



FISH PASSAGE CENTER

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MEMORANDUM

TO: FPAC

FROM: 
Michele DeHart

DATE: April 24, 2012

RE: Overview of Bonneville Dam powerhouse operations and Spring Creek subyearling Chinook passage and mortality.

In response to your request, the Fish Passage Center staff has compiled the Bonneville Dam (BON) powerhouse operations data since April 11th, along with passage and mortality data for subyearling fall Chinook at BON. Below are a few of the major observations from these data for your consideration during future operations of BON during periods of passage of Spring Creek NFH subyearling fall Chinook. More detailed data and discussions are also provided below.

- The operation of Bonneville Powerhouse 2 at the upper end of the 1% efficiency range causes additional, unacceptable levels of mortality on small subyearling fall Chinook.
- This mortality occurs due to physical modifications made to Powerhouse 2 to improve the guidance of fish through the powerhouse.
- Data collected from smolt monitoring activities and research since 2007 consistently shows increased mortality to juvenile subyearling Chinook at operations above the mid-range of the 1% efficiency.
- Data collected for the Spring Creek hatchery tulle fall Chinook releases have corroborated the research and monitoring from past years. Mortality recorded for samples of Spring Creek migrants that were collected when Bonneville PH2 was operated above the mid-range of the 1% ranged from 3.7 to 7.3%.
- The purported benefit to juvenile fish passage and survival at the higher flow operation point above the 1% efficiency range (best geometry) is speculative. The operation of PH1 at “best geometry” is not based on empirical data and does not consider the impacts to the passage mortality of additional juvenile fish diverted to the turbines, and away from the spillway or the ice/trash sluiceway routes.

- The only operation of the Bonneville Dam that is both biologically sound and supported by empirical data is to operate the PH2 units at the mid-range of the 1% efficiency following the release of the Spring Creek Hatchery, operate the PH1 within the 1% efficiency range (no best geometry operation) and spill the additional water.

Historical Summary:

Fish guidance efficiency (FGE) at the second powerhouse of Bonneville Dam (BON) had historically been very low. In order to improve the FGE, turbine intake and gatewell modifications that were designed to increase flow up gatewell slots were made at the project. Those modifications led to conditions in the gatewells that proved to be less than desirable for small migrating salmonids.

In 2007, approximately 7.7 million subyearling tule fall Chinook were released during March from the Spring Creek National Fish Hatchery. Smolt Monitoring Program personnel at the Bonneville Dam monitoring facility reported unusually high mortality in the Spring Creek smolts. They reported 4.5% mortality on March 8th and 8% mortality on March 9th, when typical mortality rates are less than 1%. The mortalities examined showed no descaling or sign of virus or bacteria, and all of the released fish had passed their detection tests before leaving the hatchery.

Based on the high mortality the Salmon Managers submitted a request for emergency spill at Bonneville Dam in order to provide fish with an alternate route past the powerhouse. The Action Agencies denied the request and continued operating the Bonneville Second Powerhouse corner collector citing no information indicated that the bypass system was causing the mortalities.

The second Spring Creek Hatchery release occurred on April 12, 2007. Spill was provided at Bonneville Dam as part of normal spring spill operations. The subyearling Chinook also showed elevated rates of moribund and dead fish. As a result, a special operation with a reduction in turbine loading to the low end of the 1% efficiency range for units in Powerhouse 2 that had been modified with minimum gap closure devices to improve fish guidance was requested. The COE complied with the request and a substantial reduction in mortality was observed (from 10% to 2.7%).

A third release of 3.5 million subyearling Chinook from Spring Creek Hatchery occurred on May 1, 2007. The survival of this release was of particular concern given the unexpected mortality incurred by the previous March and April releases. Consequently, the Salmon Managers requested the turbine units equipped with gap closure devices operate at the low end of the 1% efficiency range prior to the arrival of this third release of fish. The mortality observed for this release was considerably less than observed for the March and April releases.

More units were equipped with the gap closure devices in 2008. Given the 2007 operations the fishery agencies and tribes requested that turbine units operate at the low end of the 1% efficiency range. However, before committing to operate the turbine units at the low end of the 1% efficiency range, the Action Agencies conducted a pilot study where turbine units were

operated at the lower, mid-, and upper 1% range using Spring Creek Hatchery fish. Two tests were conducted on March 4th and March 5th. Results from these tests are summarized in Table 1.

Table 1. Mortality rates observed for Spring Creek Hatchery fish with operation of Bonneville Dam Turbines at the lower, mid and upper range of the 1% efficiency.

Operation	Mortality Rate	
	March 4 Test	March 5 Test
Low 1%	2.9	0.8
Mid 1%	21.5	6.9
Upper 1%	46.8	17.7

The data collected from this study prompted the COE to operate at the low end of the 1% efficiency range for the Spring Creek releases in 2008.

In 2009, through the COE’s Scientific Review Work Group a study was conducted that re-examined the relationship between passage effects and turbine operation within the 1% peak efficiency range. From those studies it was concluded that mortality and descaling were higher at upper 1% than at middle 1% operation and that mortality decreased with increased fish size.

These data guided operations in 2010 and 2011, where the second powerhouse at Bonneville Dam was operated at the lower end of the 1% efficiency range following the Spring Creek Hatchery releases. This effectively set the hydraulic capacity at PH2 lower during this period. The operation at a lower capacity and potentially spilling higher amounts of water is consistent with the COE TDG waiver. The TDG waiver recognizes that there is a balance of risk associated with elevated total dissolved gas that must be compared to other options for in-river migration of salmonids.

Releases of subyearling fall Chinook from Spring Creek and Little White Salmon NFH:

On April 11, 2012, approximately 925,400 subyearling fall Chinook were released from Spring Creek NFH, which is located about 35 kilometers above BON. An additional 7.03 million subyearling fall Chinook juveniles were released from Spring Creek NFH and Little White Salmon NFH on April 13, 2012. The fish from the April 11th release were first encountered at BON at about 0040 on April 12th. Subsequent to their arrival on April 12th, mortality rates of subyearling Chinook began to increase. The sample ending on April 13th had a daily mortality of 15.2% (which incorporates some mortality due to the cleaning of the screens) for subyearling Chinook (Table 2).

Due to these high mortalities, and the release of 7.03 million additional subyearlings on April 13th, the salmon managers submitted a System Operational Request (SOR) for a special operation at BON during the peak passage of the subyearling Chinook released on April 13th. The SOR asked the Action Agencies (AA) to implement two operations. First, operate Powerhouse Two (PH2) at the mid-point of the 1% best efficiency range. With all available units operating at the mid-range of the 1% efficiency this would have been the powerhouse capacity over the 5 days; any flows above this powerhouse capacity would be spilled. Second, if powerhouse capacity was reached with the above operational criteria, and spill amounts led to

TDG exceedances below Bonneville Dam, then the SOR called for the operation of Powerhouse One at open geometry outside of the 1% best efficiency range, while maintaining operations at PH2 at the mid-point of the of 1% range. The Action Agencies would not agree to implement the first component of the SOR. Limiting generation to the mid-point of the 1% operating range at PH2 would result in additional spill at a time when gas caps were being exceeded at Bonneville Dam.

The COE proposed an alternative operation, which called for the operation of PH1 in open geometry to minimize the time that units at PH2 would operate at the higher end of the 1%. This action effectively reduced spill by forcing more water to PH1 and therefore generating more electricity through Powerhouse 1. The issue with operating the project at open geometry is that there are no “empirical” data to suggest that forcing more fish through PH1 presents the better fish operation. In addition, there is no monitoring at Powerhouse 1 and, therefore, if there was additional mortality imposed on these fish, there is no way of knowing or measuring the impact. The Action Agencies alternative operation was implemented on the afternoon of April 13th through Tuesday, April 17th (Figure 1).

Subyearling fall Chinook from the April 13th releases were first encountered in the sample at BON at about 0100 on April 14th. The peak passage date for these subyearling fall Chinook was April 14th, with a passage index of over 1.02 million subyearling Chinook. From April 14th to April 17th, the daily sample mortality for subyearling Chinook ranged from 0.5 to 3.7% (Table 1, Figure 1). Since the alternative operation ended on April 17th, the daily sample mortality for subyearling Chinook passing through the second powerhouse increased to 5.0% on April 18th, 5.9% on April 19th, and 7.3% on April 20th (Table 2, Figure 1). During this time, the passage index for subyearling Chinook was decreasing but still in the 21,230 to 58,700 range (Table 2).

During the period of high mortality for subyearling Chinook, mortality rates for yearling Chinook and steelhead juveniles at BON, were much lower (0.0-2.6%) (Table 2).

Table 2. Subyearling Chinook passage index and mortality at Bonneville Dam for the period of April 1 to April 23, 2012. Percent mortality data are also shown for yearling Chinook and steelhead for comparison.

Date	CH0 Passage Index	Percent Mortality		
		CH0	CH1	ST
4/11/2012	3,446	2.1	0.0	0.0
4/12/2012	104,842	5.6	0.0	0.0
4/13/2012	73,614	15.2	0.0	0.0
4/14/2012	1,024,655	0.5	0.0	
4/15/2012	205,980	5.3	0.0	0.0
4/16/2012	62,484	2.4	0.0	0.0
4/17/2012	65,910	3.7	0.0	0.0
4/18/2012	58,668	5.0	0.0	0.0
4/19/2012	32,317	5.9	0.0	0.0
4/20/2012	21,230	7.3	0.4	0.0

4/21/2012	4,853	0.0	0.8	0.0
4/22/2012	4,078	10.0	1.4	0.0
4/23/2012	4,827	0.0	0.7	0.0
4/24/2012	2,596	0.0	0.5	0.0

The operation of PH 2 to the mid-range of the 1% efficiency occurs at flows between 94.5 to 101.5 Kcfs. From the following graph it can be seen that when the first Spring Creek release came through, BON PH2 was operated at the high end of the 1% efficiency range and the mortality associated with this passage was very high at 5.6% on April 12th and 15.2% on April 13th (Figure 1). It should be noted that some of the dead subyearlings observed on April 13th were washed into the sample from screen cleaning activities and likely had been dead for some time. When the bulk of the larger Spring Creek releases occurred, BON PH1 was operated above the 1% efficiency range (best geometry), with unknown biological consequences, and PH2 was operated near the mid-range of the 1% peak efficiency range (Figure 1). This resulted in lower passage mortality at PH2 (0.5 to 5.3%) (Figure 1). However subsequent to the initial passage, when PH2 was again operated above the mid-range of the 1% efficiency range, mortality increased from 3.7% to 7.3%.

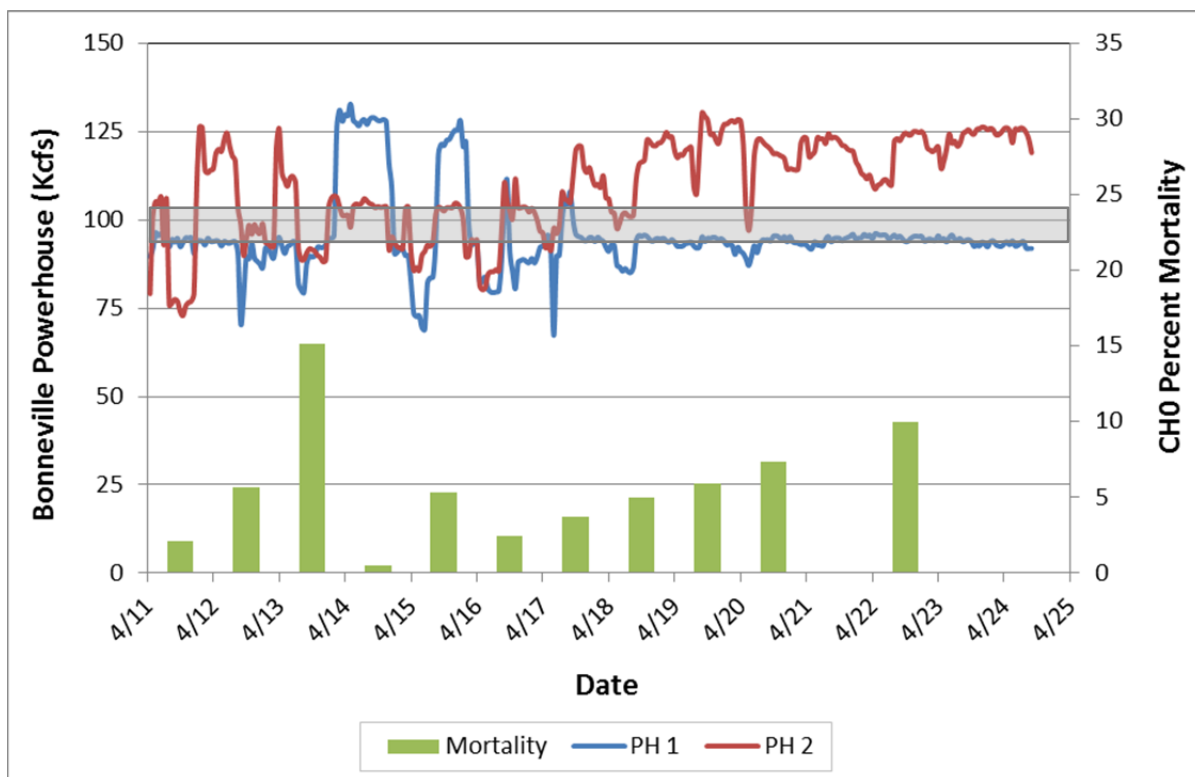


Figure 1. Operations of the first (PH1) and second (PH2) powerhouses and subyearling Chinook mortality at Bonneville Dam from April 11 to April 24, 2012. Shaded area is the estimated mid-range of the 1% peak efficiency range for PH2.

CC: Doug Baus, COE
 Bill Proctor, COE
 Agnes Lut (Oregon DEQ)