# State, Federal and Tribal Fishery Agencies Joint Technical Staff

***Columbia River Inter-tribal Fish Commission***
***Idaho Department of Fish and Game***
***Nez Perce Tribe***
***Oregon Department of Fish and Wildlife***
***Shoshone-Bannock Tribes***
***US Fish and Wildlife Service***
***Washington Department of Fish and Wildlife***

June 29, 2004

Mr. Scott Dunmire
NWD Corps of Engineers
201 North 3rd Ave
Walla Walla, WA 99362

Dear Mr. Dunmire:

The state, federal and tribal fishery managers have reviewed the report entitled, "Historical Analysis of PIT Tag Data for Transportation of Fish at Lower Granite, Little Goose, Lower Monumental and McNary Dams," and offer the following review comments for your consideration, in preparation of the final report.

<u>Methods: Covariates used in analysis</u>

We have concerns regarding the characterizations of the independent variables used in the analyses. We believe that the methods used to summarize the environmental and project operational data used as covariates in the regression analysis do not reflect the influence of the covariates in question on the smolt-to-adult survival rate. The authors state on page 3.4 that they "avoid averaging covariates because doing so reduces contrast in the data, decreasing the power to detect significant effects of covariates such as temperature, flow, and spill." Instead, as stated on page 3.12, they simply took the measurements at Lower Granite Dam occurring on the first day of detection, whether the covariate was day of detection, dissolved gas, temperature, flow, spill, turbidity, or distance from release site to Lower Granite Dam. For reflecting conditions at the time that the smolts first enter the hydrosystem at Lower Granite Dam, these single-day measurements are fine. However, most yearling Chinook and steelhead will take between two-weeks and a month to migrate in-river between Lower Granite and Bonneville dams. During these extended migration periods, the smolts encounter various spill levels and dissolved gas conditions at each dam traversed, changing flow and turbidity conditions, and a gradually increasing temperature regime. For the flow and spill-related covariates, the method of naively utilizing the measurements at Lower Granite Dam on the first day of entry into the hydrosystem does not capture the influence of these covariates on either in-river survival of smolts to Bonneville Dam or the overall SARs. It is accepted by the scientific community that SARs are a function if both in-river conditions (including project operations) and ocean conditions. However, the authors only examined the effects of in-river conditions, ignoring the confounding effects of the ocean environment on SARs. To make this analysis sufficient for input on management decisions, the authors must incorporate covariates that reflect ocean conditions, which operate independent of the hydrosystem. It is well known that ocean conditions have resulted in improved, salmon survival rates during 1998-2000 compared to the prior three years analyzed in this report. Without accounting for the confounding effects of the ocean to tease out the effects of in-river conditions on SARs, there is little scientific basis for utilizing the conclusions of this report. Utilizing a sophisticated statistical modeling approach with overly simplistic covariates representing in-river conditions and without addressing ocean survival conditions make the conclusions untenable and does not result in a rigorous analysis.

***Results: Passage route and SAR***

On pages 4.5 to 4.6, the authors cite two different studies (Budy et al versus Zabel et al) that arrived at "differing conclusions as to the significance of bypass systems on adult returns. The Budy hypothesis is that bypass systems reduce survival; the Zabel hypothesis is that bypass systems preferentially collect fish that naturally have lower survival." The authors acknowledge that both hypotheses may in part be true; however, they go on to conclude that "the length selectivity hypothesis is sufficient to explain a reduction in SAR of bypassed fish without invoking the passage stress hypothesis." The authors provide neither rationale nor data justifying why they picked the "length selectivity" hypothesis over the "bypass stress" hypothesis as being sufficient in explaining the reduction in bypass SARs. It is at least equally plausible at this point in time that the "bypass stress" hypothesis is sufficient for explaining the reduction in bypass SARs without invoking the "length selectivity" hypothesis. Further separate examination of these two hypothesis is required before one can be discounted or rejected in favor of the other.

In Table 4.1, the authors present five hypotheses related to comparing the effectiveness of different passage routes. They downplay the importance of Hypothesis H1, which compares transported fish from Lower Granite and Little Goose dams to non-detected fish, because they argue that non-detected fish are unavailable for transportation. However, the Fishery Agencies and Tribes would view this as the most important of the five hypotheses listed because a primary management research interest is to compare transportation SARs to the best in-river conditions attainable through the provision of spill. This research interest would be addressed with Hypothesis H1. A discussion of this interest and the importance of this hypothesis to management decisions needs to be added.

***Results: Regression analysis method***

There are several problems with the regression approach to evaluating the hypotheses listed in table 4.1. First, there are no mechanisms for causal relationships between the SARs that are compared. For example, the LGR/LGS transportation SAR is not a function of the nondetected SAR or vise versa. Therefore the regression approach is not appropriate. A more appropriate approach would be to conduct t-tests on the ratios of the SARS to examine the null hypothesis that they equal one. Second, a primary assumption of the regression methodology is that the independent variable is measured without error. The assumption is clearly invalid in this application, as all SAR estimates are measured with error, which results in biased estimates of the slope parameter. Again, this argues for adopting the t-test approach, which does not require this assumption as errors in the SAR estimates could be incorporated into the error estimates of the ratio.

Aside from the problems with the regression approach used in this analysis the authors mistakenly state the alternative hypothesis acceptance slopes for two of the five bivariate regression analyses performed (the alternative hypotheses are presented in Table 4.1). The alternative hypotheses are presented in Table 4.1 as one-tail tests, yet the bivariate regression results in Tables 4.2 to 4.4 and the associated plots suggest that two-tail tests were performed. The authors should clarify the type of test performed in the text. The two alternative hypotheses with mistaken acceptance slope are Hypothesis 1 (fish detected and transported from LGR/LGS) and Hypothesis 2 (fish detected and transported from LMN/MCN). The authors mistakenly state that the acceptance slope for Hypothesis 1 is "Slope<1" and Hypothesis 2 is "Slope>1", when in actuality, the opposite is true. The acceptance slopes of the three remaining alternative hypotheses are correct as listed.

***Results: Covariate Based Estimates of T:I***

The results from the covariate analyses of T:I demonstrate a lack of consistency among years within species, instilling little confidence in the results as they relate to management decisions. For example, for wild steelhead the day on which T:I = 1 varies from -94 to 139. These results are not useful in making management decisions on when to begin or end transportation. Similar inconsistencies and high variability among years is evident for nearly every species and environmental covariate examined. These results inspire little confidence in their validity or realism.

On page 4.21 the authors state that the variables "Day of arrival at LGR" and "Temperature at arrival at LGR" were the two variables most consistently chosen in the regressions with the covariates listed in Table 4.5 and the T:I ratio as the dependent variable. This was based on selecting the regression with the lowest AIC score. However, comparing AIC scores among non-nested models (i.e. across environmental covariates) is technically invalid. In addition, both of these covariates increase over time for both the springtime and summertime migrants. The T:I ratios also tend to increase over time. But do the authors believe that the mechanisms for higher SARs are simply a function of when the fish arrive at the start of the hydrosystem, and under the prevailing water temperatures that occur at the time of arrival? Clearly, this is not the case as SARs are a function of the passage experience throughout the hydrosystem and not simply conditions during the initial portion of their migrations.

On page 4.22 they present findings from published literature to support the importance of two variables (day and temperature) despite their own results suggesting the importance of three variables (day, temperature and flow). The authors' rationale for subsequently ignoring flow is confusing, illogical and suggests a bias as to which mechanisms they believe to be important In addition they overlook the link between smolt travel time between LGR and the estuary, which is affected by the flows occurring in a given year. Likewise, they overlooked that spill at a dam reduces fish delays in passing that dam and contributes to lowering predation encounters in both the forebays and tailraces of individual dams.

Additionally, the authors failed to note that they are working with an aggregate of PIT- tags from various stocks and that stock-specific effects may also contribute to the changing T:I ratios over time. A case in point is seen with PIT- tagged hatchery chinook. Hatchery chinook PIT tagged and released from Dworshak and Lookinglass (onsite releases discontinued after 1999) hatcheries have tended to be the earliest arriving stocks at Lower Granite Dam while McCall Hatchery chinook have tended to be the latest arriving stock. When stock specific SARs are computed the T:I ratios of the McCall Hatchery summer chinook stock has generally been higher than that of the Dworshak and Lookinggalss spring chinook stocks. Therefore, covariates such as "Day of arrival at LGR" and "Temperature at arrival at LGR" may be benefiting from a stock effect, which is not included in the regression model.

Covariates such as flow influence how quickly the PIT- tagged smolts traverse the hydrosystem and arrive at the estuary, and simply utilizing the flow that occurs on the day that these fish arrive at Lower Granite Dam may be inadequate to reflect the importance of this covariate on subsequent smolt success upon ocean entry. In addition, the flows that occurred in each year analyzed by the authors, with the exception of 1995, were years of above average springtime flows and at or above BIOP mandated summertime flows during most of the summer migration.

Therefore the data analyzed includes little contrast in flow, which would tend to minimize the importance of this variable on SARs. We expect to see quite a difference when low flow years such as 2001 are included in this type of analysis. Likewise, the flows during the summer migration would be changing less in the years analyzed by the authors than would have occurred in earlier years when only limited PIT- tag data are available for subyearling Chinook, or in the drought year of 2001 for which complete adult return data are not yet available for SAR analyses. These factors reduce the contrast in flow across years and limit the regression analysis to adequately evaluating the influences of flow on SARs and T:I ratios.

It is not unexpected that the covariate of spill did not remain in the authors' analyses because of the colinearity between spill and flow. This colinearity exists because as project hydraulic capacities are reached, the excess flow is spilled. Thus spill volumes and flows will tend to increase together (the spill proportion also tends to increase in these situations), making it difficult to separate the effects of these two variables in the same regression model. However, this does not diminish the effect of spill on in-river smolt survival. Dams provide three routes of passage: powerhouse bypass, powerhouse turbines, and spillways. Because route-specific survival is highest through the spillway route, the proportions of spill available at a dam will positivey affect the survival of smolts at that specific project. Despite the difficulty in teasing out the effect of spill versus flow in regression-type analyses, the colinearity between spill and flow should not be used to diminishing the influence of one factor over the other. In addition, the simplistic use of spill measured only at Lower Granite Dam to reflect the effects of spill throughout the hydrosystem and therefore SARs, is a major shortcoming of this analysis.

***Summary***

While the Anderson et al. analysis, is interesting, it has limited utility for fish passage management decisions. Although the statistical methods utilized were are sophisticated, the simplistic way that the environmental variables were created for this analysis still leads to a non-robust analysis. Environmental variables need to be generated that best represent the cumulative manner in which the environmental and dam operational conditions influence the in-river and transportation survival of smolts, and their subsequent ocean survival. We understand that accounting for the integrated nature of these environmental variables involves considerable complexity, however it would result in a better reflection of reality and provide a more robust basis for management decisions. If a particular environmental variable is influential over the entire period that a smolt is migrating through the hydro system, then an average of that variable over the total time interval (or large portion of that interval) may be more representative of the smolt experience than simply the value obtained on the day the smolt entered the hydro system. Developing the environmental variables according to the timing of survival mechanisms may make the analysis more complex, but would result in reduced chances of making erroneous conclusions regarding variables unrelated to in-river survival. The old rule-of-thumb that the quality of the analysis is only as good as the data going into it is paramount in the type of investigation performed and conclusions reached in this report. Because of the problems with the improper definition of environmental variables across the in-river migration season, we find the quality of the analyses lacking and therefore find the results insufficient for management decision making.

Sincerely,

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