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MEMORANDUM

TO: Bill Tweit (WDFW)

Michele DeHart

FROM: Michele DeHart

DATE: February 13, 2008

RE: Data request regarding higher adult mortality for Upper Columbia spring Chinook and steelhead (BON-MCN) compared to Snake River spring/summer Chinook and steelhead (BON-LGR), as reported in 2007 Draft BiOp.

Per your request, the FPC has looked into data presented in the 2007 Draft BiOp (Table 12.1 of Draft BiOp) that indicates differences in adult mortality between Upper Columbia (UCOL) spring Chinook and Snake River (SR) spring/summer Chinook, and UCOL steelhead and SR steelhead (return years 2002-2006). The mortalities reported in the 2007 Draft BiOp for UCOL runs were for the Bonneville to McNary reach (3 dams), while those for the SR runs were for the Bonneville to Lower Granite reach (7 dams). Despite the shorter reach for the UCOL runs, the adult mortalities reported for these runs were higher than those for the SR runs.

The results from our analyses are presented below, followed by a more detailed discussion. One thing to point out is that the adult mortality estimates from NOAA's Draft BiOp were adjusted for estimated harvest and straying rates. Since it is unknown what harvest and straying rates were used in NOAA's estimates, FPC staff did not adjust adult mortality to account for harvest or straying.

- Unlike the NOAA analysis, UCOL spring Chinook had lower adult mortality from BON to MCN than did SR spring/summer Chinook from BON to LGR, although this was not significant.
- With UCOL summer Chinook added to analysis (12W, 12H, and 12U) adult mortality of UCOL Chinook from BON to MCN was slightly higher than that for SR spring/summer Chinook from BON to LGR. However, this difference was not significant. Given these results, it is possible that NOAA inadvertently included UCOL summer Chinook in their analysis.

- Increased adult mortality of UCOL Chinook (with addition of summer Chinook) may be result of increased passage and higher adult mortality in July.
- Similar to NOAA's analysis, UCOL steelhead had higher adult mortality from BON to MCN than did SR steelhead from BON to LGR, although this difference was not significant. Monthly adult mortality (BON-MCN) for UCOL steelhead was more variable and consistently higher than that for SR steelhead.

Chinook:

FPC staff analyzed detections of PIT-tagged adults for UCOL spring Chinook and SR spring/summer Chinook from 2002 to 2006. Specifically, detections at the adult facilities at Bonneville (BON), McNary (MCN), and Lower Granite (LGR) dams were used in these analyses. Only individuals who out-migrated in-river were considered in this analysis. For both groups of Chinook, adult detections that occurred in the same year as their out-migration (i.e., mini-jacks) were not considered in this analysis. For UCOL spring Chinook, this analysis included PIT-tagged individuals that were coded as 11W, 11H, 11U, 15W, 15H, or 15U. We did not include 12W, 12H, or 12U individuals in this analysis, as these codes are typically used for UCOL summer Chinook. For SR spring/summer Chinook, PIT-tagged individuals that were coded as 11W, 11H, 11U, 12W, 12H, 12U, 15W, 15H, or 15U were included.

By including individuals coded as 15W, 15H, or 15U, it is possible that some unintended UCOL summer/fall Chinook or SR fall Chinook may have been included for this analysis. To eliminate possible UCOL summer/fall Chinook FPC staff removed any 15H or 15U individuals that were released as juveniles after mid-late June, as this is typically when summer/fall Chinook begin their out-migration. To eliminate possible SR fall Chinook, FPC staff removed all 15W, 15H, or 15U individuals that were detected as adults at Bonneville Dam after July 15 AND were released as juveniles after June 1.

After removing non-target tagged fish, FPC staff estimated an average adult mortality from BON to MCN for each run and compared these means with a two-sample t-test (assuming equal variances). In addition, for SR spring/summer Chinook, FPC staff estimated average adult mortality from BON to LGR.

FPC analyses revealed that average adult mortality from BON to MCN for UCOL spring Chinook was slightly lower than that for SR spring/summer Chinook, although this difference was not significant ($p=0.87$) (Table 1). Furthermore, average adult mortality of UCOL spring Chinook (BON-MCN) was lower than that for SR spring/summer Chinook (BON-LGR) (Table 1). However, this difference was also not significant ($p=0.29$).

Table 1. Average annual adult mortality for UCOL spring Chinook and SR spring/summer Chinook for return years 2002-2006.

			95% Confidence Interval	
ESU	**Reach**	**Mean Mortality**	**Lower Limit**	**Upper Limit**
UCOL Spring Chinook	BON-MCN	14.9	12.6	17.3
SR Sp/Su Chinook	BON-MCN	15.2	12.6	17.8
SR Sp/Su Chinook	BON-LGR	17.5	13.6	21.4

These results are contrary to the pattern reported in NOAA's Draft BiOp. One possible explanation for this is the fact that our analyses do not adjust mortality by harvest or straying. If NOAA's adjusted mortalities included differential harvesting or straying between the two runs, than these differential adjustments may have been enough to reverse the pattern indicated by our analyses. However, without knowing what harvest and straying rates were used, there is no way for FPC to investigate this. If harvest and straying rates were applied at a similar level for both populations, then some other mechanism must be contributing to the difference between these two analyses.

Given the peculiar nature of UCOL Chinook stocks (i.e., summer Chinook out-migrate in mid-late summer but return in spring and summer), FPC staff hypothesized that NOAA's analysis may have included UCOL summer Chinook, which may have resulted in a higher adult mortality estimate for the UCOL Chinook. To explore this hypothesis, FPC staff re-ran the above analysis with UCOL summer Chinook (12W, 12H, and 12U) included. As with the previous analysis, any UCOL summer Chinook that returned in the same year as their out-migration were removed. Results for the new UCOL Chinook group are presented in Table 2.

Table 2. Average annual adult mortality for UCOL spring/summer Chinook for return years 2002-2006.

			95% Confidence Interval	
ESU	**Reach**	**Mean Mortality**	**Lower Limit**	**Upper Limit**
UCOL Sp/Su Chinook	BON-MCN	18.7	16.3	21.1

Adding UCOL summer Chinook to this analysis resulted in an increased average adult mortality for the BON to MCN reach (Table 2) compared to that for the UCOL spring Chinook only (Table 1). In fact, with UCOL summer Chinook included, the average adult mortality from BON to MCN for UCOL Chinook was higher than that for SR spring/summer Chinook, although this difference was not significant ($p=0.09$). Furthermore, average adult mortality of UCOL spring/summer Chinook (BON-MCN) was higher than that for SR spring/summer Chinook (BON-LGR). However, this difference was also not significant ($p=0.62$).

These results are more consistent with the pattern that NOAA published in their Draft BiOp. Given this, it is possible that NOAA's analyses may have included UCOL summer Chinook, therefore resulting in higher estimates of mortality. In an attempt to explain this increase in adult mortality with the addition of UCOL summer Chinook, we looked at estimates of average monthly mortality (BON-MCN), based on the month of BON passage. Due to low sample sizes among the different runs, we were only able to estimate monthly mortality for May, June, and July.

Across all three runs (UCOL spring Chinook, UCOL summer Chinook, and SR spring/summer Chinook), adult mortality increased as BON passage month progressed, with July having the highest overall mortality (Figure 1).

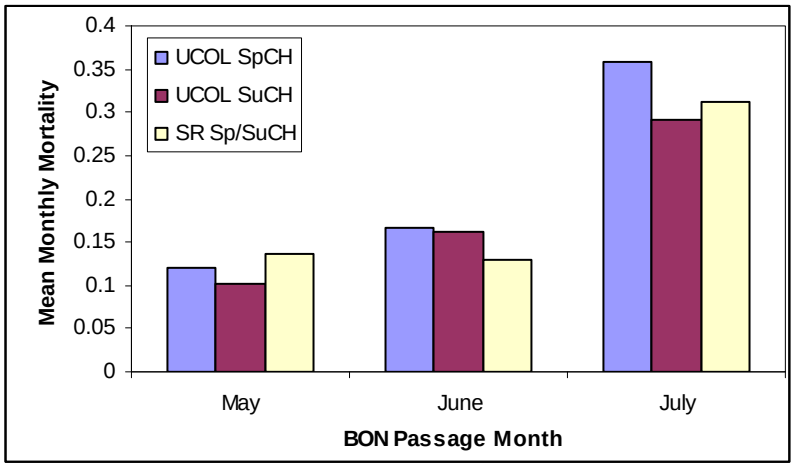

Figure 1. Average monthly adult mortality (BON-MCN) for UCOL spring Chinook (UCOL SpCH), UCOL summer Chinook (UCOL SuCH), and SN spring/summer Chinook (SR Sp/SuCH) for return years 2002-2006.

Given that adult mortality increased as BON passage month progressed, we investigated whether the addition of UCOL summer Chinook, which tend to migrate later, may have shifted run-timing of UCOL Chinook to later in the season. Therefore, a shift to a time period of higher adult mortality could have contributed to the increased overall mortality for this population.

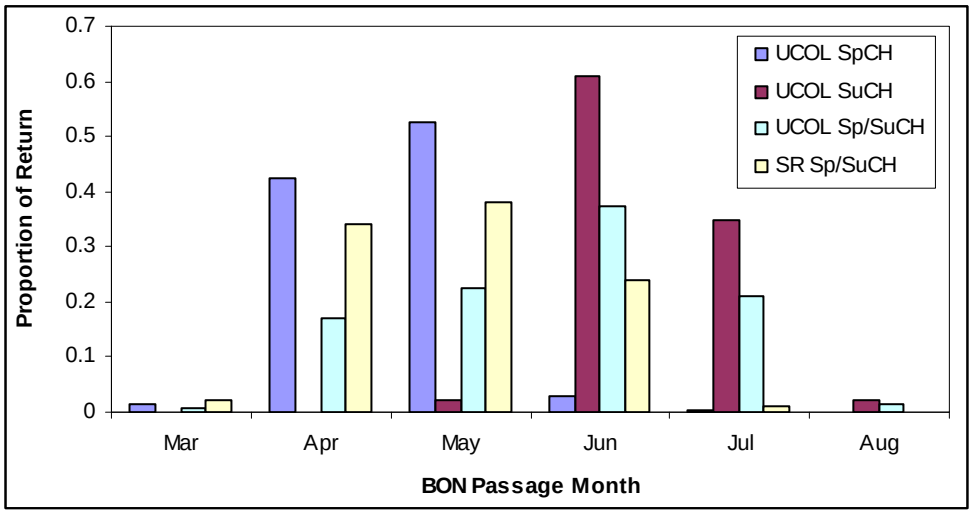

Figure 2. Monthly passage (BON) of UCOL spring Chinook (UCOL spCH), UCOL summer Chinook (UCOL SuCH), UCOL spring/summer Chinook (UCOL Sp/SuCH), and SR spring/summer Chinook (SR Sp/SuCH) for return years 2002-2006.

Approximately 98.5% of SR spring/summer Chinook pass BON by the month of July (Figure 2). Furthermore, the vast majority (>99%) of UCOL spring Chinook pass BON by the month of July, whereas the portion for UCOL summer Chinook is only about 63% (Figure 2). When UCOL spring and summer Chinook are combined, only 77.6% of adults pass BON by July. Given this, it is possible that the later passage of UCOL summer Chinook adults, combined

with the increased adult mortality in July, may have contributed to the increased adult mortality that NOAA reported for UCOL spring Chinook.

Steelhead:

FPC staff analyzed detections of PIT-tagged adults for UCOL and SR steelhead from 2002 to 2006. Specifically, detections at the adult facilities at Bonneville (BON), McNary (MCN), and Lower Granite (LGR) dams were used in these analyses. Only individuals who out-migrated in-river were considered in this analysis. As with the Chinook, adult detections that occurred in the same year as their out-migration were eliminated. This analysis included PIT-tagged individuals that were coded as 32W, 32H, 32U, 35W, 35H, and 35U.

FPC staff estimated an average adult mortality from BON to MCN for each run and compared these means with a two-sample t-test (assuming equal variances). In addition, for SR steelhead, we estimated average adult mortality from BON to LGR. Results from these analyses are presented in Table 3.

Table 3. Average annual adult mortality for UCOL and SR steelhead for return years 2002-2006.

			95% Confidence Interval	
ESU	**Reach**	**Mean Mortality**	**Lower Limit**	**Upper Limit**
UCOL steelhead	BON-MCN	23.7	18.1	29.3
SR steelhead	BON-MCN	17.7	15.1	20.3
SR steelhead	BON-LGR	21.5	18.7	24.3

FPC analyses revealed that average adult mortality from BON to MCN for UCOL steelhead was higher than that for SR steelhead, although this difference was not significant ($p=0.1$). Furthermore, average adult mortality of UCOL steelhead from BON to MCN was only slightly higher than that for SR steelhead from BON to LGR. However, this difference was also not significant ($p=0.52$).

These results are more consistent with the pattern that NOAA published in their Draft BiOp, even though the FPC did not adjust mortality estimates for harvest or straying. As with Chinook, we conducted further analyses of monthly mortality and passage timing of the two groups in order to provide insight as to why UCOL steelhead exhibit higher adult mortality than SR steelhead. Average monthly mortality was based on the month of BON passage. Due to low sample sizes among the different runs, we were only able to estimate monthly mortality for June through October.

Unlike, Chinook, there wasn't a consistent temporal pattern in adult mortality for either UCOL or SR steelhead (Figure 3). However, adult mortality for UCOL steelhead was more variable throughout the season and was consistently higher than that for SR steelhead (except in July) (Figure 3). The adult passage distribution of UCOL steelhead appeared to be more bimodal in nature, compared to the more normal distribution for SR steelhead (Figure 4).

With monthly mortality and monthly passage distribution data, one interesting pattern emerged that may provide insight into the lower mortality among SR steelhead. The lowest monthly mortality estimate (BON-MCN) obtained from this analysis was 11.6%, which was for SR steelhead passing BON in September (Figure 3). This is of importance because SR steelhead passing BON in September make up a large portion of the overall run of SR steelhead adults (approximately 27%) (Figure 4). This lower mortality in September, combined with the increased passage in September may help explain the slightly lower overall mortality of SR steelhead, when compared to UCOL steelhead.

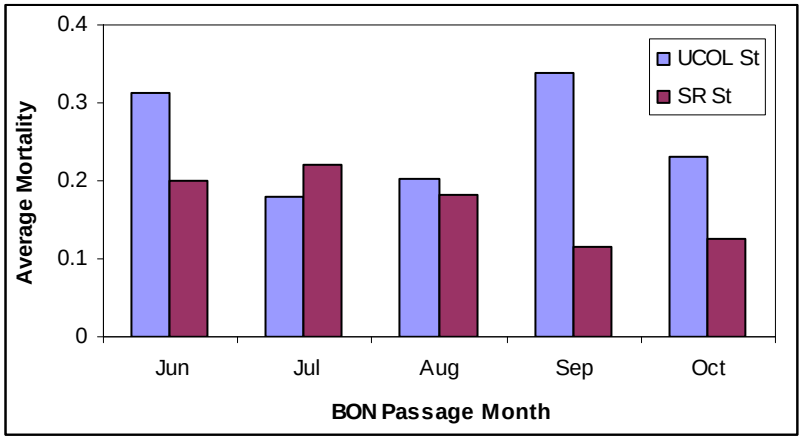

Figure 3. Average monthly adult mortality (BON-MCN) for UCOL steelhead (UCOL St) and SR steelhead (SR St) for return years 2002-2006.

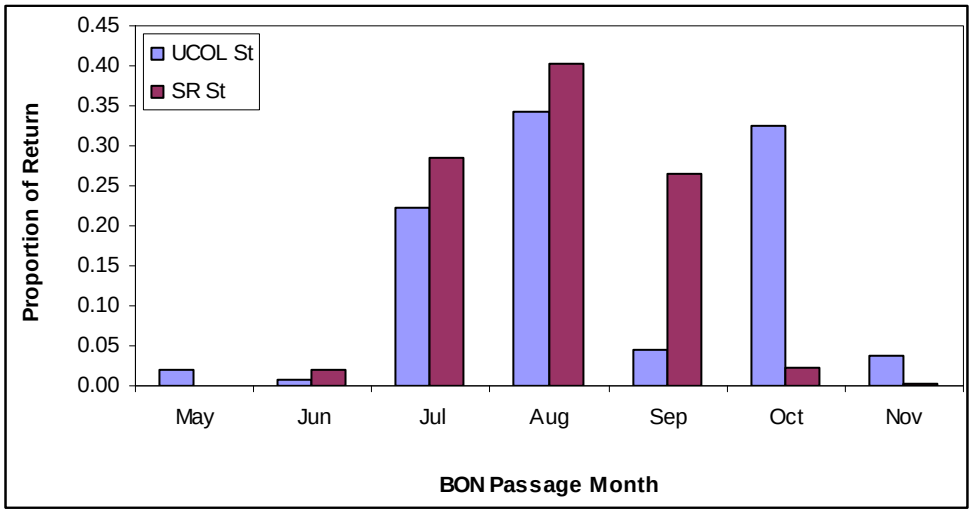

Figure 4. Monthly passage (BON) of UCOL steelhead (UCOL St) and SR steelhead (SR St) for return years 2002-2006.