Independent Scientific Review Panel
for the Northwest Power & Conservation Council
851 SW 6th Avenue, Suite 1100
Portland, Oregon 97204
www.nwcouncil.org/fw/isrp

Memorandum (2020-6) **May 7, 2020**

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

From: Stan Gregory, ISRP Chair

Subject: Review of draft Kootenai Synthesis Report

Background

In response to the Northwest Power and Conservation Council's February 18, 2020 request, the ISRP reviewed a draft report produced by the Idaho Department of Fish and Game and Kootenai Tribe of Idaho titled Kootenai Synthesis Report (February 2020). The intent of the report is to address a condition that the Council placed on several projects (based on the ISRP review, ISRP 2012-6) as part of the Resident Fish, Data Management and Program Coordination Category Review, in July 2012. The Council's recommendation for the project follows.

> *Implement with condition through 2017. Sponsors to develop a synthesis report for Kootenai River projects (1988-065-00, 1994-049-00, 2002-002-00, 2002-008-00, 2002-011-00) as described by the ISRP. By the end of calendar year 2012, sponsor to submit a timeline and plan to Council for the development of the synthesis report.*

Qualifications from ISRP 2012-6 (pages 111-124) regarding the synthesis include:

> *The Kootenai River projects have been in existence for some time and have collected a significant amount of data on river and floodplain characteristics and function. However, these data have not been used to their full potential. The ISRP recommends that a synthesis report be produced that summarizes the results that have been obtained from the RM&E efforts associated with these projects. The synthesis should not be a simple tabulation of data collected but a concise and comprehensive interpretation of community and system-scale responses that can be used to guide current and future restoration efforts on this system.*

The Kootenai Tribe of Idaho submitted a draft of the report on February 14, 2020, coinciding with the ISRP's review of the Kootenai River projects in the 2020 Resident Fish and Sturgeon Category Review. Although the ISRP is using the draft Kootenai Synthesis Report to inform the project review, the ISRP decided to also review this draft synthesis report just as it has reviewed other synthesis reports developed in response to Council and ISRP qualifications. The ISRP understands that this report was submitted as a draft, and we anticipate that our comments will inform the final report.

ISRP Recommendation and Overall Comments

Recommendation:

The draft Synthesis Report does not satisfy the ISRP's qualification from 2012. The ISRP encourages the authors to consider our comments and suggestions in preparing the final Synthesis Report, which we look forward to reviewing to determine if it meets the 2012 qualification.

Uncertainties with future coronavirus control measures make scheduling deadlines difficult. Understanding the need for flexibility, the ISRP suggests that the authors and the Council staff agree on a mutually determined date for a completed Synthesis Report. If time allows, the authors could include a proposed timeline for revising the draft Synthesis Report in their responses for the Resident Fish and Sturgeon Review.

Prior to revising the synthesis report, the authors are welcome to provide a point-by-point response to correct any misinterpretations by the ISRP. Our intent is to offer an opportunity for exchange between the authors and ISRP so that there is a clear understanding of ISRP expectations and how they can be addressed in the Synthesis Report.

Overall Comments:

The ISRP appreciates the opportunity to comment on a draft of the Kootenai Synthesis Report. We trust that our comments and suggestions will be used constructively by the authors to improve an already complex task, a report addressing nearly 30 years of research, monitoring, and evaluation.

The excellent photos, maps, and other visual elements greatly enhanced our understanding of the physical setting and the restoration actions. While our review identifies many positive aspects of the draft Kootenai Synthesis Report, the authors have not fully addressed the 2012 ISRP qualification. The intent of the request for the synthesis was to provide "*a concise and comprehensive interpretation of data*" on ecosystem responses to restoration actions "*that can be used to guide current and future restoration*" efforts. The draft synthesis report describes project objectives and details on implementation, but its descriptions of data analyses, results,

and knowledge gained from the findings are incomplete. Only a small portion of the report presents data and analyses on biophysical responses to restoration actions. Most summaries of the data are brief and lack adequate detail. In some cases, important and unexpected interpretations are provided without adequate supporting data.

The Synthesis Report would be improved by stating the goals and objectives of individual projects early in the report and describing how the projects have evolved over time to meet those goals and objectives. The report should explain the objectives, data, and results of the prior projects as well as the current proposals under review. A clear presentation of objectives is needed to understand the projects' history of restoration effectiveness. As well, there are several instances where the authors should present the data that support key findings, revisit many of the key findings to ensure they are supported by rigorous interpretation of data, and clearly indicate how the lessons learned from data analyses improved planning and design decisions.

ISRP Comments on Kootenai Synthesis Report Sections

Executive Summary

The Executive Summary begins well by describing general land-use and ecological changes that have occurred in the Kootenai River basin over the last century. It would be more informative if it includes a synopsis of the loss assessment, key research and monitoring findings, lessons learned, important problems encountered, major solutions and programmatic adjustments, and a few sentences about how emerging challenges are shaping future activities. These important aspects of the project are important contexts for planning future restoration actions and informing other projects in the Columbia River Basin. Since many readers may not have time to read the entire report, the Executive Summary becomes a vital avenue for conveying the restoration "story" for the Kootenai River basin. The last paragraph on page iv could be easily expanded to two to four pages to educate the reader about relationships among the five projects, which are not well described in the Executive Summary, and to identify major advances that have been achieved since the project's inception nearly 30 years ago. Given the breadth and complexity of this effort, a four to five-page executive summary seems warranted.

1. Introduction

This chapter provides a basic overview of the purpose, content, and organization of the Kootenai Synthesis Report. Overall, the intent of the report is well presented. However, a paragraph or two describing the gravity of the issues and the rationale for the research, monitoring, and restoration projects would improve the Introduction.

The report organization outlined in the Introduction raised concerns for the ISRP. Most of the draft report is largely a summary of fish and reach characteristics, a description of the projects, and a narrative of how the evaluation process will work. However, the 2012 request from the ISRP was to provide "*a concise and comprehensive interpretation of community and system-scale responses that can be used to guide current and future restoration efforts on this system*." Of particular concern is the general lack of data-driven analyses of community and system-scale responses in all chapters. The report should describe how quantitative physical and biological responses were used to guide restoration efforts. The Introduction would benefit from a discussion of how the data and lessons learned support decision-making for restoration actions. In addition, a summary of the total funding amounts and major sources would be informative.

2. Problem and Solutions

This section includes a problem statement, descriptions of project responses to the problem, and a concluding section on "putting it all together."

The problem statement is very general and could apply to most temperate zone river valleys where large dams have been built. The statement could be improved by judiciously adding quantitative information about when and how fish populations and habitats have declined, or by providing data in sidebars or in a quantitative summary as an appendix.

The high level of cooperation between the IDFG and the Kootenai Tribe and among the various individual projects is commendable. Descriptions of each project clarified the general activities of each and helped identify connections among projects. It was especially helpful that the authors indicated where additional, detailed information was located for several—but not all—of the projects. Nevertheless, it is reasonable to expect that a synthesis of this scope would include or would cite in appropriate chapters detailed information for all projects, including Libby Dam Sturgeon Flows and Temperature Management.

The proponents are to be commended for their forward-looking inclusion of the unpredictable issues raised by climate change. Moreover, the possibility that cold water in the system may offer refuge from climate change is worthy of further investigation. The inclusion of socioeconomic factors that might influence projects in the future is also commendable.

The ISRP recognizes that putting it all together for any complex program is extremely challenging. The report offers a glimpse into the complexities associated with the Kootenai ecosystem by three examples of collaboration that highlight white sturgeon recovery, burbot reintroduction and investigations, and the nutrient addition program. These examples are helpful. However, the report needs to explain how the five BPA-funded projects are integrated into an entire program as well as how the modified operations of Libby and Corra Linn dams are incorporated.

3. Subbasin Orientation

This section describes the Kootenai River Subbasin, Kootenai River, and Kootenay Lake and acts as a general biophysical atlas of the Kootenai River and Kootenay Lake. It is well crafted for a public audience. However, it does not satisfy the requirements of a critical scientific summary of landscape-scale analyses, one that serves as a quantitative context for prioritizing restoration activities on the landscape. For instance, the biophysical characteristics and uses of uplands and former floodplains are not described in any detail. Yet, these characteristics and the inherent human-induced changes (e.g., roads, fire, harvest, agriculture) substantially influence the ecology of the river and lake. Climate characteristics and seasonal water conditions (e.g., winter ice dynamics, temperature, and chemistry) need to be characterized. Attention should be given to riparian conditions, invasive species, and the rationale and expectations for the restoration efforts. Most of these important basin characteristics can be described by modifying the existing text, supplemented with topical and/or empirical sidebars and appendices.

4. Overview of Focal Native Species

This section covers Kootenai River white sturgeon, burbot, kokanee, native salmonids (other than bull trout), and bull trout.

The authors have a deep understanding of the natural history of focal fish species in the Kootenai River system, and they are aware of numerous data and information gaps. Their insights about critical knowledge gaps will inform future prioritization of research, monitoring, and restoration. Equally valuable, the synthesis report could identify which gaps need to be addressed immediately, with available resources, and which can be addressed later.

Overall, few concrete data-driven results are offered in this section, and those presented are often difficult to understand or are not consistent. As well, the report describes a few biological relationships—barriers for bull trout populations, warmer temperatures and greater zooplankton abundance in wetlands, and factors responsible for sturgeon recruitment failure—as hypotheses, but these are not stated or evaluated as formal hypotheses. The authors should either state them as explicit hypotheses and evaluate them based on the results of their studies or not use the term “hypothesis” when discussing these relationships. Examples, questions and comments for clarifying the chapter’s content are provided in Appendix A of this review and in the recent ISRP reviews of individual proposals.

Specific Comments on this Section:

1. The URL (Uniform Resource Locator) links for assessing references are not working. Therefore, several recent articles could not be examined even though they seem critical to findings presented in the text.
2. As mentioned for previous sections, presentation of quantitative examples of data summaries, analyses, and results in appendices would improve this section.

5. Ecosystem-based Restoration and Mitigation

This section addresses conservation aquaculture for sturgeon and burbot; nutrient addition; floodplain protection, mitigation, rehabilitation, and loss assessment (KROME); and Kootenai River habitat restoration.

In general, this section provides a reasonable overview of the projects, their goals, objectives and inter-connections, main results, and interpretation by the authors about the key biophysical processes limiting focal fish populations. The ISRP appreciates that restoring a river valley is a long-term and complex endeavor. The numerous activities and their scale and scope are impressive. However, we have several technical concerns about data analyses and interpretations. Some concerns are described in the text below, while more specific questions and comments are presented in Appendix B.

Ultimately, the bottom line is whether the activities are having observable positive effects on the ecological system and on the focal fish species. After many years of restoration, data collection, and financial support, it is expected that the researchers can reasonably articulate the benefits of these projects for focal fish populations and the contributions of the work to understanding the ecosystems and their restoration. The nutrient additions appear to have had some benefits for largescale sucker in a short river reach. It is unclear whether other results in the report show that a self-sustaining ecosystem has been established or may become so with more time (perhaps another 3-5 years). It would be valuable for the authors to discuss whether they will be able to secure and restore enough floodplain and tributary habitat—in a reasonable period of time—to sustain focal species without the use of hatcheries.

Furthermore, a number of conclusions and key findings seem questionable because either they are not supported by the data presented or no data are provided. Some findings are cause for concern such as the shift in mountain whitefish diet to “almost exclusively Chironomids” under fertilization and the negative growth rate of these fish with nutrient addition. However, these findings are not discussed, despite reflecting a potentially important negative impact of the project. In addition, several analyses conclude “significant” effects without any statistical analysis of data. This is especially concerning given that the authors conclude, for example, that

an additional nutrient addition site is needed near the Moyie River. The ISRP questions whether this conclusion is supported by data. In addition to our questions about this conclusion, we could not determine how the data are used to modify prioritization or design of restoration activities.

While the ISRP commends the proponents for collecting such rich physical, biological, and chemical datasets for their projects, this section requires major revision to 1) add the data required to support key findings, 2) revisit many of the key findings to ensure that reported benefits of the program are supported by rigorous analysis of the data, and 3) indicate clearly how the technical lessons learned from data analyses guided planning and design decisions about the projects.

Specific Comments on this Section:

1. Section 5.2. The documented response of multiple trophic levels to nutrient additions is clearly presented. This sub-section is a good template against which to judge other aspects of the restoration program, including South Arm fertilization and habitat restoration.
2. The Index of Ecological Integrity (IEI) of the KROME project is a vitally important element of the overall restoration program. Nevertheless, few data are provided on key elements of the IEI, such as trends in birds and aquatic invertebrate communities, which could show whether restoration actions are being effective.

6. Learning and Adaptation Process

The need for coordinated learning and programmatic adaptation is reflected in the report, and the ISRP supports regular meetings and workshops to address this topic. It is good that the meetings and workshops are professionally facilitated, and Figure 73 helps to document roles and responsibilities across the projects.

Nevertheless, progress made toward implementing an overarching learning and adaptation process across all projects has been slow and has not achieved the intended functions recommended in previous ISRP reviews. A formal adaptive management process is one of the most important components of a successful program. The concerns raised by the ISRP regarding interpretation of results highlight the critical need for a more structured and robust plan for learning and adaptation. The revised Synthesis Report needs to clearly describe their plans and timelines to develop an adaptive process to connect data, evaluation, and adaptive decision making at the program scale.

The projects are collecting vast amounts of information. Yet, data management, technical analyses, information availability, and processes for sharing information are not described. A discussion of how these essential components of learning and adaptation are accomplished would substantially improve the content. Likewise, a sidebar on efforts and processes for maintaining and improving the skills and retention of the scientific, technical, and modeling staff would be a welcome addition. After all, people are the most important resource underpinning successful long-term endeavors. This information will help identify future needs of the programs and provide valuable lessons for other projects in the Columbia River Basin.

Specific Comments on this Section:

1. The Synthesis Report needs more thorough descriptions of the collective decision-making process. For instance, the South Arm fertilization program and the white sturgeon substrate enhancements have shown no benefits. Still no mention is made in the "Learning and Adaptation" section about how projects are being modified in response to the results. The impression is that the restoration projects are going to continue regardless of whether the target populations show signs of improvement or not.

2. An explanation is needed as to why the Adaptive Management Plan effort was abandoned as being premature. This appears to be a major deficiency. Why would the other co-managers in the basin not participate in an adaptive management process?

7. What's Next

This section addresses uncertainties, challenges, and looking forward.

Section 7.2 Challenges is a useful part of the report. The authors have provided a strong summary of how climate change, Libby Dam operations, Columbia hydropower system operations, changing water chemistry, fish predation and invasive species, socio-economic factors and local community support, and the expansion of stalked diatoms (Didymo) pose constraints on Kootenai restoration activities and success.

However, a substantial revision of the full section 7 is required to better connect the restoration activities to the original objectives, uncertainties and challenges. Some general points to consider:

1. The listing of goals and objectives at the end of the report is odd. It would be logical to state goals and objectives at the beginning of the document so that readers can evaluate the projects' outcomes. The report should align the results with the original

objectives, although that may be difficult given that objectives have likely changed over the past 30 years and most are not SMART objectives. When presenting results, measured responses should be compared to the goals and objectives to evaluate project success.

2. Based on their thorough understanding of the basin and its resources, the authors could briefly indicate which uncertainties could be addressed immediately (in the next few years), which will require longer to address, and which may be not be possible to address.

3. The challenges are clearly stated in sub-section 7.2 but are not directly addressed in the future activities. Where possible, the report could describe the links between these challenges and the near-term and long-term activities they identified.

Section 7.3 (Looking Forward) is taken directly from proposals under review by the ISRP and requires substantial revision. The proposed research is not written in the same manner as the rest of the Synthesis. Further, it is not clearly linked to major uncertainties and challenges, and it needs to be. The authors should integrate this section with the style of the rest of the report and consider adding a comprehensive figure (flow chart) to illustrate the linkages.

A project-scale adaptive management process is not included in the section on Looking Forward. This activity will require considerable effort, attention, and timely adjustment. As well, regular syntheses and peer-reviewed publications are essential for success, but they are not mentioned as important future activities.

As a minor editorial comment, several figures and photos show direction of river flow, but some do not. Directional arrows should be added where lacking.

Appendix A. ISRP Questions and Comments on the Overview of Focal Native Species (Pages 48-69). Note that many of the questions and comments are nearly identical to those in the recent ISRP reviews of specific proposals.

Sturgeon

p. 49 and 53. The size of the white sturgeon population is 1,744 with annual recruitment of 85. The report states that this level of natural recruitment is not sufficient to sustain the population. However, this statement is not consistent with the figures provided. Changes in abundance (N) over time (t) depend on survival (S) and recruitment (R) as determined by, $N_{t+1}=N_t*S + R_t$. At equilibrium $N_{t+1} = N_t$ and the recruitment needed to balance the population is R = N*(1-S). Given N of 1,744 and S of ~0.96, results in an annual recruitment requirement of 70. Therefore, an explanation is needed as to why the estimated recruitment of 85 fish/year is not sufficient to maintain the population. Did the authors compute the required recruitment at a survival rate of 0.95 (i.e., ~85 recruits/year) and mean to say that the current recruitment is much less than this? Further, it is unclear how the few larvae sampled annually (< 10, p. 52) relates to the 85 recruits/year (p. 49) since the detection probability for larvae and the number of larvae required to produce a 1-year old recruit are not known.

p. 52. It is unclear how the conclusion of a recruitment bottleneck for the juvenile stages was determined. Perhaps the authors mean to say that survival of juvenile hatchery sturgeon is lower due to high densities. It is equally unclear if the authors mean to relate this to recruitment of wild sturgeon.

p. 52. There are additional problems with clarity on this page. The statement that hatchery "sturgeon reared on ambient river water have declined in fork length at-capture since 1992" seems to imply that individual fish have been shrinking, but presumably it is the mean fork length of hatchery sturgeon at capture that has declined since 1992. Are the authors meaning to say that growth rates have been declining? Further, the statement that size or growth is less for fish reared on ambient river water is contradicted in the following sentence as fish reared in "accelerated water temperatures" apparently also show this pattern. What does "accelerated water temperatures" mean? Are the authors meaning to say that warmer water temperature leads to accelerated growth in the hatchery?

p. 52. "This suggests that the substrate additions did not negatively affect spawning behavior." Was substrate enhancement expected to interfere with spawning? The authors should use the stated objectives to evaluate project success. None of the objectives of habitat restoration was to <u>not</u> degrade habitat by conducting habitat restoration, so why mention it? Perhaps the logic is that there is no benefit currently shown, so it is at least worth stating that it is not having negative effects. This seems like an odd way to evaluate the benefits of restoration actions.

p. 52. The first bullet suggests two actions (nutrients and off-channel wetlands) to improve growth and survival. How do these relate to intraspecific competition? What if one action is positive and the other negative resulting in no effect?

p. 53. 5th bullet from the bottom: "Will hatchery-origin juveniles spawn further upstream over presumably better habitat?" Note that juveniles do not spawn. Further, considering the last bullet, have the proponents determined the natural incidence of polyploidy in wild fish?

Burbot

p. 57. How do the first two bullets differ? As well, the second bullet under Recruitment Failure – temperature should be its own hypothesis.

p. 58, third bullet. Figure 7 has nothing to do with the topic. As well, see the fourth bullet: These numbers and opening the fishery suggests that maybe burbot are OK. Of the 17,500 age 4+ adults, how many were hatchery vs wild? Furthermore, the first bullet at the top of p. 55 states that an objective in the KVRI (2005) was: "Maintain at least 2,500 adults in a Burbot population in the Kootenai River and the South Arm of Kootenay Lake." The six-fold increase in the burbot population seems substantial and warrants explanation.

p. 59. "We have seen survival of pre-feeding larvae in off-channel habitats." One cannot see survival, but one can see fish. Are the authors suggesting that the presence of fish in off-channel habitats indicates that survival rates are higher than in the mainstem? Using data, please inform readers how this is known.

Kokanee

p. 63. The ISRP does not follow the logic behind the high number of eggs planted in 2010 and the larger returns to Goat Creek in 2016. If fish return at age 3 to spawn, wouldn't a high return also have been expected in 2013? Why isn't the time series of Goat Creek escapement presented?

There is no mention of whether the trends in kokanee escapement in Table 3 are driven by fertilization in the South Arm (SA), which started in 2003 or how a fertilization effect is separated from variability in egg plants over time. The basic problem is that higher egg plants between 2003 and 2008 occurred at the same time as the SA fertilization. Egg plants stopped in 2013 and escapement in Idaho tributaries has declined. This decline suggests that lack of egg planting is the limiting factor for kokanee returns.

p. 63. "Before the current Kokanee collapse, Kootenay Lake kokanee responses to nutrient addition in the last few decades were dramatic. Spawners contributing to the South Arm

Kootenay Lake and Kootenai River tributaries in British Columbia and Idaho have generally been less dramatic." This document provides no empirical information on this topic and no citation supporting the claim that fertilization resulted in a dramatic increase in kokanee abundance. So far, the synthesis report has not shown any response of kokanee to fertilization in the South Arm (Table 3). The ISRP also cautions the authors to avoid vague terms like "dramatic," and instead provide quantitative measures of population response.

p. 64. Clearly, the problems in Kootenay Lake, which have been apparent for Gerrard rainbow trout for some time, have not resulted in changes to fisheries management. In spite of problems in Kootenay Lake, the proponents recommend continuing with fertilization, which does not make sense to us. This decision should be based on thorough evaluation as part of a thorough adaptive management process. A much more detailed and logical rationale for the fertilization program is required given the poor state of fish populations it was intended to benefit.

Other Focal Fish Species

p. 65. The response of mountain whitefish to fertilization is inadequately described, but no mention of the response of rainbow trout is provided, even though rainbows are targeted in the fishery (and the hypothesis is that rainbow trout will respond positively to nutrient additions). Why?

p. 67. "Rainbow trout biomass was 42% greater in the post-treatment period relative to the pre-treatment period, and this response was most pronounced in the control zone." How do the authors interpret this result? Here are two alternatives: 1) the increase in biomass has nothing to do with fertilization given the response in the control zone; or 2) there was a benefit of fertilization, which was confounded by fish from the fertilization zone moving into the control zone.

p. 67. "Although Mountain Whitefish biomass responded positively to nutrient addition, none of the effects were well supported by the model. Similar but less pronounced responses were observed for CPUE." A description of the model is needed. Was the model not based on CPUE data?

p. 68. The ISRP is aware that researchers are using PIT tags to follow rainbow trout growth in the Kootenai River. The ISRP suggests that a PIT tag study could be incorporated in the study of mountain whitefish and largescale sucker to validate scale analyses and to directly track age and growth metrics.

p. 69. It appears that not much is known about bull trout with respect to fertilization and restoration actions. Is this correct?

Appendix B. ISRP Questions and Comments on Ecosystem-based Restoration and Mitigation (Pages 70-119). Note that while many of the questions and comments are nearly identical to those in the recent ISRP reviews of specific proposals, there are additional issues that need to be addressed in the final Synthesis Report.

p. 71. The hatchery is planning to double the number of adult sturgeon spawned annually; however, the first paragraph on page 72 suggests that sturgeon carrying capacity has been reached. Therefore, should the number of juveniles released be reduced or at least not increased?

p.71-72. There are several genetic issues that should be addressed in the Synthesis Report, perhaps as a sidebar. For instance, since the hatchery is planning to double the number of adults spawned annually, the report could explain how the project is addressing genetic diversity. The authors could discuss approaches to reduce possible genetic swamping (e.g., releasing equal numbers of fish from different families). The synthesis should clearly discuss these genetic issues and explain how the project is adjusting the number and family origins of hatchery juveniles released due to carrying capacity issues.

p. 73. "Ongoing and new habitat and nutrient restoration and mitigation actions in the Braided and Straight reaches, including those described in Section 5.2 and Section 5.4, will be critical to the future success of Kootenai Sturgeon." There is no support for this statement based on results presented. Presumably, sturgeon growth would improve with fertilization, but the synthesis reports that sturgeon growth has declined (due to density-dependence). No data have been presented showing how fertilization has improved growth rates for a given density condition. The synthesis report should critically examine whether the data support the restoration hypotheses, not simply restate the hypotheses.

p.76. The authors describe a fascinating parentage-based-tagging program for burbot but do not provide information on what insights it provided. The lessons learned from this activity would be a positive addition to the Synthesis Report.

p. 77-78. The Libby Dam "Catch-22" hypothesis is interesting, but no data or citations are provided. It is unclear whether this hypothesis is entirely speculative or is supported by data. A synthesis report is intended to synthesize data to address such hypotheses and identify the need for future studies if there are gaps and uncertainties.

p. 78. "Diversifying the general release strategy to include more early life stages of Burbot has been a success." No data or citations are provided to support this statement.

p. 78. Nimz Ranch and Ferry Island Side Channel experiments. The flaw is that the survival and growth rates in the enhanced side channels are not compared to a control (non-enhanced) site.

Hence, one does not know if survival or growth rates in enhanced sites are any higher than in non-enhanced mainstem sites.

p. 83. Critical conclusions are drawn regarding increasing N and changes in TN:TP over time, but no data are provided. In addition, there is no indication whether, or how, the nutrient dosing changed in response to the changing N loads that modified TN:TP over time. Apparently, some of these data are in the Hoyle (2020) report, but that report was not available to the ISRP. For this synthesis to stand alone as a contribution to understanding the Kootenai system, it is essential that the supporting data be provided within the report.

p. 84. Here is an instance where the term "significant" is used, but no statistical analysis was conducted (one of several such instances in the report). If the authors are intending to refer to ecological significance, then there needs to be some documented reference to indicate that the change in biomass is large or small relative to other sites in this system. Otherwise, significance needs to be demonstrated with appropriate statistics.

p. 84. The report indicates that biomass was "significantly" lower in later years but does not discuss whether the dosing program should be modified. How should dosing vary with Libby Dam operations or with wet and dry years?

p. 85. Data on the blue-green algae should be presented. The Synthesis Report should describe existing plans and responsibilities for when and how to respond to rising cyanobacteria populations. If such plans and processes do not exist, the report should identify them as future needs.

Figs. 35 and 36. For clarity, it would be helpful to keep line colors consistent among these figures (e.g., the line denoting "Downstream" is red in Fig. 35 but blue in Fig. 36).

Fig. 36. The dates are missing on the x-axis of this plot, so it is impossible to interpret the results. The ISRP assumes that the months where values are higher in the NAZ are the spring and summer months. Furthermore, while chlorophyll abundance is clearly higher for KR14, a time series analysis does not indicate statistical or ecological significance. Also, why is chlorophyll abundance so high at KR14, which is a control site? It is higher than the nutrient concentrations in the NAZ. There is no interpretation of KR14 in the report.

p. 85. Same comment as above regarding "significance" of chironomid increases in abundance. If one is simply interpreting the box plots in Figure 37, then the variability in biomass appears to have increased, but one cannot conclude that the biomass has increased for most years (except 2011, 2015 and 2016). Also, what are the units on Figures 37 and 38, and what do the boxes and points represent?

p. 86. The ISRP was concerned to learn that the increase in macroinvertebrate biomass was produced by reducing the diversity of the community to "almost exclusively Chironomids." This result seems to indicate that the nutrient additions are having a negative impact on the invertebrate community, but the Synthesis Report does not discuss either the need for better understanding this issue or how the program should be modified to address it. The proponents should indicate why this is not a concern, especially if it is not considered to be a contraindication of the nutrient addition program.

Fig. 38. Why is there no variability represented for the sites since 2011? Was only one site sampled?

p. 88. The ISRP questions the interpretation that Fig. 40 "shows mean abundance estimates for three focal indicator species (i.e., rainbow trout, mountain whitefish, and largescale sucker) have substantially increased in recent years." Again, no statistical analysis was conducted, but visually, there is no trend for mountain whitefish abundance over time. Furthermore, the rainbow trout and largescale sucker populations appear to have begun rebounding before the nutrient fertilization began in 2005. Are there other mechanisms that might explain why these two fish species are becoming more abundant?

Fig. 41. Similar to the previous comment, the lack of deviation from the control trend in CPUE for mountain whitefish and rainbow trout suggests that the proponents are overstating the benefits of this nutrient addition program.

p. 88. The time series plots in Figure 40 have a y-axis labeled abundance. It is our understanding that the program measures Catch Per Unit Effort (CPUE) and does not quantify abundance. How was CPUE translated to abundance? The text refers to a "model" at the bottom of p. 88 but provides no explanation.

p. 90. No explanation is given about the opposite trends in growth increments for suckers and whitefish (Fig. 42) or the positive response in rainbow trout CPUE in the control zone. In the absence of a more detailed interpretation, the proponents "believe the nutrient addition project has been a substantial contributor to observed increases." Conclusions should be based on data rather than simply on intended outcomes.

p. 90. "In addition, biomass and abundance of nearly all native fish species have increased in response to the nutrient addition project. More specifically, we have learned that largescale suckers and rainbow trout most notably responded to nutrient addition, as evidenced by growth, abundance, and biomass." In contrast, the text and Figure 41 both indicate that rainbow trout abundance increased in the control zone, and growth increments of mountain whitefish have declined over time and since the nutrient addition in 2006. Growth increments for largescale sucker were increasing prior to the nutrient addition in 2006. Wouldn't these

responses to nutrient additions be better characterized as “mixed”? The rationale for expanding the fertilization program to another site does not appear to be well supported given the mixed response of fish populations. The conclusion that the nutrient addition is a substantial contributor to higher densities of rainbow trout and largescale sucker needs to be verified with statistical analyses and objective interpretation of the data.

p. 90. What studies “in the 1990s and 2000s” and otolith studies are being referred to here? Since the otolith studies are used to contradict previous conclusions of low mainstem spawning and to justify the additional nutrient fertilization site, further discussion and references are warranted.

p. 91. The authors speculate that nutrient concentrations have not increased following fertilization because they are moving up through the food chain, but no data are presented to support this finding. If anything, the data presented in this report (Fig. 43) contradict this statement. A mass balance analysis of the aquatic ecosystem would be required to assess this hypothesis.

p. 91. “… an experimental whole-lake nutrient addition program (Walters et al. 1991) was adaptively implemented in Kootenay Lake beginning in the early 1990s.” The program does not appear to be adapting operationally given the crash in kokanee and Gerrard trout populations and lack of management response (see Fig. 45 for the kokanee trend, the Gerrard trout trend is not shown).

p. 91. “Managed nutrient levels continue to increase and sustain biological production among many trophic levels, including the support of valuable native fish populations and their associated fisheries.” Trends in zooplankton production (Schindler et al. in press) and kokanee and Gerrard trout abundance in Kootenay Lake do not support this statement.

p. 92. Why is it desirable for phytoplankton to decrease following nutrient addition?

p. 92. The report indicates that mysid densities are higher in the South Arm but does not provide any indication of how much higher. Also, is the target of concern (i.e., 463 ind/m^2) a mean across multiple samples? Multiple months? A rationale for setting the target at 463 ind/m^2 is needed.

Fig. 43. It is not clear from this figure that nutrient addition has affected *Daphnia* in any of the arms. Instead, the rise in *Daphnia* appears to be driven by the decline in kokanee.

Fig. 45. Since the kokanee population has been in decline since 2010, are there any data to support the finding that predation by bears is responsible for low returns of adults? Or are the

authors' saying that that bear predation in 2015 reduced fry production for only the following spring – in 2016?

p. 92 and 93. How do the authors explain the fact that *Daphnia* production in all arms started to substantially increase in 2013, yet fertilization in the North arm began in 1992 and in the South Arm in 2004? The timing of increased *Daphnia* production is more closely aligned with the collapse of the age 1-3 kokanee abundance (Fig. 44), suggesting a release of the *Daphnia* from predation. Yet the authors conclude that managed nutrient levels support valued native fish populations and their fisheries. This interpretation of the data seems unwarranted and potentially misleading.

Section 5.3-5.4. The intent of the synthesis report as outlined by the ISRP in 2012 was to synthesize results, not to reiterate what actions have been or will be undertaken. These sub-sections are largely a description of what has been or will be done. The report needs to better distinguish between summaries of project activity and evaluations of project implementation objectives. Data presented to evaluate whether the restoration actions have been effective at increasing the abundance of wetland and riparian wildlife populations, or fish populations are insufficient. The only potential fish benefit that has been documented is that some pools have been made deeper and that there has been an 11% increase in upstream movement of white sturgeon due to the deeper thalweg or pool-forming structures (e.g., Fig. 52).

p. 111. The ISRP appreciated the clear explanation of how the pool ladder is expected to support white sturgeon recruitment. However, if the river is lacking flow cues, does that mean this work is for naught?

p. 111. The ISRP was not able to find the Hardy (2020) reference but is curious to see the analyses used to conclude that the ladder pools contributed to 11% "improvement" in upstream migration. It is not clear what improvement means, and intuition would suggest that the primary driver is the high flow, not the pools, that made the fish move. Further clarification is needed to support this finding.

p. 115. The concept of habitat *selection* better represents what we know about the choice of habitats, since it is impossible to know what fish prefer. There is a considerable literature showing that where fish are found at a particular time of day and time of year, under a specific set of conditions (e.g., proximity of predators, prey availability), does not necessarily reflect the value of that habitat/location with respect to growth, survival rate, or reproductive potential. We suggest replacing the word preference with selection in discussing where fish were observed. Simply observing a fish in a location doesn't indicate preference (e.g., Rosenfeld et al. 2016). They may have selected that location because it is better than the other available habitats, but that does not mean that it is their preferred habitat. Furthermore, observing them using the structures is not necessarily an indication that the response is beneficial. They may be

benefitting from the structures by reduced energy expenditure, but they may be subject to other negative impacts associated with concentrated densities. At any rate, the point is that a benefit cannot simply be assumed just because they were observed to be using the structure. A possible alternative for future studies would be to use the hydraulic model to estimate energy expenditure based on mean fish length and modeled velocities (e.g., Railsback et al. 2009).

p. 115. Please provide further explanation for the interpretation of Figure 66. The fish position data do not show that sturgeon prefer to spawn over constructed features. The vast majority of positions are not over these features. Thus, there is no support for the statement that "some sturgeon prefer the constructed features." To determine the habitat suitability index in this example, one should determine the area of cells with and without habitat enhancement and then compare the ratios of the number of fish positions in the area of enhanced substrate to the number of fish positions in the area of unenhanced riverbed. It seems clear that the ratio for enhanced substrate is lower than for unenhanced riverbed.

p. 120. "The IDFG detected adult spawning use and egg deposition over both SEPP sites, confirming that substrate additions likely did not negatively affect spawning behavior. Although successful spawning was detected, few larvae were collected on the SEPP during these evaluations." It is imperative that the author's use restoration objectives to evaluate restoration success. The objective of restoration was successful spawning and larval recruitment, and lack of increased larval abundance indicates that restoration has not been successful. Simply state that results show that the substrate additions have not improved recruitment.

Literature Cited

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