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MEMORANDUM

TO: Christine Petersen, BPA

FROM: Michele DeHart

DATE: October 19, 2012

RE: Summary of mortality, descaling, injury, and gas bubble trauma data from Smolt Monitoring Program (2002-2012)

In response to your request, the FPC staff has summarized mortality, descaling, injury, and gas bubble trauma (GBT) data from FCRPS sites that are a part of the Smolt Monitoring Program (SMP). In all, six FCRPS sites are part of the SMP, including: Lower Granite Dam (LGR), Little Goose Dam (LGS), Lower Monumental Dam (LMN), McNary Dam (MCN), John Day Dam (JDA), and Bonneville Dam (BON). For this data request, we summarized mortality, descaling and gas bubble trauma data for migration years 2002 through 2012. However, the injury data are only for migration years 2009 through 2012. The injury data are collected as part of the US Army Corps of Engineers (COE) at-project monitoring and prior to 2009 the data collection was not standardized among hydro projects. In 2009, at the request of the Fish Passage Advisory Committee, the FPC coordinated with the COE to develop a standardized condition monitoring effort that assures consistency among all the hydro projects.

Below are a few of our findings, followed by a more detailed explanation of each of these “condition” metrics and how the data were summarized for this analysis.

- The daily mortality, descaling, injury, and GBT data collected through the SMP are primarily used at the FCRPS projects to identify possible management concerns as they occur. Sudden increases in mortality, descaling, injury, and/or GBT are generally indicative of a problem with the project or operation and that requires an intervening management action.

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- Given that these different condition metrics fluctuate daily, it is important to note that focusing solely on annual estimates of mortality, descaling, injury, and/or GBT is not sufficient to adequately describe a particular year.
- Weighted average mortality rates at the Snake River projects, MCN, and JDA have been variable over the past 11 years as a function of river conditions and project operations. There have been no specific increases or decreases in recent years.
- Weighted average mortality rates at BON have been higher over the past five years (2008-2012) when compared to the previous six years (2002-2007). This pattern is particularly evident for subyearling Chinook and sockeye. The increased mortality rates at BON coincide with changes that were made to the juvenile bypass system at the second powerhouse prior to the 2008 migration season.
- There was no discernible pattern in the weighted average descaling rates at most of the FCRPS projects, except LGS. Weighted average descaling rates at LGS appear to have decreased over the past five years (2008-2012) when compared to the previous six years (2002-2007).
- Compared to other species and other sites, sockeye juveniles at BON consistently had higher levels of descaling over the 11 years analyzed (Weighted Average Range: 5.5% to 21.1%).
- With a limited number of years of condition data, detecting among-year patterns in weighted average injury rates is difficult. However, among species, it appears that steelhead had the highest weighted average injury rates, for all sites.
- The GBT monitoring program has consistently shown over years' of implementation that signs of GBT are minimal when TDG is managed to the criteria levels of 115/120% TDG.
- Historical observations suggest that signs of GBT begin to increase as TDG increases above the criteria levels, and will approach the action criteria for GBT when TDG levels are near the 130% supersaturation levels in the tailraces, or forebays, of dams.

Mortality:

Mortality data are collected at all SMP sites on all target salmonid species. Mortalities are generally broken into two different categories: sample mortalities and facility mortalities. At all sites, sample mortalities are those fish that are dead in the sampling tank or GBT fish that die after being sampled at the separator. These mortalities include fish that died prior to being diverted to the sample and that died as a part of the sampling process. Facility mortalities are generally only quantified at the transportation sites (LGR, LGS, LMN, and MCN). Facility mortalities are fish that are found dead in the holding raceways after having passed through the bypass system. This mortality may occur after the sample gate and therefore, not all facility mortalities at transportation sites are represented in the sample. Consequently, estimating mortality at transportation sites presents a dilemma since using the sum of sample and facility mortalities may overestimate the mortality rate, while using the sample mortality alone may underestimate the population mortality.

Prior to 2008, SMP personnel at JDA and BON distinguished mortalities in the sample tank as facility mortalities or sample mortalities. Facility mortalities were designated as those that were already dead before entering the sample tank. Sample moralities were only those fish that were killed during the sampling process. Since 2008, the distinction between the two types of mortalities was dropped and all mortalities recovered in the sample tank at JDA and BON have been recorded as sample mortalities.

At transportation sites, we explored two methods of estimating daily mortality. One method involved estimating daily facility mortality, which is the facility mortalities divided by the daily collection. The other method involved estimating daily sample mortality, which was the sample mortality divided by the daily sample. These two methods had similar results, particularly with respect to the ranges of daily mortality estimates. Given these similarities, daily mortality estimates presented in this report are based on sample mortalities for these sites. For JDA and BON, daily mortality was estimated by dividing the sum of the sample and facility mortalities by the sample count for each species.

When summarizing the daily mortality data, we only included days where a minimum of 20 individuals were sampled. This was done in order to remove days with low sample sizes and, thus, potentially inflated mortality rates. Daily mortality estimates were then weighted, based on the daily passage index. This weighting allowed us to estimate a weighted average mortality for each of the 11 migration years. A weighted average mortality is a more fair representation of the overall seasonal mortality, as it gives more weight to the days where a higher number of juveniles passed, versus giving equal weight to all days. Tables 1 through 6 provide summaries of the weighted average seasonal mortality rates for each of the FCRPS sites over the past 11 years.

Table 1. Weighted average mortality (percent) for subyearling Chinook (CH0), yearling Chinook (CH1), Sockeye (SO), and Steelhead (ST) at LGR. Minimum and maximum mortality rates are provided in parentheses.

Year	CH0	CH1	SO	ST
2002	2.2 (0.0-5.9)	0.8 (0.0-6.5)	13.7 (0.0-31)	0.3 (0.0-4.2)
2003	2.8 (0.0-13.8)	0.8 (0.0-16)	N/A	0.4 (0.0-8.6)
2004	1.1 (0.0-9.5)	1.6 (0.0-6.9)	8.0 (3.8-18.5)	0.3 (0.0-6.1)
2005	2.0 (0.0-20.0)	1.2 (0.0-6.0)	3.1 (0.0-10.0)	0.2 (0.0-2.4)
2006	1.0 (0.0-12.0)	1.2 (0.0-3.6)	N/A	0.5 (0.0-3.8)
2007	0.8 (0.0-14.3)	0.3 (0.0-4.3)	1.2 (0.0-3.1)	0.2 (0.0-3.4)
2008	1.3 (0.0-8.0)	0.7 (0.0-7.1)	10.3 (0.0-35.7)	0.3 (0.0-7.4)
2009	1.5 (0.0-14.5)	0.7 (0.0-4.5)	N/A	0.2 (0.0-0.9)
2010	0.8 (0.0-7.9)	0.4 (0.0-10.2)	N/A	0.2 (0.0-2.0)
2011	1.2 (0.0-12.4)	0.6 (0.0-3.3)	2.9 (0.0-12.7)	0.2 (0.0-5.0)
2012**	0.9 (0.0-6.7)	0.8 (0.0-4.8)	0.8 (0.0-2.9)	0.3 (0.0-3.6)

* For sockeye, there were no days in 2003, 2006, and 2010 where samples met or exceeded 20 fish and only one day in 2009

** Migration year 2012 data are through October 17.

Table 2. Weighted average mortality (percent) for subyearling Chinook (CH0), yearling Chinook (CH1), Sockeye (SO), and Steelhead (ST) at LGS. Minimum and maximum mortality rates are provided in parentheses.

Year	CH0	CH1	SO	ST
2002	0.4 (0.0-32.0)	0.4 (0.0-5.6)	0.1 (0.0-3.6)	0.5 (0.0-8.2)
2003	0.9 (0.0-15.4)	0.7 (0.0-7.0)	N/A	0.4 (0.0-9.1)
2004	0.3 (0.0-6.3)	0.2 (0.0-13.0)	N/A	0.2 (0.0-14.8)
2005	0.3 (0.0-3.7)	0.7 (0.0-5.0)	0.4 (0.0-4.3)	0.4 (0.0-4.5)
2006	0.7 (0.0-6.7)	0.7 (0.0-7.5)	N/A	0.1 (0.0-7.1)
2007	0.2 (0.0-4.6)	0.2 (0.0-4.3)	N/A	0.1 (0.0-6.3)
2008	0.4 (0.0-5.5)	0.3 (0.0-3.3)	N/A	0.1 (0.0-4.8)
2009	0.7 (0.0-10.3)	0.2 (0.0-13.6)	0.2 (0.0-8.0)	0.1 (0.0-3.3)
2010	0.8 (0.0-15.6)	0.4 (0.0-5.7)	N/A	0.1 (0.0-1.1)
2011	0.8 (0.0-12.1)	0.7 (0.0-9.5)	N/A	0.1 (0.0-2.0)
2012**	0.2 (0.0-6.5)	0.3 (0.0-8.3)	N/A	0.1 (0.0-3.3)

* For sockeye, there were no days in 2003, 2004, 2007, 2010, and 2012 where samples met or exceeded 20 fish and only one day in 2006, 2008, and 2011.
** Migration year 2012 data are through October 17.

Table 3. Weighted average mortality (percent) for subyearling Chinook (CH0), yearling Chinook (CH1), Sockeye (SO), and Steelhead (ST) at LMN. Minimum and maximum mortality rates are provided in parentheses.

Year	CH0	CH1	SO	ST
2002	0.8 (0.0-16.3)	0.3 (0.0-10.5)	3.2 (0.0-33.3)	0.5 (0.0-9.8)
2003	0.5 (0.0-16.4)	0.2 (0.0-6.1)	N/A	0.3 (0.0-4.0)
2004	0.5 (0.0-19.6)	0.5 (0.0-2.4)	N/A	0.2 (0.0-2.2)
2005	0.3 (0.0-3.7)	0.3 (0.0-1.6)	0.0 (0.0-0.0)	0.3 (0.0-5.6)
2006	0.4 (0.0-15.0)	0.4 (0.0-3.7)	1.3 (0.0-4.8)	0.3 (0.0-2.6)
2007	0.6 (0.0-21.2)	0.3 (0.0-4)	N/A	0.2 (0.0-10.7)
2008	0.2 (0.0-14.3)	0.1 (0.0-4.3)	0.0 (0.0-0.0)	0.1 (0.0-2.9)
2009	0.2 (0.0-19)	0.1 (0.0-4)	0.0 (0.0-0.0)	0.1 (0.0-2.7)
2010	0.3 (0.0-7.1)	0.2 (0.0-2.1)	N/A	0.2 (0.0-1.5)
2011	0.3 (0.0-62.9)	0.0 (0.0-0.4)	0.0 (0.0-0.0)	0.1 (0.0-1.2)
2012	0.5 (0.0-46.9)	0.3 (0.0-6.8)	0.0 (0.0-0.0)	0.2 (0.0-2.0)

* For sockeye, there were no days in 2003, 2004, and 2010 where samples met or exceeded 20 fish and only one day in 2007.

Table 4. Weighted average mortality (percent) for subyearling Chinook (CH0), yearling Chinook (CH1), Sockeye (SO), and Steelhead (ST) at McNary Dam (MCN). Minimum and maximum mortality rates are provided in parentheses.

Year	CH0	CH1	SO	ST
2002	0.9 (0.0-10.0)	0.7 (0.0-5.2)	1.9 (0.0-6.3)	0.7 (0.0-5.4)
2003	1.2 (0.0-5.9)	0.7 (0.0-4.3)	1.1 (0.0-25.0)	0.8 (0.0-5.1)
2004	0.8 (0.0-10.4)	1.1 (0.0-3.1)	2.2 (0.0-9.5)	0.3 (0.0-3.8)
2005	0.8 (0.0-6.3)	0.9 (0.0-4.0)	2.5 (0.0-13.6)	0.3 (0.0-1.6)
2006	0.5 (0.0-14.8)	0.8 (0.0-11.9)	0.6 (0.0-3.0)	0.4 (0.0-1.6)
2007	1.7 (0.0-5.2)	0.7 (0.0-4.0)	1.5 (0.0-4.5)	1.0 (0.0-4.1)
2008	0.9 (0.0-7.5)	0.5 (0.0-7.4)	0.6 (0.0-20.0)	0.3 (0.0-11.1)
2009	1.7 (0.0-8.8)	0.7 (0.0-9.4)	0.0 (0.0-4.5)	0.2 (0.0-4.0)
2010	1.0 (0.0-9.5)	0.6 (0.0-9.4)	1.1 (0.0-17.6)	0.4 (0.0-3.7)
2011	2.2 (0.0-8.4)	1.6 (0.0-23.1)	1.5 (0.0-14.0)	0.3 (0.0-3.1)
2012	0.9 (0.0-9.4)	0.4 (0.0-2.0)	0.8 (0.0-5.1)	0.4 (0.0-4.5)

Table 5. Weighted average mortality (percent) for subyearling Chinook (CH0), yearling Chinook (CH1), Sockeye (SO), and Steelhead (ST) at JDA. Minimum and maximum mortality rates are provided in parentheses.

Year	CH0	CH1	SO	ST
2002	0.3 (0.0-1.5)	0.4 (0.0-3.3)	1.8 (0.0-4.3)	0.3 (0.0-7.4)
2003	0.3 (0.0-4.0)	0.4 (0.0-3.6)	0.5 (0.0-5.0)	0.3 (0.0-2.3)
2004	0.3 (0.0-4.0)	0.7 (0.0-3.0)	0.8 (0.0-4.5)	0.3 (0.0-6.3)
2005	0.3 (0.0-2.8)	0.9 (0.0-86.8)	0.1 (0.0-3.7)	0.3 (0.0-84.4)
2006	0.2 (0.0-3.3)	0.3 (0.0-6.9)	0.9 (0.0-5.1)	0.2 (0.0-2.0)
2007	0.3 (0.0-4.8)	0.2 (0.0-2.1)	0.5 (0.0-2.2)	0.4 (0.0-9.1)
2008	0.2 (0.0-4.8)	0.2 (0.0-1.4)	0.2 (0.0-2.7)	0.3 (0.0-3.7)
2009	0.2 (0.0-2.1)	0.3 (0.0-20.0)	0.3 (0.0-3.0)	0.1 (0.0-4.8)
2010	0.2 (0.0-3.0)	1.0 (0.0-4.8)	0.9 (0.0-4.8)	1.5 (0.0-4.8)
2011	0.5 (0.0-4.3)	0.4 (0.0-4.7)	1.6 (0.0-12.5)	0.3 (0.0-13.2)
2012	0.3 (0.0-1.5)	0.3 (0.0-4.0)	1.2 (0.0-8.0)	0.1 (0.0-5.4)

Table 6. Weighted average mortality (percent) for subyearling Chinook (CH0), yearling Chinook (CH1), Sockeye (SO), and Steelhead (ST) at BON. Minimum and maximum mortality rates are provided in parentheses.

Year	CH0	CH1	SO	ST
2002	0.9 (0.0-24.9)	1.0 (0.0-47.8)	3.9 (0.0-27.7)	0.6 (0.0-8.3)
2003	0.3 (0.0-5.0)	0.3 (0.0-6.1)	1.8 (0.0-8.7)	0.2 (0.0-2.0)
2004	0.6 (0.0-5.6)	0.8 (0.0-5.4)	0.8 (0.0-2.8)	0.9 (0.0-3.6)
2005	0.4 (0.0-2.0)	0.2 (0.0-2.9)	1.0 (0.0-4.3)	0.2 (0.0-1.4)
2006	0.5 (0.0-5.0)	0.5 (0.0-5.1)	2.2 (0.0-8.6)	0.4 (0.0-1.7)
2007	2.3 (0.0-11.7)	0.5 (0.0-6.3)	0.6 (0.0-7.4)	0.1 (0.0-3.4)
2008	1.4 (0.0-33.5)	1.1 (0.0-4.8)	1.2 (0.0-9.3)	0.2 (0.0-1.2)
2009	1.6 (0.0-12.5)	1.5 (0.0-5.7)	2.4 (0.0-7.7)	0.2 (0.0-5.0)
2010	0.8 (0.0-9.6)	0.6 (0.0-13.6)	3.8 (0.0-15.7)	0.2 (0.0-3.7)
2011	1.0 (0.0-41.7)	1.0 (0.0-8.5)	2.1 (0.0-9.1)	0.1 (0.0-2.5)
2012**	2.5 (0.0-15.4)	1.8 (0.0-4.3)	6.8 (0.0-11.0)	0.3 (0.0-4.8)

** Migration year 2012 data are through October 17.

Weighted average mortality rates at the various projects were variable among the years analyzed. For the Snake River projects, there does not seem to be a discernible pattern in the weighted average mortality rates among the years (Tables 1-3). The same seems to be true for MCN and JDA, as weighted average mortality rates in more recent years are within the range of what was observed in previous years (Tables 4 and 5). However, at BON, weighted average mortality rates seem to have increased over the past five years (2008-2012), when compared to the previous six years (2002-2007) (Table 6). This increase in weighted average mortality since 2008 is particularly evident for subyearling Chinook and sockeye (Table 6).

The increases in mortality at BON since 2008 coincides with modifications that were made to the juvenile bypass system at the second powerhouse (PH2) prior to the 2008 out-migration. These modifications were made in order to improve the proportion of fish passing through the system. A study conducted by Hughes et al. (2011) obtained information on velocity measurements near the screens. Results of this COE funded study revealed that the approach velocities in the gate wells exceeded criteria intended to improve fish passage conditions recommended by National Marine Fisheries Service and the Washington State Department of Fish and Wildlife, particularly when PH2 was operated at the upper 1% efficiency range. The high velocities and turbulent conditions under these operations could cause impingement, impact, or descaling of juvenile salmonids before they exit through the orifice into the juvenile fish bypass channel. Since 2008, the salmon managers have made many requests to operate the turbines in PH2 at or below the mid-range of the 1% efficiency range and spill additional water if necessary. While some of these requests have been granted, there are still occasions when the preferred mid-range operation has not been met, particularly during periods of high flows.

Descaling:

Descaling data are collected at all SMP sites on all target salmonid species that are encountered in the sample. Examinations for descaling follow the original Fish Transportation Oversight Team (FTOT) protocol established in the 1980's, where a fish is recorded as descaled if at least 20% of the scales are missing on either side. Descaling is defined as areas of the fish where scales have been removed by mechanical or other means (including predators) and scales have not regenerated or healed sufficiently. FPC staff summarized the last 11 years of descaling data at each of the FCRPS projects for yearling Chinook, subyearling Chinook, steelhead, and sockeye. Chinook and coho fry were not included in these analyses, nor were those fish that are examined for gas bubble trauma. When summarizing descaling data, we only included days where a minimum of 20 individuals were examined for descaling. This was done in order to remove days with low sample sizes and, thus, potentially inflated descaling rates. Daily descaling estimates were then weighted, based on the daily passage index. This weighting allowed us to estimate a weighted average descaling rate for each of the 11 migration years. A weighted average descaling rate is a more fair representation of the overall annual descaling, as it gives more weight to the days where a higher number of juveniles passed, versus giving equal weight to all days. Tables 7 through 12 provide summaries of the seasonal descaling rates for each of the FCRPS sites over the past 11 years.

Table 7. Weighted average descaling rates (percent) for subyearling Chinook (CH0), yearling Chinook (CH1), Sockeye (SO), and Steelhead (ST) at LGR. Minimum and maximum descaling rates are provided in parentheses.

Year	CH0	CH1	SO	ST
2002	0.5 (0.0-14.0)	2.4 (0.0-20)	9.9 (0.0-25.0)	4.6 (0.0-15.8)
2003	0.3 (0.0-19.6)	1.8 (0.0-8.0)	N/A	3.8 (0.0-12.5)
2004	0.6 (0.0-17.6)	3.7 (0.0-20.1)	1.4 (0.0-4.8)	3.3 (0.0-11.4)
2005	0.4 (0.0-17.4)	1.9 (0.0-12.7)	4.3 (0.0-7.4)	3.2 (0.0-10.3)
2006	0.3 (0.0-28.8)	1.5 (0.0-5.0)	N/A	2.9 (0.0-13.5)
2007	0.3 (0.0-15.0)	1.5 (0.0-4.8)	2.5 (0.0-6.5)	3.2 (0.0-9.7)
2008	0.5 (0.0-10.9)	1.3 (0.0-7.5)	2.1 (0.0-9.5)	2.4 (0.0-8.6)
2009	0.9 (0.0-28.6)	2.1 (0.0-11.1)	N/A	1.1 (0.0-7.5)
2010	0.6 (0.0-13.8)	1.1 (0.0-4.8)	N/A	2.2 (0.0-10.8)
2011	0.8 (0.0-10.8)	2.2 (0.0-13.5)	1.3 (0.0-11.8)	2.6 (0.0-15.4)
2012**	1.6 (0.0-18.7)	2.3 (0.0-8.1)	2.1 (0.0-9.1)	2.3 (0.0-8.9)

* For sockeye, there were no days in 2003, 2006, and 2010 where the number of individuals examined for descaling met or exceeded 20 fish and only one day in 2009.
** Migration year 2012 data are only through October 17.

Table 8. Weighted average descaling rates (percent) for subyearling Chinook (CH0), yearling Chinook (CH1), Sockeye (SO), and Steelhead (ST) at LGS. Minimum and maximum descaling rates are provided in parentheses.

Year	CH0	CH1	SO	ST
2002	1.4 (0.0-9.8)	3.9 (0.0-19.1)	9.9 (0.0-13.0)	3.1 (0.0-8.9)
2003	1.9 (0.0-10.0)	5.8 (0.0-13.6)	N/A	6.3 (0.0-19.8)
2004	4.4 (0.0-14.7)	3.8 (0.0-16.1)	N/A	6.0 (0.0-34.8)
2005	2.0 (0.0-12.8)	5.4 (0.0-18.5)	7.5 (0.0-18.2)	10.6 (0.0-17.8)
2006	0.8 (0.0-9.4)	2.5 (0.0-11.1)	N/A	2.7 (0.0-9.7)
2007	1.2 (0.0-20.8)	3.5 (0.0-11.8)	N/A	3.5 (0.0-20.0)
2008	0.5 (0.0-6.9)	0.8 (0.0-3.6)	N/A	0.5 (0.0-3.4)
2009	0.4 (0.0-4.2)	0.7 (0.0-5.4)	0.0 (0.0-0.0)	0.5 (0.0-4.8)
2010	0.3 (0.0-9.5)	0.4 (0.0-4)	N/A	0.3 (0.0-6.9)
2011	0.2 (0.0-15.2)	0.5 (0.0-4.0)	N/A	0.2 (0.0-3.7)
2012**	0.4 (0.0-6.9)	0.8 (0.0-3.7)	N/A	0.6 (0.0-6.7)

* For sockeye, there were no days in 2003, 2004, 2006, 2007, 2010, and 2012 where the number of individuals examined for descaling met or exceeded 20 fish and only one day in 2008 and 2011.

** Migration year 2012 data are only through October 17.

Table 9. Weighted average descaling rates (percent) for subyearling Chinook (CH0), yearling Chinook (CH1), Sockeye (SO), and Steelhead (ST) at LMN. Minimum and maximum descaling rates are provided in parentheses.

Year	CH0	CH1	SO	ST
2002	1.4 (0.0-10.0)	2.6 (0.0-14.3)	7 (0-18.5)	5.0 (0.0-21.7)
2003	1.0 (0.0-13.3)	2.8 (0.0-9.7)	N/A	4.3 (0.0-22.2)
2004	1.2 (0.0-9.5)	2.1 (0.0-7.9)	N/A	5.4 (0.0-23.1)
2005	1.4 (0.0-11.1)	3.0 (0.0-16.7)	21.2 (13.3-26.9)	5.5 (0.0-22.7)
2006	1.7 (0.0-11.5)	4.1 (0.0-12.2)	4.4 (0.0-7.1)	5.0 (0.0-15.8)
2007	2.9 (0.0-11.1)	6.7 (0.0-14.3)	N/A)	6.3 (0.0-27.5)
2008	2.5 (0.0-13.3)	4.1 (0.0-13.8)	4.9 (0.0-8.0)	6.5 (0.0-30.4)
2009	0.9 (0.0-9.3)	2.0 (0.0-6.1)	0.0 (0.0-0.0)	3.3 (0.0-8.9)
2010	2.0 (0.0-7.7)	2.9 (0.0-11.1)	N/A	4.6 (0.0-20.0)
2011	1.9 (0.0-6.9)	4.4 (0.0-8.5)	4.3 (0.0-4.8)	6.2 (0.0-16.7)
2012	1.0 (0.0-14.3)	2.5 (0.0-7.5)	3.1 (0.0-12.5)	3.3 (0.0-10.4)

* For sockeye, there were no days in 2003, 2004, and 2010 where the number of individuals examined for descaling met or exceeded 20 fish and only one day in 2007.

Table 10. Weighted average descaling rates (percent) for subyearling Chinook (CH0), yearling Chinook (CH1), Sockeye (SO), and Steelhead (ST) at MCN. Minimum and maximum descaling rates are provided in parentheses.

Year	CH0	CH1	SO	ST
2002	1.4 (0.0-9.5)	5.0 (0.0-11.8)	8.9 (0.9-34.4)	6.5 (0.0-30)
2003	1.7 (0.0-9.4)	7.1 (1.6-17.4)	5.9 (1.5-29.5)	9.7 (0.0-17.3)
2004	0.8 (0.2-16.7)	6.9 (0.0-15.2)	17.7 (5.0-29.4)	6 (0.0-15.2)
2005	1.3 (0.0-15)	4.8 (0.0-20.8)	13.4 (4.1-26.1)	5.9 (0.0-10.5)
2006	1.1 (0.0-10.6)	5.5 (0.0-10.6)	8.1 (1.6-25.7)	3.8 (0.0-8.7)
2007	1.2 (0.0-9.2)	4.4 (0.0-9.4)	9.4 (0.0-28.1)	3.8 (0.0-15)
2008	1.9 (0.0-8.7)	4.2 (0.0-6.8)	8.3 (0.0-24)	5.8 (0.0-19.1)
2009	0.8 (0.0-12.5)	2.0 (0.0-8.1)	4.5 (0.0-26.9)	2.0 (0.0-12.5)
2010	1.2 (0.0-8.0)	4.0 (0.0-8.4)	7.0 (1.8-28)	3.5 (0.0-8.8)
2011	1.4 (0.0-5.8)	3.3 (1.2-10.1)	5.6 (0.0-39.3)	3.1 (0.0-10.8)
2012	1.5 (0.0-6.3)	2.9 (0.0-9.1)	4.4 (1.7-14.3)	3.9 (0.0-19.2)

Table 11. Weighted average descaling rates (percent) for subyearling Chinook (CH0), yearling Chinook (CH1), Sockeye (SO), and Steelhead (ST) at JDA. Minimum and maximum descaling rates are provided in parentheses.

Year	CH0	CH1	SO	ST
2002	1.1 (0.0-5.1)	3.5 (0.0-10.0)	9.3 (1.7-28.8)	5.6 (0.0-50.0)
2003	1.0 (0.0-8.3)	5.4 (0.0-10.5)	4.0 (0.0-9.9)	7.0 (0.0-32.0)
2004	0.8 (0.0-4.0)	3.6 (0.0-8.2)	5.4 (0.0-11.8)	2.2 (0.0-7.4)
2005	1.3 (0.0-14.3)	1.8 (0.0-10.9)	5.4 (0.0-15.6)	2.6 (0.0-16.7)
2006	1.7 (0.0-10.3)	5.2 (1.4-18.5)	11.2 (2.1-36.7)	8.2 (0.0-23.1)
2007	1.2 (0.0-8.0)	3.3 (0.0-10.0)	9.8 (4.0-22.6)	5.2 (0.0-26.7)
2008	2.1 (0.0-8.7)	3.5 (0.0-15.9)	7.8 (2.4-26.9)	6.3 (1.4-17.8)
2009	1.5 (0.0-10.0)	2.6 (0.0-10.5)	5.1 (0.0-19.0)	2.9 (0.0-11.7)
2010	2.9 (0.0-9.7)	3.9 (0.0-10)	6.2 (0.0-21.9)	6.6 (2.3-25.0)
2011	1.8 (0.0-7.2)	2.8 (0.0-15.7)	6.5 (0.0-22.7)	3.7 (0.0-30.4)
2012	1.0 (0.0-5.6)	2.5 (0.0-11.8)	5.8 (0.0-18.5)	3.6 (0.0-18.2)

Table 12. Weighted average descaling rates (percent) for subyearling Chinook (CH0), yearling Chinook (CH1), Sockeye (SO), and Steelhead (ST) at BON. Minimum and maximum descaling rates are provided in parentheses.

Year	CH0	CH1	SO	ST
2002	0.4 (0.0-7.6)	2.6 (0.0-12.1)	6.0 (0.0-16.7)	4.8 (0.0-15)
2003	0.7 (0.0-16.1)	3.4 (0.0-12.8)	5.5 (0.0-15.4)	6.5 (0.0-20)
2004	0.5 (0.0-3.8)	2.5 (0.0-14.3)	7.8 (0.0-15.7)	4.5 (0.0-16)
2005	0.4 (0.0-3.2)	3.2 (0.0-11.7)	10.3 (0.0-17.4)	3.6 (0.0-13.6)
2006	0.4 (0.0-10.8)	3.4 (0.0-12.3)	14.1 (3.4-40.9)	3.2 (0.0-16.0)
2007	0.6 (0.0-6.7)	3.0 (0.0-14.4)	10.3 (2.5-22.6)	4.0 (0.0-21.4)
2008	0.6 (0.0-9.1)	5.3 (0.0-18.6)	12.2 (0.7-39.3)	3.3 (0.0-14.3)
2009	0.6 (0.0-5.9)	4.7 (0.0-15.3)	21.1 (2.1-29.6)	2.8 (0.0-10.8)
2010	0.6 (0.0-5.8)	2.7 (0.0-17.4)	12.5 (0.0-47.5)	2.3 (0.0-9.8)
2011	0.5 (0.0-4.9)	3.5 (0.0-11.8)	12.0 (0.0-41.2)	2.1 (0.0-6.7)
2012**	0.8 (0.0-5.9)	4.3 (0.0-16.7)	15.1 (0.0-24.1)	2.7 (0.0-10.0)

** Migration year 2012 data are only through October 17.

As with mortality rates, weighted average descaling rates at the various projects were variable between the years we analyzed. For most of the projects, there does not seem to be a discernible pattern in the weighted average descaling rates among the years, except LGS (Tables 7-12). At LGS, weighted average descaling rates seem to have decreased over the past five years (2008-2012), when compared to the previous six years (2002-2007) (Table 8). Finally, when compared to other species and other sites, sockeye juveniles at BON consistently had higher weighted average descaling rates over the 11 years we analyzed (Table 12).

Injuries:

SMP sites have been collecting and reporting standardized condition data to the FPC since 2009. In general, the target for condition monitoring is to collect detailed condition data on a subsample of each species that enters the sample, each day (or every other day at some sites). In general, the target for these subsamples is approximately 100 individuals of each species per day. There are several physical injuries that are included in this monitoring, including: 1) head injuries, 2) eye injuries, 3) operculum injuries, 4) body injuries, and 5) fin injuries. When assessing physical injuries, SMP personnel only record injuries that are not attributable to predators, disease, or parasites. Injuries that are attributable to predators, disease, or parasites are recorded in a separate category. For more information on the protocol for condition monitoring sampling, see the Condition Monitoring Protocol Manual at ftp://ftp.fpc.org/FPC32.net/Manuals/ConditionSamplingProtocol_2012.pdf.

For this data request, FPC staff summarized the last four years of injury data at each of the FCRPS projects for yearling Chinook, subyearling Chinook, steelhead, and sockeye. When summarizing injury data, we only included days where a minimum of 20 individuals were examined for injuries. This was done in order to remove days with low sample sizes and, thus, potentially inflated injury rates. To avoid double-counting, fish that exhibited multiple signs of injury were counted as a single injured fish. Daily estimates of injury rate were then weighted, based on the daily passage index. This weighting allowed us to estimate a weighted average injury rate for each of the four migration years. A weighted average injury rate is a more fair representation of the overall annual injury rate, as it gives more weight to the days where a higher number of juveniles passed, versus giving equal weight to all days. Table 13 provides a summary of the annual injury rate for each of the FCRPS sites over the four years of available data.

Table 13. Weighted average injury rates (percent) for subyearling Chinook (CH0), yearling Chinook (CH1), Sockeye (SO), and Steelhead (ST) at FCRPS projects. Minimum and maximum descaling rates are provided in parentheses.

Site	Year	CH0	CH1	SO	ST
LGR**	2009	0.7 (0.0-4.5)	0.5 (0.0-52.4)	N/A*	1.5 (0.0-10.0)
	2010	0.8 (0.0-5.0)	0.7 (0.0-12.5)	N/A*	2.2 (0.0-12.5)
	2011	0.7 (0.0-8.0)	0.9 (0.0-9.5)	0.2 (0.0-3.9)	1.8 (0.0-15.0)
	2012	1.3 (0.0-10.0)	1.0 (0.0-6.0)	2.2 (0.0-4.5)	2.6 (0.0-13.6)
LGS**	2009	0.8 (0.0-4.0)	1.0 (0.0-29.7)	8.1 (7.4-8.7)	2.2 (0.0-27.5)
	2010	0.3 (0.0-2.2)	0.9 (0.0-6.3)	N/A*	1.0 (0.0-4.9)
	2011	0.7 (0.0-10.3)	0.5 (0.0-3.5)	N/A*	2.1 (0.0-9.7)
	2012	4.2 (0.0-27.1)	1.9 (0.0-10.8)	N/A*	1.7 (0.0-11.8)
LMN	2009	1.7 (0.0-22.8)	1.8 (0.0-16.7)	0.0 (0.0-0.0)	8.3 (0.0-38.5)
	2010	5.2 (0.0-71.8)	10.0 (0.0-34.8)	N/A*	13.6 (1.8-33.3)
	2011	4.7 (0.0-57.4)	11.5 (0.0-39.6)	4.3 (0.0-4.8)	17.4 (1.0-50.0)
	2012	2.0 (0.0-38.1)	2.6 (0.0-9.8)	1.3 (0.0-8.7)	7.2 (0.0-22.7)
MCN	2009	0.8 (0.0-8.3)	1.4 (0.0-5.0)	0.4 (0.0-3.4)	2.6 (0.0-11.1)
	2010	1.1 (0.0-9.1)	1.0 (0.0-4.5)	1.2 (0.0-3.6)	2.6 (0.0-5.0)
	2011	1.2 (0.0-5.8)	2.0 (0.0-7.4)	6.7 (0.0-12)	3.8 (0.0-9.3)
	2012	1.0 (0.0-5.3)	2.4 (0.0-7.7)	2.6 (0.0-7.7)	4.8 (1.3-9.7)
JDA	2009	3.0 (0.0-8.2)	5.1 (0.0-16.5)	5.6 (0.0-17.9)	7.7 (0.0-16.1)
	2010	2.9 (0.0-25.7)	3.6 (0.0-40.0)	3.5 (0.0-9.4)	6.8 (0.0-23.1)
	2011	1.7 (0.0-7.0)	3.1 (0.0-45.0)	4.7 (0.0-32.0)	7.7 (0.5-34.5)
	2012	1.5 (0.0-9.1)	3.0 (0.0-18.4)	3.5 (0.0-12.5)	4.8 (0.0-11.7)
BON**	2009	1.0 (0.0-5.7)	2.0 (0.0-9.5)	4.9 (0.0-25.9)	7.2 (0.0-16.0)
	2010	1.3 (0.0-6.3)	1.9 (0.0-10.7)	4.7 (0.0-15.4)	5.8 (0.0-14.6)
	2011	2.0 (0.0-7.9)	2.6 (0.0-8.8)	7.8 (2.5-11.8)	8.1 (0.0-18.6)
	2012	1.8 (0.0-8.7)	2.9 (0.0-14.3)	5.9 (0.0-15.1)	6.0 (2.9-21.4)

* There were too few days (≤1) where the number of individuals examined for injuries met or exceeded 20 fish to calculate a weighted average injury rate.
** Migration year 2012 data are only through October 17.

Weighted average injury rates were also variable between sites and years. With only four years of data, it is difficult to detect discernible patterns in the weighted average injury rates among the years (Table 13). However, among species, it appears that steelhead had the highest weighted average injury rates. This appears to be the case at all the FCRPS sites (Table 13).

Gas Bubble Trauma (GBT):

The goal of the juvenile salmonid gas bubble trauma (GBT) monitoring program is to determine the relative extent that migrating juvenile salmonids have been exposed to harmful levels of total dissolved gas. The determination is based upon the prevalence and severity of GBT induced bubbles on the fish. Gas Bubble Trauma monitoring is conducted at FCRPS projects on the Lower Columbia and Snake River including: BON, MCN, LGR, LGS, and LMN. In general, sampling occurs two days per week at the Lower Columbia River sites and one day a week at each of the Snake River sites throughout the spring and summer spill programs. One exception is LGR, where no GBT monitoring takes place during the summer.

The goal of the sampling program is to sample 100 salmonids of the most prevalent species (limited to Chinook and steelhead) during each day of sampling at each site, with the proportion of each species sampled dependent upon their prevalence at the time of sampling. Yearling Chinook and steelhead are sampled through the spring. Once subyearling Chinook predominate the smolt collections, the program shifts from sampling yearling Chinook and steelhead to sampling subyearling Chinook, which continues through the end of August.

Fish to be examined for GBT are collected at the separator at LGR, LGS, LMN, and MCN and by the standard collection methods at BON. Examinations are done using variable magnification dissecting scopes. The eyes and unpaired fins are examined for the presence of bubbles. The bubbles present are quantified using a ranking system based on the percent area of the fins or eyes covered with bubbles. The action criteria for GBT is established as 15% of fish showing any signs of GBT, or 5% of the fish sampled showing severe signs.

For this data request, FPC staff summarized the last 11 years of GBT data at each of the five FCRPS projects where GBT monitoring takes place. The nature of GBT sampling does not allow for the estimation of a weighted average GBT rate. Therefore, the average GBT rate for each year is simply the average of the weekly or biweekly GBT samples for a given project.

Table 14. Average GBT rates (percent) for Chinook and Steelhead at LGR, LGS, LMN, MCN, and BON. Minimum and maximum descaling rates are provided in parentheses.

Year	LGR	LGS	LMN	MCN	BON
2002	0.2 (0.0-2.0)	0.4 (0.0-2.8)	6.5 (0.0-27.4)	0.2 (0.0-3.0)	0.0 (0.0-0.0)
2003	0.0 (0.0-0.0)	1.7 (0.0-7.0)	2.6 (0.0-10.0)	0.1 (0.0-3.0)	0.0 (0.0-0.0)
2004*	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.1 (0.0-1.0)
2005**	N/A	0.6 (0.0-4.0)	0.0 (0.0-0.0)	0.0 (0.0-1.0)	0.0 (0.0-0.0)
2006	0.3 (0.0-2.0)	3.7 (0.0-17.0)	3.5 (0.0-17.9)	0.0 (0.0-0.0)	0.9 (0.0-10.0)
2007	0.0 (0.0-0.0)	10.0 (0.0-46.8)	6.3 (0.0-41.5)	0.0 (0.0-0.0)	1.2 (0.0-7.5)
2008	0.0 (0.0-0.0)	1.8 (0.0-25.0)	1.3 (0.0-12.0)	0.1 (0.0-1.0)	0.3 (0.0-1.9)
2009	0.0 (0.0-0.0)	0.2 (0.0-1.7)	0.0 (0.0-0.0)	0.0 (0.0-1.0)	0.5 (0.0-2.5)
2010	0.0 (0.0-0.0)	1.5 (0.0-15.0)	0.9 (0.0-5.0)	0.0 (0.0-0.0)	0.0 (0.0-1.0)
2011	0.0 (0.0-0.0)	1.0 (0.0-13.9)	2.2 (0.0-23.0)	0.8 (0.0-5.0)	0.3 (0.0-3.2)
2012	0.1 (0.0-1.0)	0.1 (0.0-1.2)	0.2 (0.0-2.0)	0.9 (0.0-8.1)	0.3 (0.0-2.4)

* GBT monitoring at Snake River sites was limited to three weeks in April.
** Due to no voluntary spill, there was no GBT monitoring at the Snake River sites in the spring of 2005. GBT monitoring at LGS and LMN began with the initiation of summer spill in late June.

Previous reviews of the GBT monitoring program have found that signs of GBT are minimal when total dissolved gas (TDGS) is managed to 115% forebay/120% tailrace criteria. In fact, very few signs of GBT are observed when TDGS levels are near 120% in the forebay. Historical observations suggest that signs of GBT begin to approach action criteria when TDGS in the tailraces or forebays are near the 130% supersaturation levels (2011 FPC Annual Report). However, it is important to note that when TDGS levels approach the 130% range the FCRPS is typically in an uncontrolled spill situation, and there are no actions that can be taken to reduce TDGS.

Discussion:

Mortality, descaling, injury, and GBT data are used at the FCRPS projects to address possible management concerns as they occur. Sudden increases in mortality, descaling, injury, and/or GBT are generally cues that there may be a problem with the project or project operations and that management actions may be warranted. Given that these different metrics fluctuate daily, it is important to note that focusing solely on annual estimates is not sufficient to adequately describe what was seen in a particular year.

For example among the years we reviewed, the weighted average mortality rate for subyearling Chinook at LGR ranged from 0.8% to 2.8%, which is relatively low (Table 1). However, the maximum daily mortality rate in these years ranged from 5.9% to as high as 20.0% (Table 1). Examples like this can be seen at all the sites for all of the various condition metrics that we have summarized for this data request.

Furthermore, without looking at the daily data, it is difficult to determine whether a high weighted average estimate is due to a single event or events that occurred in that year or if levels were elevated for the entire season. For example, the weighted average descaling rate for subyearling Chinook at LGR in 2012 was the highest among the years we analyzed (Table 7). When the daily descaling rates are plotted over the entire year, it becomes clear that this high weighted average descaling rate is partially due to higher than average descaling rates in June and early September through October (Figure 1). Again, this is just one example of why it is important to consider the daily rates of mortality, descaling, injury, and GBT when evaluating management actions.

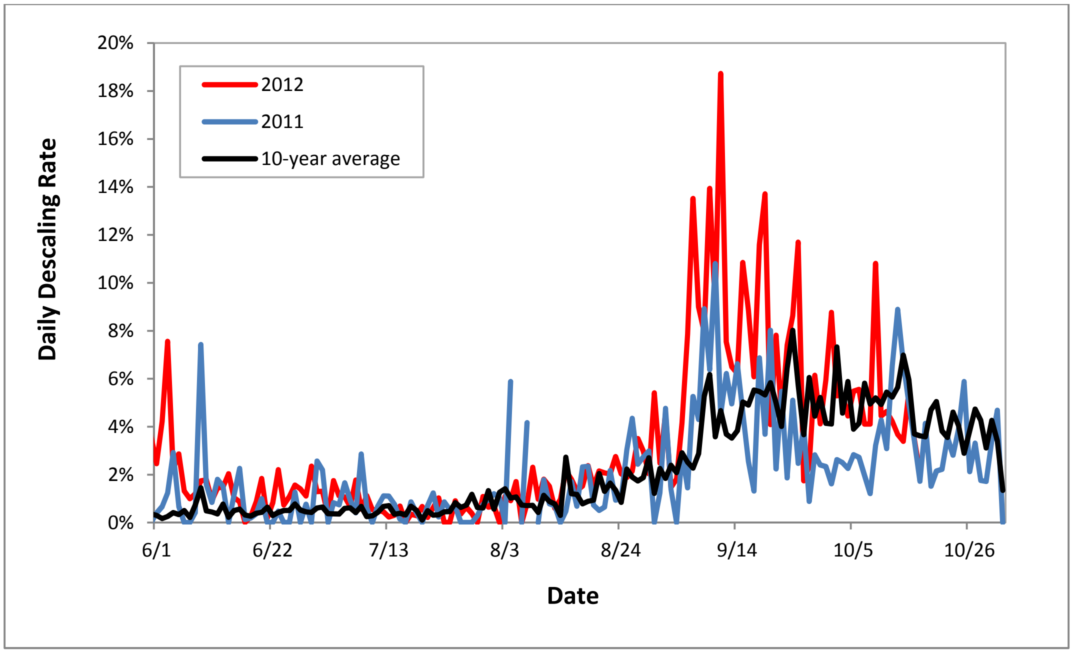

Figure 1. Daily descaling rates of subyearling Chinook at LGR in 2012, 2011 and the 10-year average (2002-2011). Descaling data for 2012 are only through October 17th.

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DATA REQUEST FORM

Request Taken By: Michele DeHart **Date:** 3-oct-2012

Data Requested By:

Name: Christine Petersen (BPA) **Phone:**

Address: **Fax:**

Email: chpetersen@bpa.gov

Data Requested:

summarize descaling, injury, GBT, mortality data from SMP (10 years)

Data Format: Hardcopy ☐ Text ☐ Excel ☐

Delivery: Mail ☐ Email ☐ Fax ☐ Phone ☐

Comments:

Data Compiled By: [signature] **Date:** 18-oct-2012

Request # 59

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