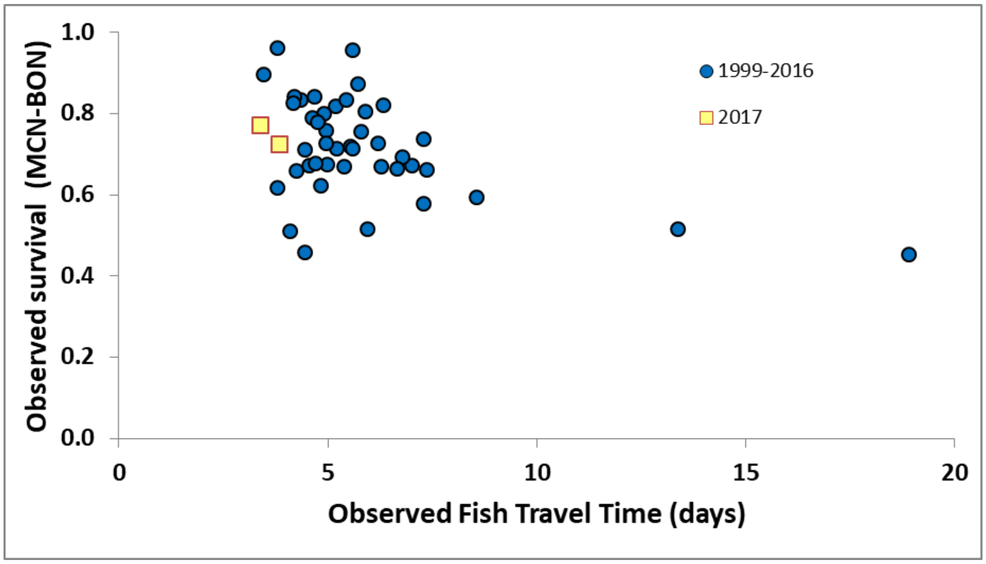

Figure 16. Observed survival and fish travel time for hatchery and wild yearling Chinook in the MCN to BON reach. Estimates for 2017 are the yellow boxes.

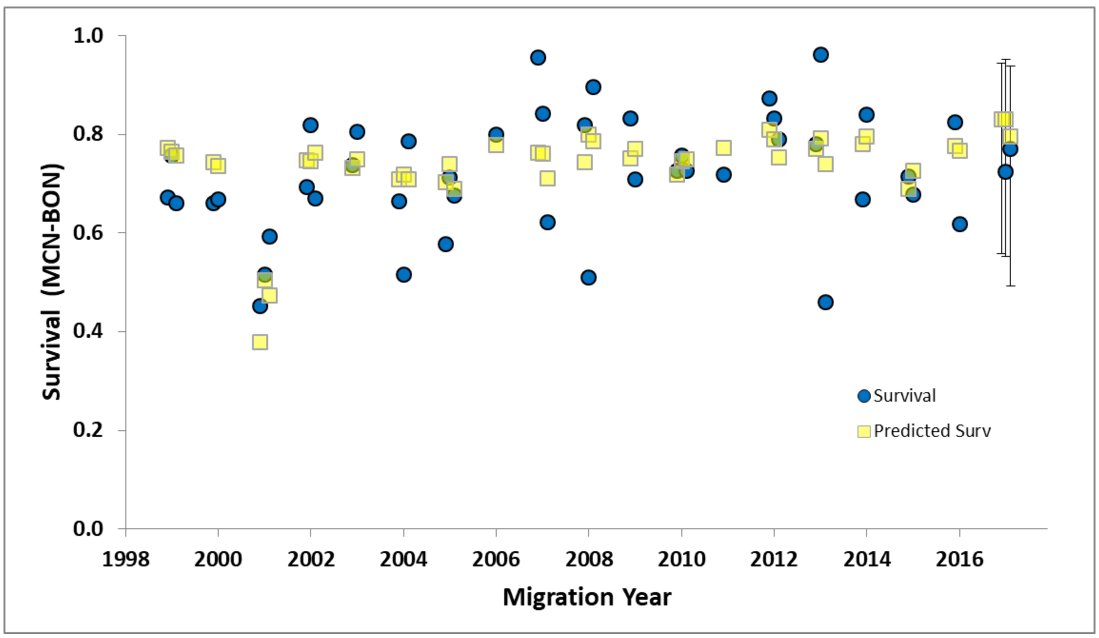

Figure 17. McNary to Bonneville Dam survival for hatchery and wild yearling Chinook. Estimated survivals are represented by blue circles while model predicted survivals are shown as yellow squares.

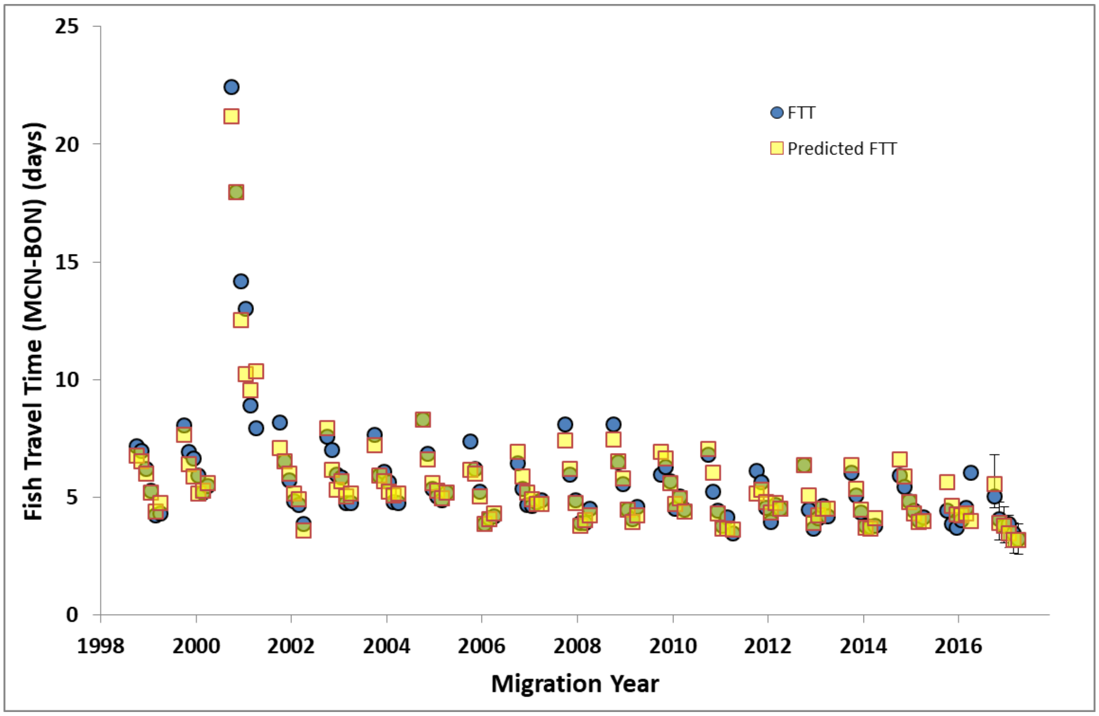

Figure 18. Travel Time in the MCN to BON reach for hatchery and wild yearling Chinook for the years 1999 to 2017. Estimated mean travel times are represented by blue circles while model predicted travel times are shown as yellow squares.

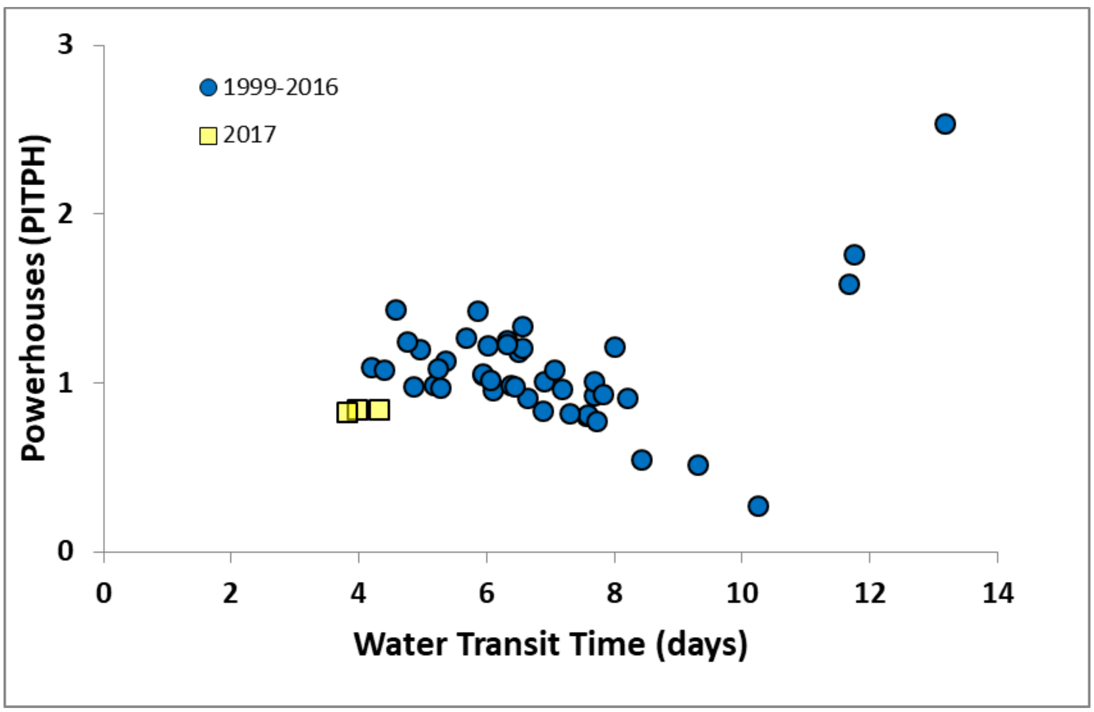

Figure 19. Water Transit Time and PITPH estimates for yearling Chinook cohorts in the MCN to BON reach for the years 1999 to 2017.

Bypass Mortality Events in 2017

High flow years are usually accompanied by high amounts of woody debris caused by flooding in tributaries that delivers large amounts of floating debris into the hydro-system. In 2017, debris in the bypass systems caused systems in some cases to malfunction; causing plugged orifices, poor gatewell conditions and debris jams in the bypass facilities. Below are some of the most notable juvenile salmon mortality events that occurred in the bypasses at dams in the Lower Snake River and Middle Columbia River in 2017. In the incidents listed below, over 12,000 juvenile salmonids mortalities were estimated/counted in the juvenile bypass facilities at these four dams during the 2017 spring migration.

- **Lower Monumental Dam, Beginning March 31**; The orifice appeared to be free of debris at 0640 and was cycled again. This action released a large collection of debris and approximately 250 fish mortalities into the collection channel. Another inspection of the gatewells and orifices immediately following this event resulted in no apparent problems/blockages. The next inspection of the orifice gallery around 0930 revealed an additional obstruction at the same orifice (number 15). The Project Biologist responded quickly and inspected gatewell 3B where he observed an additional 30 mortalities.
- **Little Goose Dam, April 11**; has experienced higher than normal debris load through the juvenile collection system recently. On April 11, at approximately 1300 debris caused the separator to become plugged and water overflowed out of the adult release pipe. A total of 94 juvenile salmon and steelhead were overflowed onto the ground.
- **Bonneville Dam, April 26;** Project Fisheries was informed of fish in the scroll case and conducted a fish salvage. Roughly 700 fish were salvaged, all juvenile salmonids, but hundreds of mortalities were left behind. The next day the mortalities were recovered and counted. Five additional live fish were salvaged, along with 728 dead juvenile salmonids.
- **Little Goose Dam, April 28**; debris blockage was found near the barge loading junction box above the barge dock. The barge loading junction box is a gate that allows fish to be routed either to the river via secondary by-pass or routed into the barge loading line for barge transportation. A total of 395 juvenile Chinook salmon and steelhead were found on the ground below the junction box next to the barge dock due to a debris blockage that caused the junction box to overflow.
- **Little Goose Dam, May 1;** Units 1, 2 were removed from service on scheduled outage May 1, 0900hrs for routine inspection and trash raking. During video inspections of vertical barrier screens (VBS) tears in the mesh were found and the units were kept out of service. We have only an initial report estimating the magnitude of the mortality that may be associated with fish becoming trapped behind the VBS mesh. In the first torn panel examined, a 55 gallon drum was half full of mortalities. We have torn VBS mesh panels in gatewells 1b, 2a that will all likely contain varying levels of mortality. We have no good estimate for the total amount of mortality from all panels at this time, but are suggesting possibly 5,000 smolts.

- **John Day Dam, May 1**; John Day fisheries was notified of smolts stranded on top of two bulkheads just deployed at two MU12 intake gatewells B & C. An immediate visual inspection determined that there were approximately a couple of thousands of smolts per gatewell and from the forebay deck, they all appeared dead. A quick salvage operation was organized and a fish biologist assisted by a maintenance worker was lowered into the slots, in a man basket, for a closer evaluation. A subsequent fish rescue resulted in up to estimated 1,000 live smolts being netted and released into adjacent gatewell 12-A in good condition. (There were only 9 mortalities noted there afterwards.) Next, all the remaining fish mortalities from MU 12 gatewells were recovered and transported to the JD SMF laboratory for counting and further identification. A total of 3,417 total dead smolts were collected and counted.
- **Little Goose Dam, May 3** at 0700 hours; plugged orifices in gatewell slot 3B were discovered. Both orifices were immediately and successfully back flushed to remove debris. A total of 2,240 juvenile salmonid mortalities were collected on the separator due to this incident. Unit 3 was taken out of service (OOS) for trash rack raking on May 5.
- **Lower Monumental Dam on May 24**; small woody debris caused a blockage in the B-side (larger fish) of the juvenile fish separator exit. The blockage resulted in the mortality of 283 juvenile salmonids.

References

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