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MEMORANDUM

TO: Bob Heinith

FROM: Michele DeHart

DATE: August 15, 2006

RE: NOAA Fisheries' Fall Chinook Conversion Rate Estimates

In response to your request, the FPC reviewed the fall Chinook salmon conversion rate analysis presented to the Northwest Power and Conservation Council and provided to you by Ritchie Graves of NOAA Fisheries. Our review addresses two points: 1) whether or not NOAA Fisheries' conversion rate estimates are representative of run-at-large survival conditions; and 2) whether or not the NOAA Fisheries 2005 conversion rate estimates, which were the lowest in their 5-year dataset, can be attributed to project operations (i.e., court-ordered summer spill).

Based on our review, we arrived at the following overall conclusions:

- PIT-tag-based conversion rate estimates may not be representative of the run-at-large due to the differential treatment of tagged versus untagged fish during juvenile outmigration (e.g., whether or not they were transported as smolts).
- Conversion rates based upon the existing PIT tag data may be misleading; therefore, their limited utility for aiding management decisions surrounding project operations and/or harvest management needs to be fully recognized.
- NOAA Fisheries' dataset can not be used to assess the effects of summer spill on adult fall Chinook salmon survival, as PIT-tag detections and fishway counts indicate that very few of these fish were present in the Lower Snake River during the 2005 summer spill operations.
- Given the limited value of using PIT-tag-based fall Chinook conversion rates, the basis for the low values reported for the 2005 migration remains unclear. However, we found an indication that the legacy of juvenile transportation effects (i.e., impaired homing of transported smolts returning as adults) may partly explain the observed pattern.

PIT-tag-based conversion rate estimation and issues

NOAA Fisheries' estimates of fall Chinook conversion rates are for unknown-origin (a combination of wild *and* unmarked-hatchery fish; 13U on PTAGIS) and hatchery-origin (13H) age-2+ salmon (i.e., inclusive of jacks) from 2004-2005 and 2001-2005, respectively (data courtesy of R. Graves, NOAA Fisheries; **Table 1**). By using these tag groups the NOAA Fisheries' representation of "wild" fish includes a significant proportion of hatchery/natural salmon. The conversion rate estimates are based on the PIT-tag data reported at the University of Washington's Columbia Basin Data Access in Real Time (DART) website that are calculated as the proportion of adults detected at a downstream dam (e.g., Bonneville Dam) that are subsequently seen at upstream dams (http://www.cbr.washington.edu/dart/dart.html). NOAA also adjusts these values to account for Zone-6 fishery harvest (Technical Advisory Committee estimates) and inter-dam stray rates (radio telemetry estimates). While there are a number of important issues associated with adjusting conversion rates using NOAA Fisheries' approach, we do not address them here; See Dauble and Mueller (2000) and Caudill et al. (2006) for a complete review of these issues.

In our assessment, we focused primarily on the question of whether or not the existing fall Chinook PIT-tag data could be reliably used for adult conversion-rate estimation. For a number of reasons, we believe that these data cannot, at present, be used to draw inference on run-at-large conversion rates as is implied by the NOAA analysis. First, in order for PIT tags to be utilized in the determination of overall conversion rates, adults should be tagged in proportion to their abundance across populations and the run-at-large. Contrary to this requirement, however, PIT-tags used in adult conversion rate estimation are typically inserted into *juvenile* salmon from particular populations as part of focused research studies. This results in some populations being more heavily represented in the tagged group than others. In addition, tagged juveniles are handled differently than untagged run-at-large juveniles during outmigration; for example, the default operation for PIT-tagged fish is to return them to the river unless alternative treatments for specific studies are applied. These treatment criteria can vary from year to year, raising further questions regarding how well the PIT tag population represents the run-at-large. Further, minimum-size and temperature limitations during juvenile tagging operations, which frequently occur for fall Chinook, make it such that tagged fish may not adequately represent the populations from which they come (i.e., samples may be biased towards larger and sometimes earlier-migrating members of the population). Finally, the potential post-release effects of study treatments on juvenile survival could contribute to the disparity between tagged and untagged populations. Given all these considerations, it is clear that presently the groups of fish PIT-tagged as juveniles are not designed for estimating run-at-large adult passage success/conversion rate monitoring and management.

In addition to poor representation of run-at-large populations, the differential treatment of tagged versus untagged juvenile salmon during smolt outmigration may cause a positive bias in PIT-tag-based conversion rates relative to run-at-large values. As indicated above, the default operation for PIT-tagged fish is to return them to the river, unless specific study criteria require other operations. When PIT-tagged smolts are detected at transportation dams, they are typically handled differently than untagged fish; the majority of untagged fish are transported from Lower Snake sites to below Bonneville Dam by truck or barge, whereas tagged smolts are permitted to complete an inriver outmigration. Both published studies and recent analyses we conducted suggest, however, that smolt transportation can disrupt juvenile imprinting and subsequently impair an adult's ability to home to its natal stream upon return. In fact, we plotted the adult conversion rates generated by NOAA Fisheries versus the percent of juveniles that migrated inriver and observed that the greater the proportion of fish that migrated inriver as juveniles, the greater the NOAA Fisheries conversion rate estimate (**Figure 1**). Since most of the PIT tagged fish migrated inriver it suggests that the existing PIT-tag-based conversion rates could be biased high relative to what the untagged run-at-large experience. It is important to note that both the Technical Advisory Committee's count-based conversion rates and the University of Idaho's radio telemetry studies confirm this suggestion (i.e., both are considerably lower than the DART/NOAA estimates).

In conclusion, PIT-tag-based conversion rates, as presented by NOAA Fisheries', are likely a poor representation for the run-at-large and there is a suggestion that the differential treatment of the tagged and untagged population may also cause the estimates to be biased high. Considering the importance of conversion rates to in-season harvest management, day-to-day decision-making about project operations, and to ESA recovery target evaluations, we suggest that PIT-tag-based estimates presented by NOAA Fisheries should be interpreted cautiously.

Using PIT-tags to draw inference on project operations

As you requested, we also reviewed the 2005 conversion-rate decline represented in the NOAA Fisheries' analysis relative to summer spill activities. Although we believe that the PIT-tag-based conversion rates may not be representative of run-at-large values, we considered the utility of the 5-year NOAA Fisheries' time series for evaluating the effects of project operations on fall Chinook survival. We focused specifically on summer spill occurring at Lower Snake projects during 2005, using arrival timing distributions and travel time estimates for 2001-2005. Two important conclusions can be drawn from these data.

- First, the majority of fish used by NOAA Fisheries' to calculate their conversion rates were not present in the Lower Snake during the summer spill period. Most of the fall Chinook bound for the Snake River did not arrive at Bonneville Dam until the last week in August (i.e., just before spill ended in the Lower Snake on 31 August; **Figure 2**). Additionally, when their arrival timing at McNary Dam is considered (**Table 2**), their exposure to the court-ordered spill was negligible.
- Second, trends in travel times (BON-LGR) and arrival timing distributions suggest adults migrating during 2005 did so at a similar rate and within a similar timeframe as fish in earlier, non-spill summers (**Table 2**). Thus, there was no evidence for a spill-related delay in adult passage success.

Given the issues raised above, and the fact that the adult travel time and arrival distributions are also estimated using PIT-tag data, these observations (like conversion rates) could also need to be interpreted with caution. However, run-at-large fish-ladder counts are consistent with the passage timing conclusions presented here. For this reason, it is safe to conclude that few fall Chinook experienced spill conditions in the Lower Snake River in 2005.

Thus, there is little evidence suggesting that the adult survival trends reported by NOAA Fisheries can be attributed to summer spill operations.

References cited

Caudill, C.C., C.C. Peery, M. Keefer. 2006. Idaho Researchers Discuss Adult Salmon Survival. Columbia Basin Bulletin 30 June 2006.

Dauble, D.D., and R.P. Mueller. 2000. Difficulties in estimating survival for adult Chinook salmon in the Columbia and Snake rivers. Fisheries 25:24-34.

Table 1. Adult fall Chinook (hatchery-13H; wild/hatchery or unknown-13U) Bonneville-to-Lower Granite conversion rates (DART-based), harvest levels, and stray rates used to estimate NOAA's adjusted conversion rate.

Year	Group	DART Conversion	TAC Harvest	Stray rate	NOAA Conversion
2001	13H	0.81	0.16	0.00	0.97
2002	13H	0.76	0.22	0.00	0.98
2003	13H	0.83	0.14	0.00	0.97
2004	13H	0.82	0.14	0.00	0.95
2005	13H	0.66	0.18	0.00	0.80
2004	13U	0.69	0.14	0.00	0.80
2005	13U	0.50	0.18	0.00	0.61

Table 2. Adult fall Chinook (hatchery-13H; wild/hatchery or unknown-13U) Bonneville-Lower Granite travel times and McNary Dam arrival distribution summary statistics (i.e., proxy for Lower Snake entry). Note, no detection capabilities existed at McNary Dam prior to 2002.

				McNary Arrival Date		
Year	Group	Median (range) Travel time (d)	n[1]	Minimum	10th percentile	Median
2001	13H	12.8 (9.2-60.6)	NA	NA	NA	NA
2002	13H	12.9 (8.9-44.6)	143	31-Aug	12-Sep	24-Sep
2003	13H	13.1 (8.9-40.9)	228	27-Aug	9-Sep	25-Sep
2004	13H	11.9 (8.0-53.9)	269	18-Aug	4-Sep	14-Sep
2005	13H	12.1 (7.8-33.8)	135	17-Aug	4-Sep	13-Sep
2004	13U	12.0 (8.1-57.5)	78	13-Jul	8-Sep	15-Sep
2005	13U	14.4 (9.0-47.9)	103	26-Jun	27-Aug	18-Sep

1. Count at McNary Dam

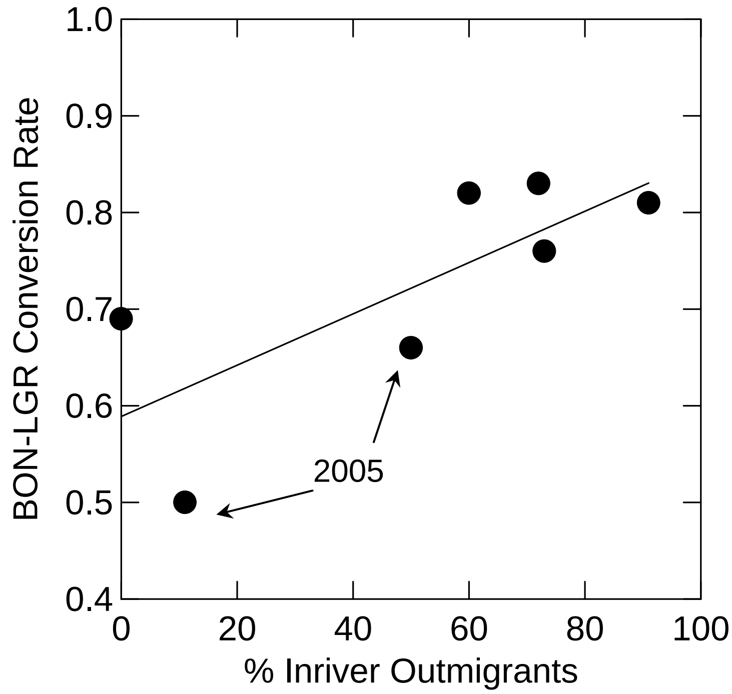

Figure 1. Scatter plot of adult fall Chinook conversion rates (unadjusted) against the % of returning adults that outmigrated as inriver smolts. Each observation corresponds to a given migration year (n = *5* for 13H and *n* = 2 for 13U). The line corresponds to the fitted linear regression model, which was significant (F = 6.6, P = 0.05, R^2 = 0.48).

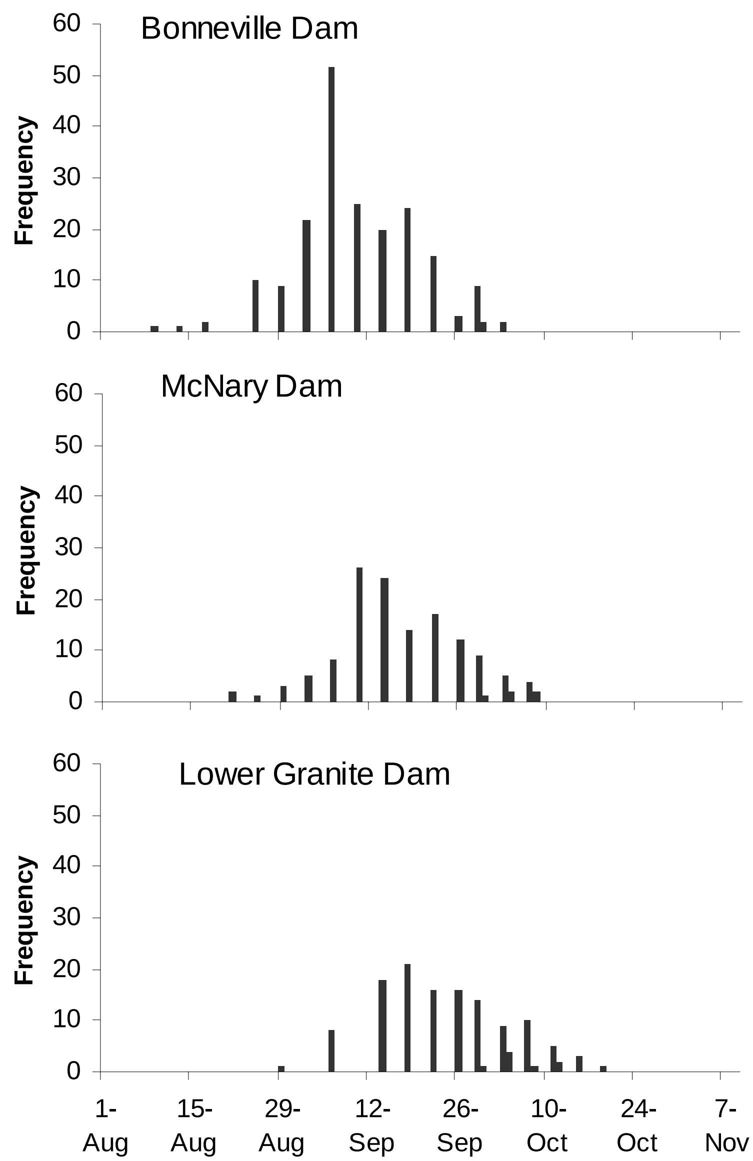

Figure 2. Adult fall Chinook (hatchery origin, 13H) arrival timing distributions for the 2005 migration year at Bonneville Dam, McNary Dam, and Lower Granite Dam.