



Independent Scientific Review Panel

for the Northwest Power & Conservation Council
851 SW 6th Avenue, Suite 1100
Portland, Oregon 97204
isrp@nwcouncil.org

Memorandum (ISRP 2009-50 Updated)

Original: December 2, 2009

Updated: February 19, 2010

To: W. Bill Booth, Council Chair

From: Eric Loudenslager, ISRP Chair

Subject: Update to Final Review of the Yakama Nation's Accord Proposal, Upper Columbia Nutrient Supplementation (2008-471-00)

Background

At the Council's June 17, 2009 request the ISRP began a review of the Yakama Nation's Columbia River Fish Accord proposal titled Upper Columbia Nutrient Supplementation (2008-471-00). The project is intended to assess and characterize nutrient availability, and if needed the project proponents will perform controlled experimental addition of limiting nutrients to enhance natural production of anadromous salmonids and their supporting ecological functions and limnological conditions in rivers in the Methow Subbasin.

On July 10, 2009, the ISRP released a preliminary report requesting a response on nine specific items ([ISRP 2009-27](#)). On October 26, 2009, the Council submitted the Yakama Nation's response documents which included point-by-point responses to our review comments and an updated project proposal that incorporates the responses. We organize our review around the nine items in our preliminary review.

[Update: In February 2010, it was brought to the ISRP's attention that our review contained comments to elements not included in the Yakama Nation's nutrient enhancement proposal for the Methow Subbasin but instead applied to the Shoshone-Bannock Tribes' nutrient enhancement proposal for the Salmon River Subbasin (#2008-904-00; see [ISRP 2009-53](#)). The timing of the response reviews of these similar projects overlapped. We examined our comments and re-examined the proposal and found that we incorrectly attributed some comments to the Yakama proposal on components that were only in the Shoshone-Bannock Tribes proposal. The critical and primary points of our review were correctly attributed to the Yakama's proposal; consequently, our final recommendation is unchanged.]

The mistakes in our earlier memo are corrected below. Incorrect statements are indicated with red, strikeout font. Updated text is in blue font and bracketed. We apologize that our mistakes distracted from the main points of our review and are grateful the mistakes were brought to our attention.]

ISRP Recommendation

Does Not Meet Scientific Criteria

Overall Comments

The increasing popularity of trophic system enhancement as a method for increasing salmon production in the Columbia Basin indicates the need for careful assessment of the technique's effectiveness. Unfortunately, the study described in this proposal is unlikely to improve our understanding of this technique. Many of the issues that were raised in the initial set of ISRP comments were not adequately addressed in the response and would need to be addressed for this project to be technically justified.

ISRP Specific Comments on Nine Items Raised in Preliminary Review

ISRP Preliminary Comment 1: Provide more detail on the process that will be used to determine nutrient limitation. How will the information on nutrient concentration, trophic processes, etc. be used to determine whether there is a nutrient deficiency and, if so, what element is constraining production? Consider the use of nutrient diffusing substrates to augment this portion of the study. Additional background information on current carcass abundance in the system also would be useful.

ISRP Final Comments: The discussion on this issue was considerably expanded in the revised proposal and some of the ISRP concerns were addressed. The addition of the nutrient diffusing substrate (NDS) experiments will provide a more definitive indication of the nutrients limiting primary production at the study reaches. We were puzzled that existing water quality data from the Methow watershed was not included in the proposal. Information of this type is likely available and would provide some indication of the current nutrient status of the study sites. Comparison of current nutrient concentrations with the Redfield ratio could provide a preliminary indication of what nutrients are likely to be limiting and might indicate the extent to which nutrient limitation varies spatially within the study watersheds. These data should prove useful in designing the NDS experiments.

However, a larger question remains regarding the value of identifying the nutrients limiting primary production to the overall experiment. Understanding that a specific stream reach may be N or P limited, or co-limited by N and P, is informative to this experiment only if the treatments to be applied will be customized for the identified nutrient deficiency. Regardless of the deficiency identified, however, it appears that the same treatment will be applied in this study; addition of salmon carcass analogs (SCA). The real question of relevance to this study is whether or not primary production will respond to the nutrients released from the SCA. In order to relate the results of the NDS experiments to the SCA treatment, it would be very important to understand the N and P content of the SCA and the rate at which they release these nutrients. There is no mention in the proposal that this information need will be addressed.

Finally, the very detailed assessment of nutrient limitation associated with this study clearly implies that the project proponents believe that the primary mechanism by which the SCA will impact trophic system dynamics is by bottom-up enrichment caused by increased nutrient availability. However, as noted in the original comments from the ISRP, SCA can be

incorporated into the trophic system of a river via two different pathways. Stimulation of primary production by the nutrients released from decomposing SCAs is one possible mechanism. However, existing research on SCA has clearly established that fish will directly consume this material. Therefore, the SCA have the potential to impact trophic productivity even at sites where no clear nutrient limitation to primary production can be identified. Direct consumption was not adequately addressed in this proposal.

***ISRP Preliminary Comment 2:** Consider enhancing the methods to be used for measuring primary production. At a minimum, total periphyton biomass should be measured along with the measure of chlorophyll content. A measure of whole-system metabolism would considerably improve this aspect of the study.*

ISRP Final Comments: Several issues related to this comment were not adequately addressed. Periphyton biomass determination was added to the study. However, sufficient detail was not provided on the methods to be used in chlorophyll, biomass, and algal assemblage determinations to enable a thorough evaluation. ~~The response document included mention that measures of whole-system metabolism would be included in the study.~~ [The ISRP suggests that the project proponents consider measuring whole-stream metabolism.] This measure would provide a valuable indication of alterations in trophic system function with the addition of SCA as it enables the determination of both primary production and community respiration. An increase in trophic productivity would be reflected in increases in either or both these system attributes. [Information on this technique may be found in the following two publications:

Bott, T.L. 2007. Primary productivity and community respiration. Pages 663-690 in F.R. Hauer and G.A. Lamberti, editors. Methods in Stream Ecology. Academic Press, San Diego, CA

Young, R.G., and A. D. Huryn. 1999. Effects of land use on stream metabolism and organic matter turnover. Ecological Applications 9:1359-1376.]

~~However, the methods to be used in conducting the whole-system metabolism assessment were not included in the revised proposal. This technique is sophisticated and requires specialized equipment, so a detailed discussion of how this aspect of the study will be accomplished should be included.~~

***ISRP Preliminary Comment 3:** The invertebrate sampling protocols are not fully described and in some cases appear to be inappropriate to answer the questions being asked. Indicate how the Hess samples will be processed and approximately how many samples will be taken, given the significant costs inevitably associated with sample processing. Why is there no measure of invertebrate density and biomass included? How will the information on invertebrate community composition be related to nutrient status and productivity? Fully describe how the Hess samples and kick-net samples will complement each other.*

ISRP Final Comments: The description of the methods for invertebrates has been expanded considerably in the section entitled “Methods by work element and trophic level” and some of the clarifications requested in the original ISRP review have been addressed. This section implies that biomass, density and an estimate of invertebrate production will be incorporated into the

study. However, no details on how production will be estimated are provided and the methods to be used in measuring biomass appear incomplete (for example no mention of the manner by which biomass estimates will be corrected for loss of weight caused by storage in ethanol was provided). Biomass, density and production are likely to be more closely allied with alterations in trophic productivity than invertebrate taxonomic composition, and therefore may be more useful in assessing impacts on food availability for fish. However, the section of the proposal beginning on page 28 that discusses data analysis indicates that the only invertebrate metrics that will be considered are abundance and taxonomy, conflicting with the information provided in the earlier section of the proposal. A comprehensive discussion of the methods that will be used to estimate secondary productivity and the statistical procedures that will be used to assess response of biomass and production to the addition of SCA should have been included in the revised proposal.

A rationale for including 250 macroinvertebrates in each sample should be provided. Some research suggests that larger sample sizes would be more appropriate as some rare, larger bodied taxa may be omitted with small sample sizes.

***ISRP Preliminary Comment 4:** More fully describe the methods to be used in evaluating juvenile fish populations. Will density and biomass be measured? If so, how will these population attributes be measured?*

ISRP Final Comments: The protocols to be used for juvenile fish populations remain incomplete in the revised proposal. However, parr is the life-stage of the fish that is likely to be most influenced by any changes caused by SCA addition. Therefore, assessment of juvenile salmon population levels, biomass, and growth rates are key to understanding the mechanisms by which SCA addition affects the fish.

The response of the project proponents indicated that they were not sure that they could obtain permission to sample parr because of the ESA status of the Chinook and steelhead populations in the Methow drainage. It should have been possible to determine the feasibility of obtaining an ESA permit for electrofishing, stomach sampling, and PIT tagging prior to developing this section of the proposal. The question of ESA permit aside, the proponents also note that "Adding these in-stream measures will significantly increase costs for the proposed work and may not be possible with funds available." This statement seems to indicate that even if sampling approval is possible, this work may not occur. The ISRP believes these data would be among the most relevant for assessing the value of SCA for increasing productivity of listed stocks of salmon and steelhead. For this reason, we would encourage the project proponents to consider economizing on some of the other study elements (nutrient limitation determination **or** benthic macroinvertebrate sampling), ~~or organic matter transport measurements~~ and shifting resources to juvenile fish sampling.

The extent to which the SCA are consumed by juvenile salmon, steelhead and resident fishes should receive additional attention. As noted above, distinguishing between the effects of direct consumption versus bottom-up, trophic enhancement on fish growth rate will be important. Measures of juvenile fish density and growth rates over time coupled with stomach samples would enable this determination. It would be of critical importance to collect stomach samples at study sites at the time the SCAs are present in the stream. [\[The proposal suggests that these samples will be collected seasonally. But the most critical period for collecting stomach samples](#)

will be within a month after SCAs are added.] ~~However, the proposal indicates that the proponents will be relying on stomach samples collected as part of another study. The degree to which these other projects have been coordinated with this effort was not discussed in the proposal.~~

The response mentioned the use of stable-isotope analysis in the study but provides no specific information as to how this method would be employed, simply indicating that this part of the study is still being developed. With an appropriate sampling schedule, stable isotope analysis could be used to determine the relative effect on fish growth of direct consumption of SCA versus bottom-up effects on trophic productivity. It has been established that a relatively small fin clip will provide sufficient tissue for analysis. Ideally, this technique would be used in conjunction with stomach samples. But if ESA permitting prohibits gastric lavage, stable isotopes analysis may provide a viable option for determining fish diet. If this restriction on sampling does occur, the stable isotope samples may become critical to understanding how SCA influence system productivity. Therefore, a full description of this method should have been included.

***ISRP Preliminary Comment 5:** Describe how adult abundance and smolt production will be measured at the Methow study sites. Without this information, determining the effect of nutrient addition on the productivity on salmon and steelhead will be either very difficult or impossible.*

ISRP Final Comments: The methods to be used for enumerating returning adults and emigrating smolts appear to be appropriate. The project proponents propose to use smolts/redd as an indicator of the effect of enhanced trophic production on smolt production. This metric is appropriate providing that a sufficient proportion of the river upstream of the trap will be treated with SCA to ensure that most, or all, of the juvenile fish above the screw trap have access to SCA. A power analysis of the smolts-per-spawner values would provide an indication of the size of change that could be detected following SCA addition.

***ISRP Preliminary Comment 6:** Describe how potential density-dependent effects of fish population response to food limitation will be addressed. How will the effects of water temperature, flow, and changes in other habitat attributes be accounted for when assessing the responses to nutrient addition?*

ISRP Final Comments: It might be possible to infer that SCA addition improved growth and productivity of fish if all other things were relatively constant, but it is highly unlikely that other things will remain constant over the duration of the study. Year-to-year changes in habitat attributes like temperature and flow are very common and can have substantial effects on the performance of juvenile salmon. The density of fry and parr at the study sites also is likely to vary among years and changes in density could have a considerable impact on fish response to alterations in trophic productivity. Our comments on these issues were intended to encourage the project proponents to develop methods for addressing this variability in their study design. However, the responses provided did not address this concern.

The project proponents provided the following paragraph in response to our concerns about density-dependent effects:

“Regarding density-dependent growth regulation, if food is/becomes limiting we would expect to see a response manifested as lower fish condition, length, weight, and smolt production per spawner, or possibly reduced numbers of outmigrants. Conversely, if nutrient augmentation increases food availability (relative to empirical pre-treatment values), we would expect to see some level of increase in mean fish length, weight, condition, production rates. If food is not limiting smolt production, then little response to nutrient augmentation should be observed relative to fish condition and production rate over time.”

This response does not address the ISRP concern that parr growth rate response to enhancement of trophic productivity could be greatly modified by density-dependent effects. There are several density-mediated scenarios that could complicate the interpretation of growth rates. Very high densities may result in limited or no response to SCA addition because, even with augmented food availability, food could still be sufficiently scarce that nearly all consumption by the fish is used for metabolic maintenance; little growth actually occurs. At low population levels, food may not be limiting growth, even if trophic production is low. Under these conditions, additional food availability due to SCA addition may not be reflected in any increase in growth. As fry and parr density is likely to change from year to year, an accurate estimate of density each year of the study will be key to interpreting any changes observed in growth rates.

The project proponents suggest that they can adequately account for the effect of variable environmental factors like temperature and flow, by monitoring outmigration timing:

“Regarding density-independent regulation, flow and temperature can directly affect system productivity, habitat suitability, and therefore fish growth and condition. Some of these responses occur in predictable a manner. One means to address effects of environmental condition is to monitor outmigration timing. Presumably, unsuitable conditions, such as low flows and high temperatures, would prompt early emigration of juvenile salmonids from rearing areas. By continuously operating screw traps at the mouths of the Methow and Twisp rivers throughout the outmigration season, and at any additional new locations, we will document outmigration patterns and events, such as premature emigration of parr and pre-smolt stages, along with the standard suite of fish performance metrics described above, and relate that to environmental conditions.”

This response does not address the concern. If conditions at a study site became so inhospitable that emigration occurs, it would reveal very little or nothing about the effect of trophic enhancement on these fish, other than to suggest that the study location was inappropriate for enhancement. Rather the ISRP comment was raising the issue that any responses in fish growth rate following SCA addition may be modified by environmental conditions like flow, water temperature, etc. and these conditions will vary temporally and spatially. Therefore, the effect these habitat attributes may have on salmon parr needs to be considered in interpreting any responses associated with SCA addition.

***ISRP Preliminary Comment 7:** Consider the application of a bioenergetics model to identify appropriate hypotheses and design experiments.*

ISRP Final Comments: The project proponents should consider using an available bioenergetics model rather than developing one (e.g., Fish Bioenergetics 3.0 <http://limnology.wisc.edu/research/bioenergetics/bioenergetics.html>). Using an existing model

and parameterizing and/or modifying as required for this study could substantially reduce the amount of effort required to accomplish this part of the study.

***ISRP Preliminary Comment 8:** Include a more detailed description of the adaptive management process that will be used in moving this study forward.*

ISRP Final Comments: A section has been added to the revised proposal entitled “Adaptive Management Framework.” However, this section really provides only a brief discussion of the experimental design of the study, not a description of how the results of this, and other nutrient-enrichment efforts in the basin, could be used to inform management decisions regarding the application of this method. However, this section is useful in that a timeline for the project is provided.

***ISRP Preliminary Comment 9:** Describe how the evaluation will deal with the presence of and confounding effects of hatchery fish and the role of hatchery fish carcasses in the study design and evaluation, including the identification of their marine-derived nutrient contribution.*

ISRP Final Comments: The ISRP comment that hatchery fish spawn in the area was misinterpreted. We were not suggesting that hatchery carcasses should be introduced as a treatment but that carcasses are present from returning hatchery fish (and the few wild fish that do return) and will add MDN into the system. If enough salmon return to the study reaches, the carcass material could stimulate a trophic response. The amount of carcass tissue deposited at the study reaches is also likely to vary considerably among years. Therefore, some process for controlling the amount of carcass tissue added to the study sites should be included in the study to minimize confounding effects from this source. At a minimum, the amount of carcass tissue deposited at each site each year of the study should be measured.