



Independent Scientific Review Panel

for the Northwest Power & Conservation Council

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Memorandum (ISRP 2009-53)

December 11, 2009

To: W. Bill Booth, Chair, Northwest Power and Conservation Council

From: Eric Loudenslager, ISRP Chair

Subject: Final Review of Accord Proposal, Salmon River Basin Nutrient Enhancement
(2008-904-00)

Background

At the Council's June 12, 2009 request, the ISRP began a review of the Shoshone-Bannock Tribes' Columbia River Fish Accord proposal titled *Salmon River Basin Nutrient Enhancement* (2008-904-00¹). The proposed project seeks to partially mitigate for the dramatic decline of anadromous salmonids (and the associated reduction of available marine-derived nutrients to freshwater spawning and rearing habitat) by experimentally enriching nutrient limited upper Salmon River subbasin streams with carbon, nitrogen, and phosphorus using salmon carcass analogs.

On June 30, we released our preliminary review ([ISRP 2009-26](#)). We found that the research proposed could be of significant benefit to the development of salmon restoration plans for the Columbia Basin. The enhancement of nutrient availability and food web productivity has been widely promoted as an effective restoration strategy, but our understanding of ecosystem-level responses to nutrient addition is limited. This study will provide new information on the utility of salmon carcass analogs as a potential enhancement tool. However, we requested a response on six specific items.

On November 3, the Council forwarded the Shoshone-Bannock Tribes' point-by-point response to our concerns and a revised project narrative. Our review follows below, organized by our six concerns.

ISRP Recommendation

Meets Scientific Criteria (Qualified)

The ISRP believes this study will generate important information on this increasingly popular restoration technique. The project proponents responded adequately to most of the comments provided by the ISRP. However, some of the changes in the revised proposal were not described in enough detail for a scientific review. The ISRP recommends that the following items be considered before implementing the project and addressed by the proponents in future

¹ www.nwcouncil.org/fw/projectselection/accord/200890400.pdf

categorical or geographic reviews. No further responses to the ISRP are needed for this review iteration.

Qualification 1: Additional information on some of the methods are needed (see below), and power analysis on the fish response (parr and smolts, and smolts/spawner) should be included to provide some indication of the size of response that will be detectable.

Qualification 2: There is a lack of integration among some of the project components that should be addressed before beginning the study.

- a) It remains unclear how the nutrient limitation assessment relates to the salmon carcass analog (SCA) treatments. There seems to be little value to understanding which nutrient is limiting primary production at a site if the only treatment option is the application of SCA. How will the nutrient limitation data inform treatment methodology?
- b) The coarse particulate organic matter (CPOM) transport determination (really, leaf litter transport) does not seem to be related to the primary objective of the study, the effect of SCA addition on food web dynamics. The CPOM information would be valuable only if there is some hypothesized link between leaf litter transport rates and the manner in which SCA will impact food web dynamics.

ISRP Comments on the Six Responses

ISRP June 30 Review - Item 1. Nutrient and food limitation. Provide detailed methodology on the assessment of nitrogen or phosphorus limitation and food limitation in stream fishes. How will researchers determine if nitrogen or phosphorus is the key limiting nutrient? What methods are proposed to determine if food is limiting smolt yield or growth rate?

Significantly more detail on the process that will be used to determine N and P limitation was provided in the response. However, several elements of this aspect of the project were not fully covered. The proposal does not describe how frequently determinations of nutrient limitation would be made with the nutrient diffusing substrates (NDS) (e.g., seasonally, summer vs. winter?) or the location of the NDS evaluation sites along the test streams (detection of upstream-downstream shifts in nutrient limitation might be possible with the correct distribution of NDS).

Some questions also still exist about the relationship between the nutrient limitation evaluations and the treatment to be applied (salmon carcass analogs, SCA). Identifying the specific nutrient, or combination of nutrients, limiting primary production in a stream reach would be most relevant if this study were proposing to add inorganic nutrients in a ratio and at a concentration suggested by the NDS experiments. This study will apply the same treatment, regardless of the limiting nutrient identified – addition of 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 nutrients. There is no mention in the proposal that this information need will be addressed.

The proponents raised an interesting possibility in their response to our comment about potential contamination of the SCA. They note that if SCA samples are contaminated, they will switch to treatment with inorganic N and P (solid pellet or liquid form). If inorganic nutrient additions are a possibility, the project proponents might consider applying this treatment at some of their study sites and contrasting the response with that caused by SCA application. If inorganic nutrients were to be included as one of the treatments, the nutrient limitation work becomes a very central component of the study. Addition of an inorganic nutrient treatment also would aid in determining whether SCA responses were governed by bottom-up or top-down responses in the food web, as nutrient additions could only affect the system through bottom-up pathways.

More details should have been provided on the techniques that will be used to examine fish populations. In particular, approximate sample sizes and specific response metrics should be given, with more details on sample frequency and methods of analysis. This type of information will be required to assess food limitation, examine the response in fish abundance and growth rate to SCA addition and to appropriately parameterize the bioenergetics model.

The invertebrate sampling, especially drift, can provide a good indication of food available for the fish. However, insufficient detail was provided on the methods to be used for drift sampling to enable the ISRP to evaluate this component of the study.

ISRP June 30 Review - Item 2. Eyed egg boxes may provide inconsistent and variable results and may not ensure the stream is at juvenile carrying capacity. How will the evaluation deal with variable juvenile density in the analysis?

The response indicates that sample sites will be chosen where egg box production is absent, and we applaud this decision. The ISRP agrees that natural rearing densities are likely to be low, but compensatory growth may still occur in ultra-oligotrophic streams and growth responses to nutrient addition may still be detectable at low rearing densities. These conditions will complicate data interpretation. The project proponents indicated that they intend to address the effects of variable juvenile salmon density as a covariate in their analyses of the SCA responses. However, no details on how this analysis would be structured were provided. It will also be important to census other potentially competing species (e.g., other salmonids, some cyprinids), as these organisms may also influence experimental outcomes.

ISRP June 30 Review - Item 3. The key response variable to address effectiveness of salmon carcass analog addition should be wild smolt recruitment as a function of spawner density. This measure will require an estimate of wild smolt production from the study sites. How will this be accomplished?

Ideally, smolt and adult salmon abundance data would be available for all study sites. But the ISRP appreciates the practical difficulties and expense associated with obtaining these data. Results from investigations at Yankee Fork Salmon River on parr and smolt emigration should be generally informative about the freshwater life history of salmon in the Salmon River basin but will not provide any quantitative information about the effect of SCA on juvenile salmon. If there are too many practical impediments to adult and smolt trapping at the study sites, are there any alternatives to estimate smolt productivity as a function of adult recruitment at the sites where whole stream SCA enrichment occurs?

The response that the project proponents provided to this ISRP comment included some information on outmigration timing of Chinook salmon in the Salmon River that clearly indicates that the majority of juvenile salmon leave the areas where the SCA will be added as parr during the summer and fall. This fact suggests that it may be very important to evaluate parr production and outmigration as well as smolt production. The role of system productivity in controlling juvenile migration timing may be an important element to consider in this study. Possible responses by juvenile salmon to elevated food levels could be extended residency at the treated sites and an increase in the proportion of fish migrating as spring smolts. The parr migration timing also suggests that timing of SCA application could have a significant effect on response by the fish. Application in the fall, at the typical time of salmon spawning, would occur after many of the parr have migrated from the study sites. Therefore, only the relatively small proportion of the population that overwinters in the study streams would benefit from eating SCA directly. Adding the analogs earlier in the year, when more juvenile salmon are still present, might have a much different effect. Further consideration of the issue of outmigration timing and how it might be influenced by the SCA treatments seems required, including power analysis to assess required sample sizes and detection limits.

ISRP June 30 Review - Item 4. Some project elements do not seem to support the overarching objective of the study (effect of salmon carcass analogs on food web dynamics). The response should clearly explain how the nutrient diffusing substrata, nutrient spiraling, and coarse particulate organic matter transport elements of the study will provide information relevant to the interpretation of the effects of the salmon carcass analogs on stream trophic dynamics and specifically on smolt production.

The nutrient spiraling work elements of the project will be dropped owing to the difficulty in measuring this parameter. CPOM sampling was retained, as it is “cheap and relatively easy” and whole-system metabolism was added. The addition of whole system metabolism measures is very relevant for the questions being addressed in this experiment. However, there were few details provided on the specifics of how these measures would be taken (e.g., how frequently, how large of a study section, how diffusion will be determined, etc.). The method proposed to measure CPOM retention is to add pieces of colored paper to the study streams and measure downstream travel distance. Variations of this technique have been used for decades to measure leaf transport in streams. But leaves are only one component of CPOM (typically defined as organic matter particles larger than 1 mm) and likely not the component most relevant to SCA addition. A comprehensive assessment of total annual CPOM transport would not be “cheap and relatively easy.” But even if CPOM transport were fully characterized, the relevance of the information to this study is unclear. Are the colored pieces of paper intended to provide an indication of mobility of the SCA? If so, why not simply tag a subset of the SCA and examine their movement? Or is there an expectation that streams with lower leaf litter transport rates will better retain nutrients released by the SCA? If so, a measure of nutrient spiraling length, or some other measure of nutrient retention rate, would be required to evaluate this hypothesis and the nutrient spiraling element has been removed from the study. As currently described, the CPOM transport work appears to be an interesting side-study with little relevance to the SCA treatments. If there is a hypothesis about the connection between leaf litter transport and the effect of SCA on system processes, it should be articulated clearly.

ISRP June 30 Review - Item 5. Provide some additional detail on the rationale for the variable treatment intensities over the three years of the study. How will potential cumulative impacts of repeated nutrient supplementation be assessed with this design?

The experimental design was altered to address ISRP concerns about varying SCA application rates. The revised Table 1 was helpful in illustrating the consistent treatment applications over the three years of the study. Hopefully there will not be a major disturbance (e.g., fire) in any of the test watersheds.

ISRP June 30 Review - Item 6. Discuss how the information gathered from these investigations will be used to design larger scale pilot or full implementation of salmon carcass analog applications as a salmon/stream restoration strategy.

The project proponents' response to this comment was sufficient. But given the potential significance of this experiment to subsequent management decisions on the broad scale application of stream nutrient enhancement, the adaptive elements of this work should be emphasized. The response indicates that the results of this study will be used to identify other streams in Idaho that might respond positively to SCA addition and use this information to design a series of adaptive experiments to apply SCA, or other nutrient enhancement, at the scale of an entire stream. Smolts/spawner is proposed as the principal metric that will be used in assessing the response to whole-stream nutrient enhancement. The ISRP agrees that these are logical next steps but it does raise several questions regarding the broader application of the study results. Are the number of treatment replications and the geographic distribution of the study streams sufficient to extrapolate results throughout Idaho? That is, will the selected streams represent an adequate range of natural conditions to be widely applicable?

Assuming the project proponents can demonstrate that the study results are broadly applicable, the ISRP encourages the project proponents to begin design of these next-generation studies concurrently with the execution of this study. Development of partnerships, compilation of available data from candidate study watersheds, and development of appropriate experimental designs and methods would provide a solid foundation on which to base a future proposal for these larger-scale treatments.