Independent Scientific Review Panel
for the Northwest Power & Conservation Council
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Memorandum (ISRP 2013-15) **November 6, 2013**

To: Bill Bradbury, Chair, Northwest Power and Conservation Council

From: Greg Ruggerone, ISRP Chair

Subject: Review of Progress Report on Multiscale Hyporheic Exchange Study (#2007-252-00)

Background

In response to the Northwest Power and Conservation Council's September 2013 request, the ISRP reviewed a progress report and a summary proposal for the Confederated Tribes of the Umatilla Indian Reservation's Project #2007-252-00, Multiscale Hyporheic Exchange. This project's purpose is to "identify alluvial valleys across 26,300 km^2 (in NE Oregon and SW Washington), describe how valley morphology and hydrologic regime interact to determine the character and magnitude of temperature influence on the river channel, and use this understanding to predict 1) the potential distribution of Chinook and summer steelhead and 2) how different alluvial valley forms will influence the resilience of water temperature in response to climate change."

This project was first proposed and reviewed in the Research, Monitoring, and Evaluation an Artificial Production Category Review process. The ISRP recommended that the project met scientific criteria (ISRP 2010-44) but offered the qualification that the project produce a progress report within a year. The ISRP requested that the progress report describe results to date and outline a study design that explains how the project will link hyporheic processes and the geomorphic classification to restoration planning and actions, habitat effectiveness evaluation, and salmonid performances. In June 2011, the Council recommended that implementation beyond 2014 be based on the ISRP's and Council's reviews of the progress report.

Review Recommendation and Comments

Response Requested - The ISRP requests a response to each of the issues discussed below.

In the original review of the Multi-Scale Hyporheic Exchange Project, the ISRP thought this project could provide important insights on the influence of geomorphology, vegetation, and hydrologic regimes in alluvial valleys on hyporheic flow, water temperature, and subsequent salmonid distribution, growth, and abundance. Therefore, this project, in concept, has great potential for contributing important information on one of the pressing issues associated with

conserving and restoring Columbia River fish stocks. Due to ISRP concerns about some of the project elements, the ISRP requested a progress report after one year. Comments below relate to this progress report and an updated study proposal. Unfortunately, these documents indicate that many of the qualifications raised in the 2011 ISRP review have not been addressed. In addition, the study design and methods have significantly changed, compromising the potential of this project to achieve the stated objectives.

The progress report is very brief, which is partly due to the project sponsors not yet analyzing any of the temperature data they have collected. The primary completed activity appears to be a Digital Elevation Model (DEM) exercise to identify a few alluvial reaches for assessment within the ceded lands of the CTUIR.

The study approach described in the revised proposal differs substantially from that in the proposal originally reviewed by the ISRP. The initial proposal described the use of a combination of LiDAR-derived DEMs and forward looking infrared (FLIR) images to characterize the morphology and thermal patterns of relatively-intact alluvial reaches. In contrast, the new documents describe a study approach that uses 10-m DEMs rather than LiDAR and relies on three temperature loggers per site instead of FLIR imagery. Further, hyporheic flow paths are complicated. For example, multiple and twisting pathways can occur in the same reach and often run in different directions at different depths. Hyporheic flow paths are also easily disrupted by seemingly small perturbations, such as a thin layer of fine sediment. At scales practical for restoration actions, and especially for salmonid spawning, these fine-scale features can be vitally important. Understanding these and other three-dimensional physical complexities at the reach scale are essential for designing effective restoration actions and for making informed adaptive management decisions. The revised study design does not sufficiently address these complexities.

The initial study approach would have been much more effective at characterizing the complex flow and thermal patterns of alluvial reaches. LiDAR-derived DEMs contain far more detail than 10-m DEMs and would reveal floodplain features not detectable with the lower-resolution data now being used. Use of a limited number of temperature loggers cannot provide anything near the spatial resolution of temperature patterns that would have been possible with FLIR images. Use of LiDAR and FLIR to conduct this study was one of the attractive features of the original proposal. The submitted documents should have included some discussion as to why this approach was abandoned and how this change alters expectations for the project.

The revised proposal is not detailed enough to enable a review of its scientific merits. Specifics on study design, work elements, methods, metrics and deliverables are limited. Some of the major items requiring expansion and clarification include:

1. The proposal indicates that baseflows, floodplain size, channel complexity, species and density of riparian vegetation, and summertime temperatures will be used as independent variables in regression analyses to determine which of these factors have a significant effect on thermal patterns of alluvial valleys. Yet, details on how these data will be obtained were not provided. For example, baseflow information for the study sites can be generated using data from nearby gauging stations and then using graphical

and empirical methods or by using HYSEP software developed by the USGS. Will one or more of these methods be employed?

2. The proposal indicates that well-established metrics of channel complexity will be used but does not explain what metrics will be used and why they feel they are relevant to the questions being addressed. Measures of channel complexity, such as the River Channel Complexity Ratio (O'Neill and Thorp 2011), Brice's Braiding Index (Brice 1964), Rust's Braiding Parameter (Rust 1978), the Friend and Sinha's Index (Friend and Sinha 1993) and others have been developed. Landsat photographs are commonly used to quantify river channel braiding. Other researchers have employed Landsat Bands 4, 5, and 7 to increase the contrast between land and water to facilitate the collection of braiding data. It would be helpful to know what indices of complexity are being considered and how they will be calculated.
3. The analysis of the temperature data being collected also requires additional clarification. Briefly, three temperature loggers will be deployed at each study site. Temperature logger #1 will be located upstream by a distance equal to the length of the study valley. Logger #2 will be sited at the upstream edge of the valley while Logger #3 will be placed at the downstream end of the valley. The effect of an alluvial valley on mainstem river temperature will be estimated by comparing the temperature difference seen between loggers #2 and #3 (test area) with that observed between loggers #1 and #2 (control area). The value obtained from this comparison will be used as the dependent variable in their regression models. The manner in which this difference value will be generated needs to be better defined. For instance, how will multiple months of temperature differences be used to produce this dependent variable? Will it be converted into a monthly or seasonal average or maxima or will it take some other form? Will it be weighted by flow?
4. The progress report states that the sponsors will use a model that quantifies the buffering and lagging effects of hyporheic water on surface water temperatures. Presumably model outputs will be used to help quantify the effect of alluvial valleys on river temperatures. Details on how the outputs from this model will be used are needed.
5. Data on conductivity, air temperature, and pressure are being collected, but the proposal did not describe how these data will be used. The type of pressure data collected needs to be identified, e.g., barometric pressure.
6. The use of stilling wells is mentioned in the progress report, but there is no reference to them in the revised proposal. How will data from the wells be used?
7. A brief description is needed on how possible multicollinearity among the independent variables will be assessed.
8. The methods used to estimate how study sites may respond to future climate change needs to be clarified. It is mentioned that the Regional Climate Model 3 will be used to modify daily mean water temperature and flow data. But explanation is needed on why this should be done or why the daily mean values were chosen for this analysis.

Furthermore, it is unclear how future water temperatures and flow rates will be predicted.

9. The capacity of each study valley to resist projected effects of climate change will be ranked. Details about the ranking process should be included in the proposal.
10. One project objective is to examine the relationship between hyporheic flows and salmonid distribution and performance, including multiple species and life stages. There was very little discussion in the progress report or revised proposal of how the temperature results from this study will be used to better understand salmonid performance, either currently or in a warmer future.

One of the major objectives of the revised proposal is to identify how factors such as floodplain surface area, slope, vegetation type, baseflow, and channel configurations in alluvial valleys affect mainstem water temperatures and use this information to develop a classification system for alluvial valleys based on potential resilience to increased summertime temperatures. A troubling aspect of the progress report is the fact that the sponsors planned to examine 30 alluvial sites across the ceded lands of the CTUIR to develop this classification scheme, but they have been able to locate only 5 sites that met their study criteria. The rationale for 30 sites in the study was the desire to examine the thermal influence of hyporheic water exchange across a range of alluvial valley types. It seems highly unlikely that the full range of alluvial valley conditions can be adequately captured with 5 sites. Neither the progress report nor the updated proposal contains any indication of whether the number of study sites will be increased in the future. The proposal should contain a full explanation of how this issue is being addressed.

Availability of study sites may be limited by the stringent site selection criteria. Each study reach had to be within a geomorphologically bound valley with small or no tributaries; have an active stream gauge or are otherwise amenable to flow calculations; have adjacent alluvial and bedrock channels; and have minimal hydrologic and anthropogenic disturbances. These criteria may limit the sites available for study as well as eliminate the consideration of the influence of tributaries and human impacts on hyporheic temperatures and flows. The project sponsors should consider relaxing their selection criteria to increase the number of the study sites and to enable tributary flows, tributary drainage areas, and various human disturbances to be included in the classification process. Broadening the range of conditions should still enable the identification of locations or habitats that should be protected and also would provide guidance on the important elements to restore in degraded alluvial valleys.

The original ISRP review suggested that the sponsors consider including several restored floodplain sites in the study to evaluate if current approaches to floodplain restoration are effective at re-establishing hyporheic flows. The CTUIR area includes sites where very large floodplain reconnection efforts are being implemented, including Meacham and Iskuulpa creeks. The revised proposal does not indicate that there is any intention of examining sites with restored floodplains to determine if these sites do exhibit some of the thermal characteristics common to intact alluvial reaches. Including this type of assessment as part of this project is needed and would answer important questions about the effectiveness of floodplain restoration efforts.

Several other deficiencies in the revised proposal and progress report are:

1. The original ISRP review of this project indicated that completion of the Hyporheic Potential Index (HPI) assessment for portions of the Grande Ronde and Walla Walla was a worthwhile project goal. The update contains no information on progress against this goal. In fact, no mention of the HPI is included in either the update or the revised proposal.
2. There is limited discussion about integration with other regional habitat programs. Notable is the lack of discussion regarding opportunities to link to landscape scale planning efforts being done by the USFS and BLM, which could provide opportunities for future land acquisitions and to influence land allocations and management practices needed to maintain or restore conditions in areas of high value for hyporheic thermal refuge habitat.
3. A discussion is needed about other ongoing efforts that are collecting data that would complement that being generated by this project. Some description of linkages with other projects should be included in the proposal.
4. A discussion is needed of adaptive management principles to ensure effective application of study results. This is a critical gap that should be addressed.
5. One of the desired products of this project appears to be the creation of a system of protected alluvial valley reaches that can serve as reserve networks for cold-water aquatic communities. It would seem that some assumptions about the ideal number, size, and distribution of alluvial sites with cool water would be critical in designing such a system of protected areas. It is not clear how an appropriate distribution of sites would be determined. Additionally, there is no mention of what management guidance will be needed for reserve sites and whether their selection will require changes in current management/land use in adjacent areas of a watershed. There does not appear to be a component of the project that will provide this type of information.

The progress report and revised proposal raise more concerns than address the qualifications provided by the ISRP two years ago. The lack of a clearly defined experimental design, incomplete description of field and analytical methods, the absence of an adaptive management approach, and other concerns make it difficult to assess the scientific merits of the study.

In summary, a revised proposal should incorporate:

- a more thorough description of how and why this project has changed from the original proposal
- some discussion of what the limited number of study sites means for the likelihood of success
- a more complete description of study design and methods
- an overview of the process that will be employed to classify alluvial valleys, and
- a better description of how project results will be used to assess salmonid response and guide restoration efforts.

Literature Cited

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