Independent Scientific Review Panel
for the Northwest Power & Conservation Council
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Memorandum (2021-5) **June 1, 2021**

To: Richard Devlin, Chair, Northwest Power and Conservation Council

From: Stan Gregory, ISRP Chair

Subject: Follow-up Review of MFWP Response for Libby Dam Mitigation Project (#1995-004-00)

Background

At the Northwest Power and Conservation Council's request of March 31, 2021, the ISRP reviewed a response from Montana Fish, Wildlife and Parks (MFWP), regarding Project #1995-004-00*, Libby Reservoir Mitigation Restoration and Research, Monitoring and Evaluation (RM&E)*. The submittal, *Response to final ISRP and Council Resident Fish and Sturgeon category review comments and recommendations for Libby Dam Mitigation (Project 1995-004-00)*, is intended to address conditions placed on the project, by the Council, as part of the *Resident Fish and Sturgeon Project Review* in October 2020. The Council recommended: *"Manager to respond to ISRP conditions in a report no later than March 31, 2021."*

The ISRP's review (2020-8) recommended five conditions for MFWP to address in a response. MFWP embedded their responses point-by-point in the ISRP's final review comments and recommendations. Our review below follows the same point-by-point format, organized by the conditions.

ISRP Recommendation

Overall Recommendation: Partially Meets Conditions

The ISRP thanks the proponents for their thoughtful and comprehensive responses to our questions and concerns. The responses revealed the depth of pre-proposal effort that provided a foundation for the proposed activities. The table below describes the ISRP's findings on each of MFWP's responses to conditions, the type of future actions needed by the proponents to fully meet the conditions, and whether additional ISRP follow-up review is needed. In any event, the ISRP recommends that the proponents report progress on the conditions in annual reports, and the ISRP will review the project's progress in the next major project review for which this project is included.

Condition	Meets Condition?	Additional Proponent Action?	Additional near-term ISRP follow-up review?
1. Desired future conditions	Partially	Yes, through ongoing work	No
2. Justification for the limited spatial scope of some activities	Yes	No	No
3. Climate and land use change	Partially	Yes, through ongoing work	No
4. Nutrient fertilization facility	No	Yes, plan development	Yes, review of separate plan
5. Donor stock selection	Partially	Yes, through ongoing work	No

ISRP Comments on the MFWP Responses

Updated Project Goals and Objectives

The goals and objectives clarify the project's direction and are generally well framed (i.e., SMART), though some details remain unclear or should be revised. While this aspect is not required to meet conditions, it is recommended that these be reviewed and updated for the benefit of the project. For example:

- Goal 1
    - Objective 1d: Do the proponents mean increase <u>*annual*</u> growth by 70 mm?
    - Research question: Identify what aspects of aquatic invertebrate community are to be improved.
    - Alternate question: Given the experimental nature of the fertilization activity, articulating both expected and unexpected routes as hypotheses and alternate hypotheses, and collecting the data to evaluate those hypotheses, is an important element of understanding the ecosystem-scale response.
    - The results of this work will be of interest to scientists and managers. The ISRP advises the proponents to consider an additional objective (and associated budget) for producing peer-reviewed publications and for regional dissemination of results.
- Goal 2
    - Some objectives need to be revised as SMART. For instance, "Reduce the risk" is not measurable, but "removing WCT" (to a desired density, for example) is measurable. Similarly, "expand the distribution" is vague but "re-establishing a self-sustaining population" is measurable.
- Goal 3
    - This will be a rich dataset. The ISRP recommends that there should be a supporting objective (and associated funding) for archiving the data in a publicly accessible online data management system.
- Goal 4
    - The objectives are generally well written; however, it is unclear what distribution and abundance of woody vegetation will be considered as successful under objective 4b.

- Goal 5
    - The objectives are well written as revised. No further suggestions.

Condition 1. Desired future conditions
Recommendation: Partially Meets Condition

The proponents provide five statements about desired future conditions. The first three address hybridization in fishes and restoring native fish populations. The desired future conditions are further described in subsequent sections of the response. In general, these give an understandable vision of what will be achieved in the coming two decades. Most importantly, perhaps, is the acknowledgement that 0% introgressive hybridization is an aspirational goal, and that significant reduction to low levels (<10%) is a more achievable target -- at least in the near term. Table 1-1 provides tangible targets in this regard. It will be important for the proponents to define the <10% introgression target. For instance, is it <10% of populations with mixed ancestry or <10% of non-native genes within each population?

The 4th statement does not specifically address desired future conditions in Koocanusa Reservoir. It states only that research will be conducted and, therefore, does not provide a vision of desired (or achievable) future conditions in response to hydro-operations. Are the research activities directed toward an ecological goal for the reservoir (with the cooperation of those leading the hydro-operations), or are they only documenting ecological conditions over time? A definitive response is needed to fully meet this condition.

The 5th statement attempts to quantify desired future conditions in the Montana portion of the Kootenai River but does so only in a vague way by saying that primary, secondary, and tertiary production will be increased by 25% over the next two decades. It is not clear how this will be achieved for the entire Montana reach of the Kootenai River, especially since primary and secondary productivity are not being quantified and the P-fertilization experiment is intended to impact only 3.5 miles below the dam. A more quantitative approach that includes measurable attributes to assess progress toward desired (or achievable) future conditions is needed to evaluate the realism of this vision, and to fully satisfy this condition.

The ISRP requests the proponent to provide this information in the next annual report.

Condition 2. Justification for the limited spatial scope of some activities
Recommendation: Meets Condition

The proponents provide a strong justification for the apparently limited scope of some activities. The ISRP acknowledges that the spatially limited activities balances identified needs with limited budgetary and personnel resources. The ISRP was encouraged by the support of justifications with peer-reviewed literature.

Condition 3. Climate and land use change
Recommendation: Partially Meets Condition

There is a fundamental need to understand the scope of challenges facing complex ecosystems from climate change as well as from human-driven changes in the watershed. Truly adapting to them at a local scale is a substantial challenge for any project. Nevertheless, approaches for ecological forecasting are available and evolving to a level where they are becoming incorporated into numerous programs (Dietze et al. 2018). The ISRP urges the proponents to consider these perspectives and tools in shaping the project's future directions.

The proponents articulate a solid understanding of how climate change may impact the system. The ISRP appreciates this level of thinking and encourages the group to keep it foremost in mind as they move forward. It is still not clear, however, how this understanding will be incorporated into on-the-ground adjustments to the overall strategic plan and activities. The proponents have prioritized headwaters because that is where contemporary conservation science largely suggests to focus. Nevertheless, climate driven changes will take place throughout the system. The ISRP trusts that, as long as there is a strong Adaptive Management process in place, the proponents will be forward looking and will make appropriate decisions in advance of irreversible ecological changes. It may be prudent to conduct scenario planning to visualize the most likely significant impacts from projected changes in climate, and then develop an adaptive management plan in response.

Land use change is a difficult issue because of the numerous and diverse causes of change. Coal mining is a well-known concern being tracked by the responsible Montana and British Columbia agencies, and the ISRP will be interested to learn in future annual reports or proposals how the results of these efforts are informing project activities. However, nothing is said about other existing or emerging changes in human-driven land use. Will these not have significant impacts on the reservoir and river? For instance, the ISRP notes that Total N concentrations are increasing in the Kootenai/y River. What are the potential consequences for the reservoir? A more thorough discussion of existing and emerging changes in land use, and how those may impact the ecological system, is needed to fully meet this condition.

The ISRP requests the proponent to provide this information in the next annual report.

Condition 4. Nutrient fertilization facility
Recommendation: Condition Not Met

The ISRP appreciated the additional detail on the proposed fertilization to better inform the review of the project. While the activity may be important for restoring rainbow trout production and controlling *D. geminata* in the river, numerous aspects require additional information and discussion. For instance:

- The engineering/physical aspects are not described in the response or in the original proposal. There are possible issues with mixing added nutrients (laminar vs turbulent flow, and the density of nutrient addition water relative to river water) and physical substrate surfaces (armored cobble/bedrock below dam vs cobble farther downstream) that require consideration. A basic description of the facility and the approach to avoid mixing issues would be helpful.

- While the proponents provide adequate justification that most P is trapped behind Libby Dam, there was no evidence demonstrating that rainbow trout growth increased in response to P-fertilization in Idaho (Watkins et al. 2017), even though there was a positive response in other fish species. However, in the Montana portion of the Kootenai River, Dunnigan and Terrazas (2021) recently demonstrated a positive relationship between the N:P ratio and mark-recapture based growth rates of rainbow trout. Their results provide strong support for hypothesizing that increasing P in the Kootenai River would reduce *D. geminata*, increase benthic invertebrates, and ultimately increase rainbow trout growth.

- The proponents use dosing recommendations from the Wilhelm et al. (2018) pilot study to establish a 1.0 microgram/L dose for Jan-May. However, it is not clear where the 1.4-3.7 microgram/L dose for June-Sept came from. Please clarify.

- Rigorous and timely analysis of nutrient concentrations and associated water quality parameters are essential to conduct the fertilization successfully and to meet fundamental water quality permit requirements. It would be desirable to obtain and review results within one week of sampling, and anything longer than a week would be inadequate for the study design and for promptly assessing environmental risks. Near real-time information on nutrient concentrations can be used in adjusting nutrient concentrations and ensuring compliance. Having timely P concentrations could be accomplished by contracting with a certified analytical laboratory, one that can guarantee the necessary turnaround time on samples, or by developing an on-site analytical capacity. The ISRP acknowledges that developing an analytical laboratory on site initially would be expensive and time consuming, yet it could be cost effective over the long term and could be an analytical contracting laboratory resource for others in the region. The ISRP would like the proponents to identify their preference for an analytical strategy, and to inform us as to how quickly will it allow nutrient concentrations to be evaluated after sampling.

- The ISRP also believes that it would be advisable to collect a synoptic longitudinal series at many locations to accurately identify the longitudinal pattern of P and N concentrations. Such synoptic sampling should occur at least at the start, middle, and end of the fertilization period. The P additions will be increasing uptake capacity over the fertilization period and knowing the spatial patterns of P uptake and P concentrations will be essential for understanding the outcomes.

- The proponents argue against using N:P ratios as a criterion for adjusting fertilization rates. It is well accepted that the N:P ratio may be more important than the absolute concentrations of P in structuring the periphyton community. As well, Dunnigan and Terrazas (2021) show that the N:P ratio was one of two top predictors of rainbow trout growth and argue that the N:P ratio is a better way of assessing changes in P given detection problems for SRP. The ISRP would appreciate a better justification for using P concentrations rather than the N:P ratio for the nutrient experiment.

- There is no mention of monitoring for co-limitation from other micronutrients (e.g., silica, iron, molybdenum, chromium, and others). With the addition of P, do other micronutrients quickly become limiting to the point of suppressing periphyton growth? This may be an important consideration before launching an expensive multiyear experiment. The project should evaluate the concentrations of potential micronutrients and other studies that have documented co-limitation of primary production to determine the potential likelihood of co-limitation.

- Since the experiment needs only P and there is already an apparent abundance of N in the system, why not select a fertilizer that does not add N? Is this a cost/logistics issue where the proponents want to use a highly accessible fertilizer versus one that is actually needed?

- The proponents provide multiple practical reasons for site selection, though notably none of them is based on ecological factors. The practical reasons are valid, but it seems like some measure of the effectiveness of fertilizing the selected reach is also needed, particularly since the elevated P will only persist and function a short distance downstream, as shown by the Idaho studies. The only ecologically oriented justification is that this section of the river has the lowest P and has high *D. geminata* growth, which appears to be driven by low P. However, if more P is added to the system, is the habitat of adequate quality in this section of the river to support greater abundance of rainbow trout? How will the substrate characteristics in the fertilized reach affect secondary productivity? Most likely the coarse but armored substrate immediately below Libby Dam has less interstitial space, hyporheic exchange, and habitat for macroinvertebrates than bed material lower in the river.

- The reference sites are located downstream. The justification for selecting these sites is the baseline rainbow trout growth data at the sites, which is sound. The proponents acknowledge this limitation and propose a reasonable analysis strategy (page 31). Even if the BACI results are a bit suspect because of this issue, the ISRP recognizes that rainbow trout growth is an acceptable analytical metric. The proponents should actively watch for changes in the study reach that would invalidate or weaken the before-after comparison.

- While the location of reference sites may be dictated by physical circumstances, the annual addition of tons of P suggests that both inorganic and organic P will eventually move downstream. Since there are no realistic biochemical mechanisms for long-term storage in the channel or for movement to the atmosphere (as there is for N and C), it is likely that the phosphorus biologically assimilated or physically adsorbed onto organic and inorganic sediments would accumulate in the riverbed and floodplain, both in the 3.5-mile study section and downstream reaches over the long-term. Even P retained in Koocanusa Reservoir can be transported downstream either as resolubilized P from anoxic habitats or entrainment of organic material. Has the project considered the long-term consequences of phosphorus loading in the ecosystem? It is a challenging question that the ISRP feels the proponents should consider in future proposals if the project is to be implemented.

- The dosing is based on achieving an increased growth rate of 70 mm/yr in rainbow trout (using growth models), which is a strength (rather than arbitrarily setting a dose). However, the ISRP does not completely understand why 70 mm/yr was decided upon. It seems to be unusually rapid. Why 70 mm/yr vs. 50 mm/yr or 90 mm/yr for an “average” 230 mm rainbow trout? By calculating the 75th percentile of the observed average growth increment of tagged fish within the Dam section from 2011-2018, does this mean that three quarters of the fish grew at a rate of 70 mm/year without fertilization? As well, since growth slows over the life of fish, can other expected age-specific growth rates be estimated in response to the fertilization? The ISRP feels that it would be informative to have the estimated growth projections for rainbow trout of other sizes.

- Periphyton will be sampled, but the metrics are never identified (other than a visual estimate of the percentage covered by periphyton, which is highly misleading). At a minimum, Chl a per unit area should be quantified as a response to the fertilization. *D. geminata* cover and thickness will be determined but not biomass. That said, standing stock is not a sensitive measure of periphyton production. The standing stock of periphyton, measured either as AFDM or pigments, is what is left over after the invertebrate and vertebrate herbivores have consumed it. It is not a direct measure of the response of algal primary production to nutrient addition (for example, see Gregory 1983, Lamberti et al. 1989). If the proponents want to assess the algal response to the fertilization, photosynthetic rates need to be measured.

- With the addition of P, there is always the possibility of cyanobacteria emerging to take advantage of the P. Will these cyanobacterial species be monitored and what are the indices that would dictate curtailment of P additions?

- The ISRP appreciates the focus on growth responses of trout, yet nutrient addition elicits an ecosystem-scale response. The proponents are choosing not to monitor other fish species due to budget constraints but acknowledge that they also may be affected by the added nutrients. If the proponents wish to truly understand the ecological-scale response, it would be prudent to expand the scope of the investigations during the initial years to other fish species in the community. Community-level response to the fertilization could obscure the response of individual fish species, including the project's rainbow trout growth objectives. The ISRP suggests that the proponents consider measuring length and weight of all fish species when sampling for rainbow trout. Sculpins, in particular, could demonstrate the more localized effects of the fertilization on fish because they have similar food resources as salmonids and they do not migrate or disperse extensively. Collecting 30-60 sculpins, by species if more than one species is present, at several times during the fertilization period at 3-5 sites, and measuring lengths and weight, could be fairly easy and inexpensive.

- Riparian vegetation can sequester added nutrients from river water. The ISRP acknowledges that investigating this in depth would entail considerable effort. Nevertheless, the proponents may wish to consider measuring the growth of representative woody riparian vegetation (tree ring analysis), on a limited basis, before implementing the fertilization and again after 5 years in the reference reach and the treatment reach.

Recommendation: The ISRP asks the proponents to prepare a separate document for the fertilization experiment. This document should address the concerns outlined above as well as provide a long-term plan for the construction, operation, and costs of the facility and associated activities (i.e., prepare a separate project implementation plan).

Condition 5. Donor stock selection
Recommendation: Partially Meets Condition

The proponent's response described well the logic and process by which candidate donor populations (sources) are screened. This process examines diversity both within-population sources and among-populations (i.e., population architecture) based on MFWP's SNP panels. The SNP panel also examines a large set of diagnostic markers to identify whether recent hybridization with non-native gene pools has taken place.

Several other parts of ISRP's Condition 5 were not addressed in the response, and the ISRP would have appreciated clarification to fully meet the condition. Specifically, the ISRP requested information on a breeding plan for production (or perhaps a timeline for completing a plan); information on facility choice or requirements for breeding and production; anticipated stocking density targets (or the process by which they will be determined); and the risk assessment protocol aimed at ensuring donor and receiving populations are not mismatched and the donor populations will be unaffected by brood take. The specifics and rationale for these requests are included in our original review.

The ISRP requests the proponent to provide this information in the next annual report.

Literature Cited

Dietze, M.C., et al. 2018. Iterative near-term ecological forecasting: Needs, opportunities, and challenges. Proc. Nat. Acad. Sciences 115: 1424-1432.

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Lamberti, G.A., S.V. Gregory, C.D. McIntire, A.D. Steinman, and L.R. Ashkenas. 1989. Productive capacity of periphyton as a determinant of plant-herbivore interactions in streams. Ecology 70:1840-1856.

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