



# FISH PASSAGE CENTER

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## MEMORANDUM

TO: Fish Passage Advisory Committee

FROM: Michele DeHart

DATE: May 18, 2018

SUBJECT: Elevated sockeye mortality at BON and current conditions

During the May 15, 2018 Fish Passage Advisory Committee (FPAC) meeting, the Fish Passage Center (FPC) staff alerted FPAC to an event of elevated mortality for sockeye smolts at the juvenile fish facility at Bonneville Dam (BON). At that time, FPC staff informed FPAC that the mortality rate for sockeye smolts in the sample on May 14<sup>th</sup> was 28.1% and that there was no clear indication of abnormal injury rates and/or descaling. In addition, FPC staff informed FPAC of anecdotal information from John Day Dam (JDA) indicating that sockeye in the sample, which had been held in the sample tank for up to 24-hours, had signs of Gas Bubble Trauma in their fins. The purpose of this memo is to provide an update on the mortality rates observed at BON since May 14<sup>th</sup> and conditions in the Mid-Columbia River around this time.

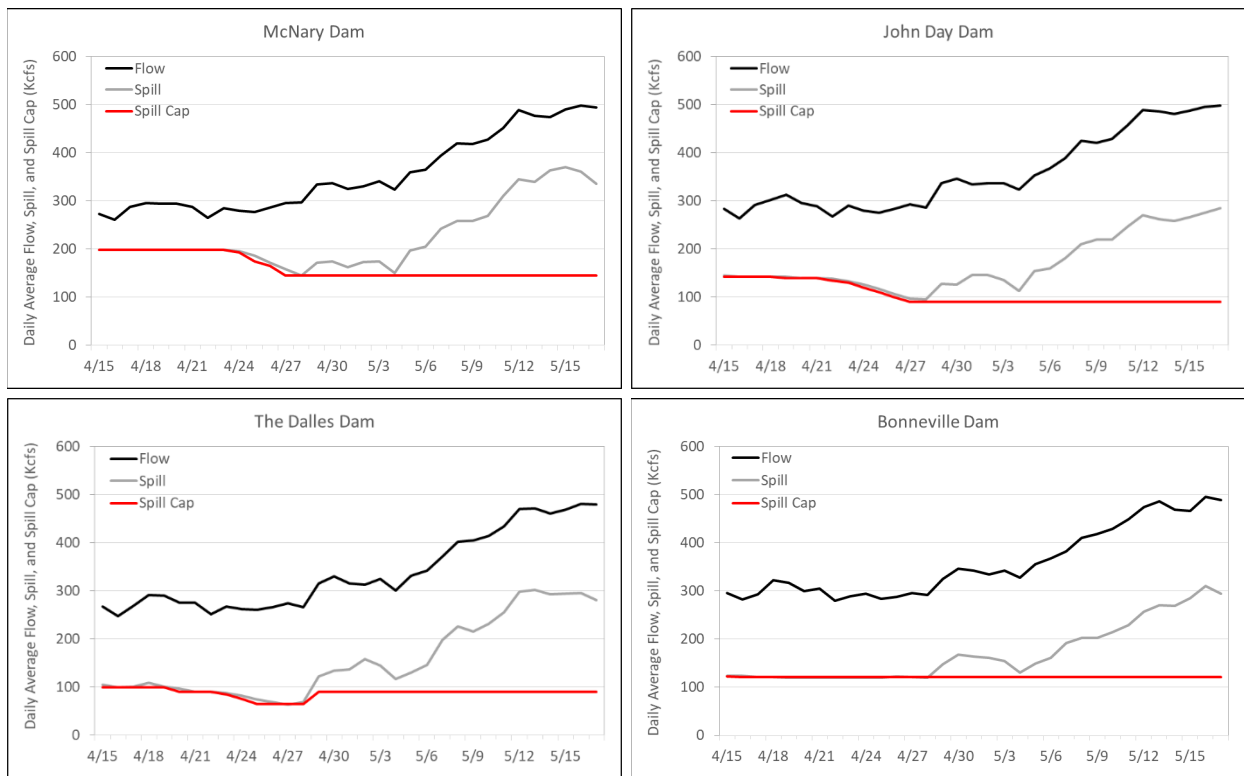
- Due to flows in excess of hydraulic capacity, spill volumes at Mid-Columbia River projects have been in excess of the estimated 115%/120% spill caps since late April. Over the last week, spill levels at each of the Mid-Columbia projects have exceeded the 115%/120% spill caps by a factor of 2 to 3 times.
- As a result of the high spill volumes, TDG has exceeded the 115% forebay and 120% tailrace waiver limits at every monitor in the Mid-Columbia River since May 6<sup>th</sup>. In addition, TDG in the Mid-Columbia has exceeded 125% over much of the last two weeks.
- The JBS at BON consists of a nearly 4.0 km transportation flume that transports fish from the second powerhouse to the juvenile fish facility. Actively migrating fish take from 37-62 minutes to be transported from the dewatering structure to the juvenile fish facility.

After entering the facility, smolts are held for 2-24 hours before they are processed by SMP personnel.

- Elevated mortality rates of 28.1% and 21.1% were observed for sockeye at BON on May 14<sup>th</sup> and May 15<sup>th</sup>, respectively. Mortality rates for sockeye at BON have decreased to 1.3%-4.7% over the last three samples (May 16<sup>th</sup>-May 18<sup>th</sup>).
- There has been an increase in GBT incidences at BON (Chinook and steelhead) over the last week. Exams conducted on May 17<sup>th</sup> had a GBT incidence rate of 17%.
- GBT lab studies indicate that mortality begins to occur in Chinook in as few as 2 hours when fish are held in shallow depths and exposed to TDG of 130%.
- Based on these data it is likely that the elevated mortality rates observed this week were a combination of prolonged exposure to high TDG in the Upper and Mid-Columbia rivers, due to flows in excess of hydraulic capacity, and subsequent holding times in shallow water.

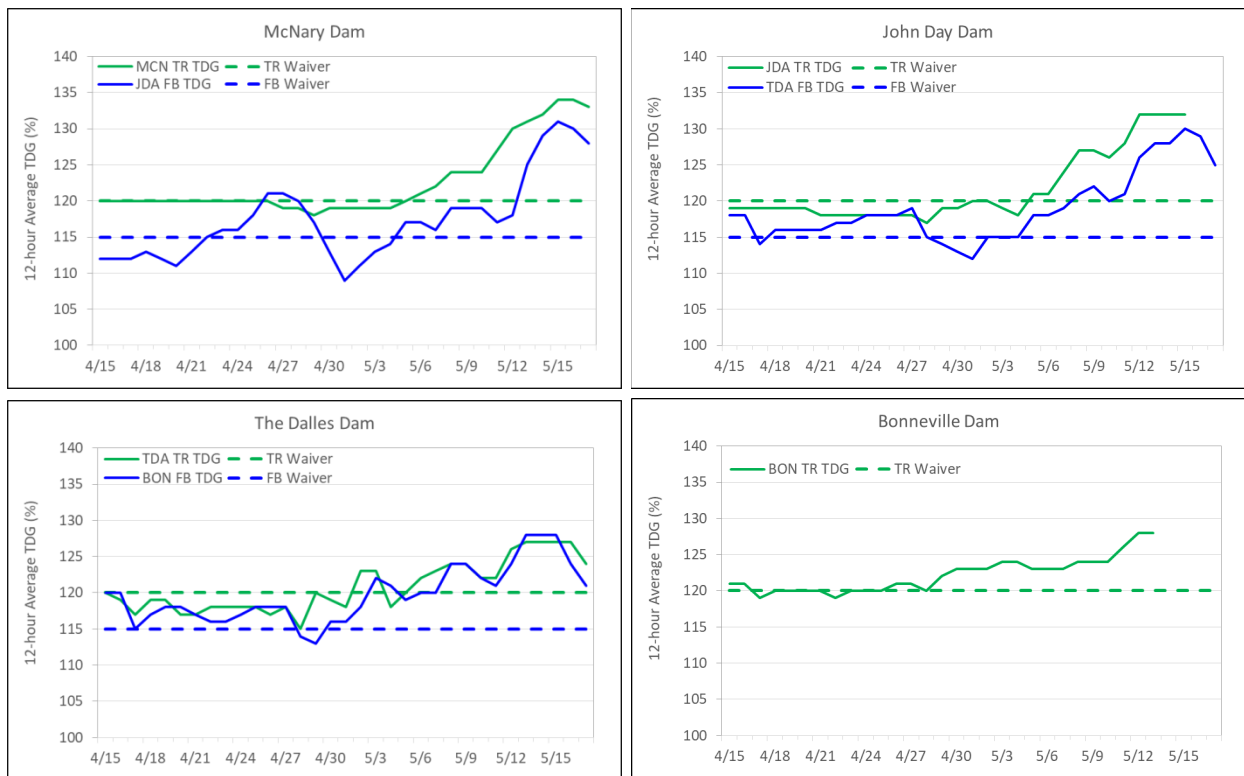
## **River Conditions**

Due to flows in excess of hydraulic capacity, spill volumes at the Mid-Columbia projects (McNary, John Day, The Dalles, and Bonneville) has exceeded the Fish Passage Plan operation of spilling to the estimated 115%/120% spill caps since late April (Figure 1). In fact, over the last week, spill at these projects has been two to three times their respective estimated spill caps. For example, the estimated 115%/120% spill cap at John Day Dam (JDA) has been 90 Kcfs all this week. Spill volumes at JDA have ranged from 246.9 to 285.1 Kcfs this week, which is 2.7 to 3.2 times the estimated cap.



**Figure 1. Daily average flow, spill, and estimated daily spill caps (Kcfs) at McNary, John Day, The Dalles, and Bonneville dams, April 15-May 18, 2018.**

Given the high spill levels observed in the Mid-Columbia River over the last several weeks, total dissolved gas (TDG) has also been elevated. In fact, TDG has exceeded the 115% forebay and 120% tailrace waiver limits at every monitor in the Mid-Columbia River since May 6<sup>th</sup> (Figure 2). Furthermore, TDG in the MCN tailrace has been above 125% since May 11<sup>th</sup> and has been as high as 134% (May 15<sup>th</sup> and 16<sup>th</sup>). Total dissolved gas in the John Day forebay has been at or above 125% since May 13<sup>th</sup> and has been as high as 131% (May 15<sup>th</sup>). Total dissolved gas in the John Day tailrace has been above 125% since May 8<sup>th</sup> and TDG in The Dalles forebay was at or above 125% from May 12<sup>th</sup> through May 17<sup>th</sup>. The tailrace monitor for JDA was out of service from late evening on May 16<sup>th</sup> through the afternoon of May 17<sup>th</sup>. Total dissolved gas in The Dalles tailrace was at or above 125% from May 12<sup>th</sup> through May 16<sup>th</sup> and TDG in the BON forebay was above 125% from May 13<sup>th</sup> through May 15<sup>th</sup>. Total dissolved gas in the BON tailrace (at Cascade Island) was above 125% from May 11<sup>th</sup> through May 13<sup>th</sup>. However, TDG at this location is unknown since May 13<sup>th</sup>, as the monitor was likely damaged as a result of the increased spill. Total dissolved gas at the Warrendale gauge has been above 125% since May 12<sup>th</sup>, and 12-hour averages have been as high as 131%.



**Figure 2. Total dissolved gas (12-hour average) from spill at McNary, John Day, The Dalles, and Bonneville dams, April 15-May 17, 2018.**

### **BON Juvenile Bypass System and Summary of Mortality and GBT Data**

The juvenile bypass system (JBS) at BON consists of a 1.22-m-diameter transportation flume to transport bypassed fish from the dewatering structure to the bypass outfall. The transportation flume travels below ground for 3.7 km and water in the pipe is maintained at a depth of 0.6 m (Ferguson et al. 2007). Evaluations of the JBS at BON in 1999 and 2000 indicated that median passage times through the JBS for actively migrating fish ranged from 37-62 minutes. These median passage times do not include the amount of time it takes for fish to move from the gatewells to the dewatering structure. Once fish enter the sampling facility, they are held for 2-24-hours before they are processed by SMP personnel and released back into the tailrace.

Sockeye smolts experienced elevated mortality rates in two of this week’s samples (Table 1). The highest mortality rates occurred on May 14<sup>th</sup> and 15<sup>th</sup>, where mortality rates were 28.1% and 21.1%, respectively. Mortality rates for sockeye smolts decreased to 4.7% on May 16<sup>th</sup>, 4.0% on May 17<sup>th</sup>, and 1.3% on May 18<sup>th</sup>. SMP personnel at the project noted that many sockeye smolts were arriving into the sample tank dead or were dying shortly thereafter. The fish from these days were found to be in otherwise good condition, with normal levels of descaling and injury (Table 1). Fish passing through the bypass system at BON pass in shallow water and are held in shallow holding tanks for up to 24-hours. As mentioned above, spill levels in the Mid-Columbia River have been above those outlined in the Fish Operations Plan since late April, due to flows in

excess of hydraulic capacity. Total dissolved gas (TDG) in the tailrace monitors at Mid-Columbia projects (McNary, John Day, and The Dalles) have been near or above 130% over the last several days and TDG at the Bonneville forebay monitor was 128% from May 13<sup>th</sup> through May 15<sup>th</sup> (Figure 2).

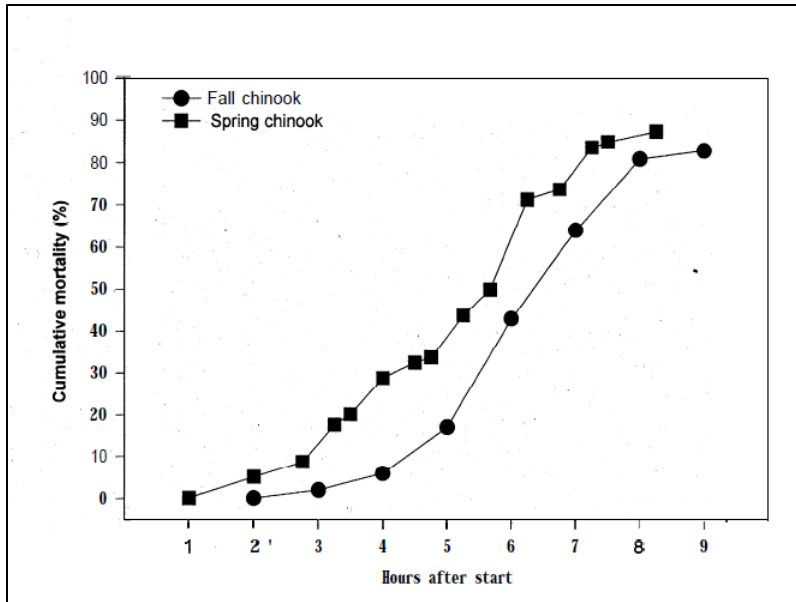
As part of the Gas Bubble Trauma monitoring program, SMP personnel at BON conduct two GBT exams per week. However, the exam that was scheduled for May 8<sup>th</sup> was cancelled, due to the release of 4.0 million subyearling fall Chinook tules from Spring Creek NFH on May 7<sup>th</sup>. GBT exams over the last two weeks have revealed increasing rates of fin GBT at BON (Table 1). The exam conducted on May 12<sup>th</sup> had an incidence rate of 3.0% and the exam conducted on May 17<sup>th</sup> had an incidence rate of 17%. All of the fish that were observed with signs of fin GBT on May 12<sup>th</sup> and May 17<sup>th</sup> had Rank 1 or Rank 2 signs. The next scheduled GBT sample at BON is Saturday, May 19<sup>th</sup>. It is important to note that only Chinook and steelhead are examined for GBT. This is because lab studies conducted on the impacts of GBT were only conducted on Chinook and steelhead.

**Table 1. Summary of sample mortality, descaling, and injury data for sockeye at Bonneville Dam over the last two weeks (May 5-18, 2018) and summary of GBT data (Chinook and steelhead) over the same period. SMP staff at BON conduct a condition sample on Sockeye every-other-day. The two days of high mortality at BON are highlighted in grey.**

Date	Percent Sample Mortality	Percent Descaled	Percent Physical Injury	Percent of GBT Sample with signs of Fin GBT
May 5	0.0%	2.6%	13.2%	0.0%
May 6	1.5%	7.4%		
May 7	0.0%	7.4%	8.6%	
May 8	0.0%	4.0%		
May 9	1.0%	4.2%	12.6%	
May 10	3.2%	4.1%		
May 11	0.8%	3.0%	3.0%	
May 12	2.2%	10.6%		3.0%
May 13	3.6%	8.5%	13.3%	
May 14	28.1%	3.3%		
May 15	21.1%	4.9%	6.0%	17.0%
May 16	4.7%	4.5%		
May 17	4.0%	2.8%	5.6%	
May 18	1.3%	5.9%		

## Conclusion

Early lab studies on the effects of GBT indicate that mortality in Chinook begins within two hours of exposure to TDG levels of 130% when fish are held in shallow tanks (Figure 3) (Maule et al., 1997). In fact, Chinook experienced 20% mortality within the first 3.5 hours after exposure at these shallow depths.



**Figure 3. Cumulative mortality of juvenile Chinook held in 18 inch (0.46 m) tanks and exposed to 130% TDG at 12°C. Figure taken from Figure 1 of Maule et al. (1997).**

Based on these data it is likely that the elevated mortality rates observed earlier this week were a combination of prolonged exposure to the high TDG in the Upper and Mid-Columbia rivers, due to flows in excess of hydraulic capacity, and holding times in shallow water while smolts moved through the JBS and were held in the juvenile fish facility at BON.

## References

- Ferguson, J.W., B.P. Sandford, R.E. Reagan, L.G. Gilbreath, E.B. Meyer, R.D. Ledgerwood, and N.S. Adams. 2007. Bypass system modifications at Bonneville Dam on the Columbia River improved the survival of juvenile salmon. *Transactions of the American Fisheries Society*. 136: 1487-1510.
- Maule, A., M. Mesa, K. Hans, J. Warren, and M. Swihart. 1997. Gas Bubble Trauma Monitoring and Research of Juvenile Salmonids, 1995 Annual Report. Project No. 198740100