Independent Scientific Review Panel
for the Northwest Power & Conservation Council
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Memorandum (ISRP 2009-26) **June 30, 2009**

To: Tony Grover, Fish and Wildlife Division Director, Northwest Power and Conservation Council

From: Eric Loudenslager, ISRP Chair

Subject: Response Requested for Accord Proposal, Salmon River Basin Nutrient Enhancement (2008-904-00)

Background

At the Council's June 12, 2009 request, the ISRP reviewed the Shoshone-Bannock Tribes' Columbia River Fish Accord proposal titled Salmon River Basin Nutrient Enhancement (2008-904-00[1]). 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.

ISRP Recommendation

Response Requested

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.

A response is requested to address the following issues:

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?
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?

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

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?
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 course 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.
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?
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.

ISRP Comments

1. Technical Justification, Program Significance and Consistency, and Project Relationships (sections B-D)

Technical justification for the proposed nutrient addition using salmon carcass analogs was supported by the scientific literature and linked effectively to the Fish and Wildlife Program. Enhancement of trophic productivity has become a popular restoration method in the Columbia Basin, but its effects are not fully understood. This proposal details what is known about food web enhancement of salmon streams and identifies several knowledge gaps that this study will attempt to address. There appears to be good communication between this project and similar studies occurring on other locations in the basin.

2. Objectives, Work Elements, and Methods (section F)

The overarching objective of this project, to evaluate food web responses to the addition of salmon carcass analogs, is an important issue for salmon restoration in the Columbia River Basin. The project proponents are to be commended on the comprehensive approach they are proposing to evaluate system responses to nutrient enhancement. The study proposed is comprehensive and ambitious (perhaps overly ambitious?) encompassing all trophic levels and with generally appropriate analytical techniques, in the field, the laboratory, and statistically. The study would include the involvement of numerous graduate students and will be led by competent researchers who are leaders in this field of study. If accomplished as planned, this study would significantly improve our understanding of stream ecosystem response to salmon carcass analog additions. However, there were places where some additional thought or clarification is required.

There are several potential complications that may arise from comparing fish production and yield that should be addressed in the response. First, the fish production results may be seriously confounded by the presence, and likely variable abundance, caused by eyed egg boxes. Studies of this nature should ideally be conducted when the system is at carrying capacity for juvenile abundance, to provide comparisons that are not confounded by density effects. Presence of the eyed egg boxes will likely cause juvenile abundance to be highly variable. A more robust approach for assessing fish response to salmon carcass analog treatments would be the evaluation of (wild) smolt yield as a function of spawner density (i.e., smolts/spawner/km as a function of the number of spawners) in treatment and control study sites. This approach could be combined with a staircase treatment design to address environmental variation as well. Further, if the sites are not at carrying capacity, it is possible that there are sufficient food resources for the limited number of fish present in the study reach, thus no need for food enhancement via salmon carcass analogs. Examination and comparison of wild smolt abundance, size at age, and recruitment trends will be necessary, as in Ward et al. (2008[2]), to assess the key response variable.

There is no indication that smolt production from the study sites will be measured (except for the detection of tagged individuals at Lower Granite Dam). The primary objective of enhancing trophic production in salmon streams with salmon carcass analogs or nutrients is to increase growth and survival of juvenile fish (egg – smolt survival). This key response variable cannot be quantified unless the smolts produced by the treated and control reaches in this study are enumerated. The response should address whether or not smolts can be sampled at the study sites, and if not, what alternatives might be available to address this deficiency. Smolt sampling should include weights in order to address the question of whether nutrient additions contribute to growth.

The proposal treats salmon carcass analog additions as simply a nutrient enhancement and focuses all evaluations on capturing bottom-up effects on food web dynamics. Salmon carcass analogs, or actual salmon carcasses, can enrich aquatic food webs in two ways; bottom-up by increasing availability of nutrients limiting primary production or by providing a direct food subsidy to secondary consumers (invertebrates and fishes). The assessment approach proposed does a very thorough job of examining the bottom-up response to salmon carcass analog additions. It does not explicitly present an approach for assessing the effect of the direct food subsidy. The stable isotope analysis and sampling of fish stomachs can be useful in assessing this potential enrichment pathway. Samples would need to be collected at the appropriate time (soon after salmon carcass analog placement) in order to evaluate direct consumption of the salmon carcass analog and distinguish the response from this pathway from bottom-up enrichment of the food web. The methods that will be used to assess the direct consumption of salmon carcass analogs should be included in the response.

Study site selection will be critical to the experimental outcome. Results of nutrient additions will be expressed differently in streams with varying background nutrient concentrations (and nutrient ratios). Locations should be carefully picked to match baseline nutrient concentrations as closely as possible.

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[2] Ward, B.R, Slaney P.A and D.J.F. McCubbing. 2008. Whole-river ecosystem restoration to reconcile fisheries and habitat impacts in coastal British Columbia, Pp. 587-602, In [J. Neilsen, ed.] Proceedings of the Fourth World Fisheries Congress, 4 to 7 May, 2004, Vancouver, B. C., Canada. American Fisheries Society Symposium.

It was unclear how some of the project elements fit into the overall research effort. In particular, the identification of limiting nutrients using nutrient diffusing substrates (NDS) and the evaluation of nutrient spiraling length appear to be only tangentially related to the primary objectives of this study. The proposal did indicate that the NDS work would be one factor used in identifying study sites. But it is not clear how this information would be used. Will sites with the greatest response to nutrient addition be selected?

The connection between the identification of limiting nutrients and the proposed treatment is also not entirely clear. If addition of inorganic nutrients were being proposed, the relationship between the NDS results and the subsequent nutrient addition would be obvious; use the NDS work to formulate the nutrient soup to be added to the stream. But the salmon carcass analog composition cannot be altered to address any identified nutrient limitation. The NDS results might help in the interpretation of a food web response at a site; the change in food web dynamics could be attributed to an increase in the concentration of the element that the NDS work identified as limiting. But the ability to make this connection seems to add little to the value of the study and the value of the NDS work is questionable. The evaluation of nutrient spiraling length also is not clearly associated with project objectives, and in any case is often very difficult to determine. No objective is provided for this component of the study. How does the spiraling length assessment relate to the salmon carcass analog treatments? Is the hypothesis that the spiral length will in some way provide an index of how effective the nutrients from salmon carcass analog treatments are likely to be? Some discussion of how the NDS and nutrient spiraling elements of the study will contribute to better understanding the food web responses to salmon carcass analog additions or salmon releases should be included in the response or these components of the study should be eliminated.

The relationship between the salmon carcass analog additions and the CPOM transport assessment also is not clear. The release of plastic strips or colored paper has been used to evaluate the transport of leaf litter. But the CPOM released by the degradation of the salmon carcass analogs is unlikely to resemble leaves. Assessment of the distance traveled by salmon carcass analog fragments would be a useful, although not critical, addition to this study. It might be possible to do so using a biochemical marker, but this has yet to be demonstrated in the field. But the determination of short-term leaf transport distances appears to be unrelated to the objectives of the study. As with the NDS and nutrient spiraling work, the response should clearly indicate the relationship of this work to the salmon carcass analog additions or omit it from the study.

Relying on changes in AFDW and Chl a on tiles or natural substrate to evaluate the effects of salmon carcass analog addition on primary production can be complicated by differential grazing pressure between treated and reference reaches and among study streams. If invertebrate grazing pressure is high, Chl. a or AFDW may not be a good reflection of primary production. Whole-stream metabolism measures using highly-accurate DO sensors has been used to measure primary production in streams with good success for the last decade or so. You might consider augmenting the AFDW and Chl. a responses with some whole-stream metabolism measures. 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.

Another method (although not as accurate) of estimating primary production is to measure Chl a accrual on artificial substrates that have previously been "conditioned" to the ambient stream setting. This can be done by allowing artificial substrates (e.g., unglazed porcelain tiles) to incubate in the streams for a couple of weeks, then brushing the periphyton off to "reset" them, and sequentially sampling the rate of accumulation of Chl a on the substrates over about 10 days. The rate of chlorophyll accrual is an approximation of primary production if there are few grazing invertebrates on the substrates over the first 10 days.

The salmon carcass analog treatment schedule is not fully explained. The amount of salmon carcass analogs added to the study sites will vary among years so that each site will receive a high, medium, and low treatment level by the end of the study. The reason for this design is not provided in the proposal. The ISRP assumes the rationale for this approach is to ascertain the relative effect of each treatment level on each study reach. However, this design does not account for the possibility of effects of a treatment carrying into the following year. For example, if a site receives a high level of salmon carcass analogs in year 1 and a low level in year 2, it might be possible that the some of the nutrients associated with the year 1 addition would still be present at the study site and the response in year 2 could represent a cumulative salmon carcass analog addition over two years rather than a response strictly associated with the addition of a low level of salmon carcass analogs. The authors should provide a clearer explanation of the study design as it pertains to the salmon carcass analog treatment schedule and provide some indication of how the results will be interpreted in light of the possibility of cumulative effects.

A few minor points for clarification:

- Task 3.3 includes the measurement of discharge and the creation of a stage rating curve. A stage curve is only useful if stage height is being recorded but there is no indication in the proposal that stage height recorders will be installed at the study sites. If not, flow measurements at the time when flow-sensitive samples are being collected should suffice.
- What will happen if the salmon carcass analogs are found to contain contaminants?

3. M&E (section G, and F)

This proposal is for research. All comments above pertain to M&E.