Independent Scientific Review Panel
for the Northwest Power & Conservation Council
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Memorandum (ISRP 2012-18) **November 30, 2012**

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

From: Rich Alldredge, ISRP Chair

Subject: Review of the *Phase 1: Draft Kootenai River Floodplain Ecosystem Operational Loss Assessment Report* for the Kootenai Tribe of Idaho's project #2002-011-00

Background

In response to the Northwest Power and Conservation Council's October 15, 2012 request, the ISRP reviewed a report produced through the Kootenai Tribe of Idaho's *Kootenai River Operation Loss Assessment* project (#2002-011-00). The report under review is titled *Phase 1: Draft Kootenai River Floodplain Ecosystem Operational Loss Assessment Report*. It is intended to provide the foundation to build a Protection, Mitigation, and Restoration Management Plan to guide rehabilitation of the Kootenai River and its floodplain. This full effort is titled the *Kootenai River Floodplain Ecosystem Operational Loss, Protection, Mitigation and Rehabilitation Project (OLA)* and was initiated to assess and mitigate the impacts related to the operation of Libby Dam. As described by the sponsor's cover letter, they developed indices that quantify abiotic and biotic perturbations of the ecosystem and used a standardized scale in which to compare and contrast between indices. In addition, they note that products developed to build these indices (LiDAR, land cover classification maps, etc.) have provided information to other Kootenai River projects, such as the *Kootenai River Habitat Restoration Project*, the *Reconnect Kootenai River with Historic Floodplain Project*, and *Albeni Falls Wildlife Mitigation Project*.

This is a follow-up review to the ISRP's review of the project in the Wildlife Category Review (ISRP 2009-17; June 10, 2009). The ISRP found that proposal met scientific review criteria. Specifically the ISRP stated that the outstanding proposal continued to "model how research can be usefully integrated into more immediate program goals. This project is not only benefiting the subbasin but the Program overall by demonstrating what could be achieved elsewhere in terms of interdisciplinary value, program integration, and community involvement, all to benefit fish and wildlife."

Following the ISRP review, the Council recommended that an ISRP and Council review of the completed operational loss assessment was needed, and out-year budgets for capital and expense would be determined based on that review (NPCC memo, Final Decision Document –

Wildlife Category Review, July 27, 2009). The loss assessment report and this ISRP review address the Council's recommendation.

ISRP Recommendation

Response requested

Although the Index of Ecological Integrity approach is conceptually sound in providing a framework for documenting past loss of large-scale ecological integrity in the Kootenai, insufficient scientific evidence is presented to show that the Index of Ecological Integrity approach contains the sensitivity to be useful as a monitoring tool for accurately assessing smaller-scale restoration efforts.

The ISRP requests:

1. a response containing a more thorough evaluation of the accuracy, precision, and sensitivity of the component indices and of the composite Index of Ecological Integrity;
2. a discussion of the rationale for the present method of equal weighting for all metrics and component indices versus preferentially weighting metrics and indices, and under which circumstances equal weighting would be preferred;
3. information on how the Index of Ecological Integrity approach was selected over other approaches considered in developing the Operational Loss Assessment;
4. a response on the sensitivity of the Index of Ecological Integrity for detecting the more subtle effects on river function and ecological integrity expected from planned habitat modifications; and
5. other items as requested below.

The ISRP appreciates the well-organized draft and looks forward to a response. The ISRP understands that most of its requests for clarification concern the sensitivity of the various indices to detecting changes in the ecosystem due to habitat restoration actions. If the sponsor requests, the ISRP is open to discussing its review and the best approach to respond.

ISRP Comments

The ISRP reviewed the Kootenai River Ecosystem Operational Loss Assessment (OLA) Report from the standpoint of determining if the loss assessment approach provides a sound scientific basis to guide the implementation phase of the Kootenai River Habitat Restoration Project. The approach is designed to provide a foundation and context for estimating losses due to the construction and operation of Libby Dam and for developing a prioritized approach for selecting mitigation actions and assessing mitigation progress.

The ISRP found the report to be well-organized, clearly written, and informative. It is a broad scale assessment of the past major changes in ecosystem function in the Kootenai as a result of anthropogenic disturbances. It is also potentially useful as a foundation or framework to help in

developing a strategic approach for restoration. The composite Index of Ecological Integrity (IEI) includes the major abiotic and biotic factors that should be considered. It deals creatively with incomplete data and a variety of confounding factors. The individual sections provide good descriptions of methodologies and major assumptions and also note some limitations of the various component indices. Further, the overall approach used for development of the IEI and the component indices that constitute it (IHA, ISSA, IFA, IFFA, ILCCA, IWFA, RMI, RFI, and terrestrial IBIs) represents a positive, quasi-quantitative framework for characterizing and identifying issues of ecosystem integrity in the basin. The various aspects of the loss assessment, including first through fourth order impacts and the component indices associated with them, were well-coordinated, had a common goal, and used consistent methodologies to report the results and present the findings.

The consistency, and the way the report built on lower levels of the ecological hierarchy, made the report easy to read and understand. Its hierarchical design provides varying layers of resolution to help identify relative changes in various processes and functions for effects at the next higher layer. The use of "radar chart" graphics illustrating departures from previous conditions was visually instructive and made a compelling case for the use of the IEI in monitoring restoration of previously abundant fish and wildlife and for monitoring proposed improvements in functional ecological processes. Components of the ecosystem in need of immediate restoration are clearly identified on the radar charts, as are spatially distinct habitats. The approach of using various component indices of ecological integrity, such as floodplain, fish, invertebrates, and avian, is valid for characterizing the problem, especially when the indices are developed on a system like the Kootenai where there is a wide range of integrity in all of the indices. This wide range occurs because of the substantial alterations in many aspects of the system as a result of Libby Dam, levee construction, and other major habitat modifications. As a whole, the document provides a broad and inclusive framework for identifying past losses of ecological integrity that have occurred throughout much of the Kootenai River Basin.

Despite these clear strengths in depicting the linkage between historical habitat changes and ecological integrity, significant concerns exist and should be considered in moving forward. The sensitivity of the indices and their combinations for detecting the incremental changes anticipated with future habitat restoration work is questionable.

The chapters show in a quasi-quantitative sense what was already known, that is the system has changed radically in the 20th century, and the indices can individually and in aggregate depict major changes in ecological integrity. Each of the individual chapters could probably make that concluding point adequately to meet requirements for refereed publication in scientific journals. All of the indices are based on comparisons of historical and post-Libby Dam comparisons, and thus cover a very wide range of conditions in a highly altered ecosystem. What is being compared in testing the indices in the OLA is a rather pristine condition against a highly altered condition existing today.

However, even though the kinds of restoration efforts proposed for the Kootenai may be costly and, in some ways unprecedented, the overall changes due to restoration in the Kootenai are likely not major when looked at in the context of the entire river or past changes. The dams, and nearly all of the levees, will stay. This raises the question of how sensitive the component integrity indices are in detecting smaller changes that would result under proposed habitat work. Little evidence is presented that the indices are sensitive enough to be useful and cost-effective as monitoring tools for detecting minor changes in their particular aspects of integrity or in aggregate for ecological integrity. Because one of the purposes of the OLA is to guide mitigation, it is very important at this point to evaluate how the variables respond to actions "smaller" than dam construction. There is minimal sensitivity analysis presented, for example some in Chapter 9 for the individual indices or in Chapter 10 for the aggregate IEI. A clear demonstration of approaches for developing and running sensitivity analyses or for computing confidence intervals around component indices and the aggregate IEI is needed.

Not only is the sensitivity of the individual indices in question, but their combination into an overall IEI is even more troublesome. The implication of the report is that by averaging, with equal weighting, a series of perhaps marginally sensitive indices, it will yield something more than a composite marginally sensitive index. It will in fact yield an even more insensitive index. Insufficient evidence is provided that the current approach is likely to provide suitable resolution to identify more subtle effects from most individual mitigation treatments or changes in land/resource management that are likely to occur. This does not diminish the value of this work as tool for framing the issue of ecological integrity and for strategic planning of general kinds of mitigation treatments. However, if the IEI and its component indices are not sufficiently sensitive, the outcome will be an extensive and expensive monitoring effort that will not be effective at assessing progress stemming from mitigation or restoration actions.

Some support for this ISRP concern on the model's sensitivity is contained in the report results. The authors state that: *"To understand how some land (levee systems) and mitigation (augmented sturgeon flows, nutrient addition) practices contributed to an overall IEI score, the appropriate indices were recalculated to account for a given practice. The corresponding model results suggested only a small increase in the associated indices occurred when the levee systems were removed from the model."* What does this say about the effectiveness of the indices? Are the levees a significant problem for ecological integrity or not? With the amount of work proposed to mitigate for them and to help restore river and floodplain function, one would expect that they would be a significant factor in ecological integrity. An alternative interpretation might be that this result, as reported, supports the idea that the IEI is not sufficiently sensitive to detect comparatively minor changes in the habitat.

In view of these concerns, the ISRP requests more background information on why this Index approach was chosen over other possible approaches that the authors may have considered (e.g., BACI).

Clarification is requested on several other aspects of the overall report and IEI, with comments on individual component integrity indices following.

Overall report and IEI

1. Despite the habitat changes, little emphasis is placed on species benefiting from the changes. Certainly, many locally important species are negatively affected by such changes, but there are others that may prefer the new conditions. Are the ecological responses of these species adequately captured in the indices?

2. Non-native species, including invasive species, are pervasive and well established. The biological communities are a hybrid mix of native and non-native species, and will be so in the future. Non-native species can perform important ecological functions related to system-scale resilience and productivity. How are the presence and ecological roles of non-native species captured in the indices? And, as a practical matter, how can the non-native species be managed to produce positive ecological outcomes?

3. No weighting of components was attempted *within* component integrity models (e.g., IHA, ISSA, RFI, etc.) or when formulating the composite IEI. It is not clear that the approach of weighting all components equally is ecologically sound. A discussion of the rationale for equal weighting of all components is needed. Also, the amount, accuracy, and temporal duration for various data are quite variable between components and the severity of confounding effects, from factors not directly related to the construction and operation of Libby Dam, varied by component. It seems likely that the relative accuracy and resolution of each component is also likely to be unequal. For example, on page 78 in Recommendations for the IFFA it is stated "we recommend performing additional analyses to isolate the alteration of Cora Linn Dam. Furthermore, our method should be tested in restored areas by intentional levee breaches or levee setbacks and dam operation modification in order to refine its (the model) utility for floodplain restoration and planning." Consideration of a variable weighting of components based on their ecological importance and sensitivity, and on the accuracy and completeness of historic data, should be made in future refinements to the model. Each of the component-based indices used metrics that were responsive to alterations in physical habitat, hydrology and corresponding ecological processes. When presenting an overall assessment of the ecosystem is it best to use averages or to use another approach (e.g., weighted average based on ecological or management importance)? The approach of equal weighting also does not address the issue of limiting factors as they might affect the reliability of the IEI. If all factors are weighted equally, one factor that might be limiting to ecological integrity, no matter what the status of the other metrics, would be masked and not adequately considered in a system of equal weighting.

4. More statistical analysis is needed to compare sensitivity and responsiveness of metrics in their influence on component indices, such as nutrient addition and flows designed to aid sturgeon spawning. Statistical comparisons of this type would allow the authors to better understand variability in the systems and prepare participants for potential magnitude of restoration activity effects at a later point in time. From another perspective, these

comparisons would also allow authors to explore statistical power and observed significance levels.

5. More discussion of the problems associated with before/after comparisons versus a before/after/control approach would be beneficial. Perhaps a chapter devoted to this discussion would provide perspective on the IEI approach.

6. A major concern with these models is that there is no Control; all the inference is based on Before/After impacts around construction of dams. This problem is further compounded by the comparison of different reaches above and below dams. This is not to say that river sections should be ignored. It would be especially useful to test "predictions" of the IEI model. It would be useful for the authors to discuss whether this test would be on first, second, third, or fourth order and whether a response can be measured.

7. Associated with the agricultural development in the meander reach and increasing development in the town and rural areas, there is typically widespread use of chemicals, such as pesticides and fertilizers, as well as discharges from wastewater treatment plants or septic leakage associated with towns and rural dwellings. These inputs are not mentioned in the report and, therefore, it is unclear what impact they may be having on the ecological system.

8. It is not clear if there are any hatchery programs having impacts on native fish communities, predators, or the ecological system. Are the hatcheries operating within the carrying capacity of the ecosystem?

9. On page 9, it was stated, "Since each geomorphic reach is unique, we developed an IEI score for each major geomorphic reach…" There was no discussion that these reaches are connected longitudinally by the river and that the geomorphic features likely grade from one reach to the next. It seems likely that, although each has a characteristic response signature, they are not truly unique nor do they respond independently to disturbances.

10. Page 262 – There seems to be conflicting statements requiring clarification on the resolution and application of the IEI. One statement says that the method quantifies the amount of anthropogenic impacts on the river and its floodplain and that in assessing mitigation actions the results were somewhat muted but could be seen in changes to the metrics and index scores, "albeit to a small extent." In the next paragraph it is stated, "… the proposed IEI provides a useful method for defining and monitoring ecological losses caused by the operation of dams within the Columbia River basin." It seems likely that agreement on the quantitative losses, associated with dam construction and operation, will only be achieved through negotiation and that this model will be a useful tool in this process. Will the IEI have the resolution to effectively detect subtle effects of changes in water management?

11. The evaluation of the levee system on page 256 is indicative of the potential issues of applying the IEI to the Kootenai. The evaluation showed that levee removal had little impact on the IEI, because the unblocked areas were now above the channel – and they would not flood at existing flows. It seems to call into question the value of large restoration programs to restore river function if the flows will not allow such areas to be inundated on a regular basis. Some clarification is needed on this point.

12. Where applied, the ISRP appreciated the use of statistics, for example multivariate analyses in Chapter 9, to evaluate relationships among site characteristics and biotic integrity scores. This scientific approach should be used more in the document, in conjunction with the radar diagrams, to evaluate impacts.

13. It was not clear how some significant confounding efforts such as fertilization will alter the biological indices (invertebrates and fish). In a cold, unproductive environment, simply fertilizing may show stronger results than the habitat work and may mask the ability of these indices to show clear benefits of localized habitat improvements.

14. Much of the restoration work for which these indices have been prepared could be greatly affected by the outcome of the (US/CANADA) Columbia River Treaty. A discussion of how the Treaty could potentially affect the Kootenai River is needed.

15. According to the 2009 ISRP review, "Validation of many model parts will be occurring during 2010 and 2011." Therefore, determination of the value of this approach for informing restoration planning processes will not be complete until late 2011 or 2012. Is there a plan for external review of results at this time? The authors should more directly address this point, perhaps in the cover letter or executive summary.

The Index of Hydrology Alteration (IHA)

The IHA approach to assessing hydrologic changes seems appropriate, although it is not clear based on the results of this document that it will be sensitive enough to detect subtle changes. As with the other indices, it is based on an extremely wide range of hydrologic conditions in the river, from natural to very highly regulated, i.e., much wider than can be expected to occur under any slightly modified flow regime along with natural year-to-year fluctuations. As such, it is not clear that the method will have sufficient resolution for detecting subtle effects. In line with this concern, it would be instructive to find out how much resolution results from a few simulations based on the magnitude of alterations that might be expected. Under some more subtle changes, is the IHA detecting a response?

It would seem that the outcome of the Columbia River Treaty negotiations would potentially have a large impact on this index. This issue should be considered and the potential effects estimated.

The Index of Sediment Supply Alteration (ISSA)

This index uses two major assumptions: 1) "the proportion of bed material load to total load were assumed approximately constant throughout the study reach, then the percent reductions in bed material load at various downstream locations would mirror reductions estimated for suspended sediment load" and 2) "that all areas of the watershed are equal in terms of potential sediment generation." Is there any empirical regional evidence that these are reasonable assumptions? Are there typically differential patterns of potential sediment generation within a large basin or watershed? Information should be provided on the reasonableness of this assumption. These are major assumptions that deserve analysis and more discussion in the report, thereby providing for future refinement of the model.

The same concern above about sensitivity for the IHA can apply to the ISSA. The change in sediment is extreme – more extreme that any changes likely to be seen from adaptive management efforts, experiments, etc. How effective is the ISSA at detecting more subtle changes?

The use of the Cartier power function relationship may be reasonable and probably acceptable over the wide range of sediment supplies encountered. However, the power function relationship was not presented, nor was it shown in a clear example how the calculations proceeded. A clear example of the calculations would have been very helpful. The use and meaning of Table 3.2 in the context of the use of SS*is not clear. Table 3.2 variables do not seem to have been used in the calculations, yet it is laid out and asserted that the SS* relationship was instead used to estimate sediment reduction. It is also asserted that the SS* approach adequately covers the aspects of variables identified in Table 3.2, although no evidence is provided for this assertion. Some clarification would be helpful.

Questions regarding the more subtle aspects of the model function and reliability may be critical. The results clearly show major changes in sediment delivery between historical and Post-Dam scenarios, as do the results of Barton (2004). The ability to detect huge reductions in sediment delivery can be expected, as would the differences between the canyon, braided, and meander reaches based strictly on watershed areas and the 90% versus 100% trapping efficiency of the Libby vs. tributary dams. However, future projected changes in sediment delivery under future flow scenarios may not be nearly as great, and the resolution ability of the ISSA to capture these subtle changes is questionable and perhaps doubtful. Similarly, in the recommendations, it is indicated that it might be possible to develop more spatially sensitive information on sediment yield within the Kootenai basin. However, it is not clear if the authors thought that this approach would result in adequate sensitivity to much more effectively predict sediment delivery under subtle changes in flows.

Index of Fluvial Alteration (IFA)

This section should provide more specificity and clarity as to the operation of the model, and how particular values were selected and the ramifications of those selections. The same resolution issues of concern mentioned above apply to the IFA. The authors state that "Overall, the most substantial alteration resulted from the comparisons between the historic and post-regulation flow regimes… Differences in the results relative to the pre- and post-sturgeon flow years were limited, and likely within the resolution of the analysis." This quote describes the ISRP concern well. How are incremental changes to be detected in this approach? More information is needed to address the sensitivity of the methods.

Some statistical comparisons would be useful to put the variability and averages between and among time periods (e.g. pre/post dam; sturgeon flows) in perspective. The data in Table 4.5 (p. 55) could be a good "test case." The authors write "Although the sturgeon flow augmentation (sturgeon flows) hydrograph approximates the general shape of the natural hydrograph, they are still very divergent from the natural flow regime. To capture the influence of this shift in Libby Dam operation on the downstream hydrology, the post-Libby Dam period is represented in terms of two scenarios. Therefore, four scenarios were considered in the IHA calculation to cover the three time periods listed above." The four scenarios are summarized in Table 2-1.

On Page 18, was there an analysis of the models during these time periods? If so, were there any measurable first order impacts from these releases for sturgeon?

Index of Fluvial Floodplain Alteration (IFFA)

Chapter 5 does a good job balancing a description of methods used with an interpretation of the modeling results. It is not clear if any attempt was made to validate model predictions, using current conditions. If not, this could be a useful approach.

A key result of this section seemed to be that "our study demonstrates that set backs and/or strategic breaching of the levee system alone could only restore a small amount of the fluvial floodplain processes in the braided and meander reaches of the Kootenai River. Therefore, any large-scale restoration of floodplain fluvial processes and ecosystem functions in these reaches or in the canyon reach would require changes in the operation of primarily Libby Dam but also Cora Linn Dam in the meander and braided reaches." This is mainly because of the lack of connectivity with backwaters at existing flows. The same issue arises with the Wetland Index, IWFA). This statement seems to argue against major habitat efforts until the flow issue has been addressed.

Index of Land Cover Classification

This was a lengthy section whose results seemed confounded by past disturbance history and limited amounts of consistent data over the time period for assessment.

This section is extremely methodological and the descriptiveness must be, in many cases, taken at face value. However, as in the other sections, the comparisons were made between extreme cases 1934 versus 2004. The capability to detect smaller differences within the present day Kootenai River is not clear.

The section dealt with efforts to map land cover in historical times and to identify differences between now and then. A powerful photo on p. 82 (Fig. 6.1) identifies that the forests seen in the photo no longer occur along the river. The reference to shorebirds using an unexpectedly inundated area (Nimz property) may have been suggestive of its potential, but more details are needed about the cause and extent of the flooding and the specific habitat attributes needed to improve conditions for shorebirds.

Aquatic Invertebrate Index

As in the other indices the resolution of the methods is in doubt. Royer et al. (2001) selected the indices based on significant differences between test and reference sites. It is appropriate to ask how different the reference versus test sites are compared to the kinds of differences projected in proposed habitat work. The metrics may be stronger than the fish metrics below because of the strong links of many invertebrates to specific localized habitat features. However, it is very intricate to analyze, and the sampling protocols for reliable and sensitive data are suspect. Would results be more predictable in a small stream than a large river like the Kootenai?

The chapter contains an Interesting presentation of pre- versus post-fertilization values (e.g., RMI in Table 8.8, p. 174, Number of taxa Table 8.9. p175), but a statistical comparison would be beneficial.

The River Fish Index

The River fish index is not a particularly convincing approach for guiding the implementation phase based in its usefulness in detecting changes in the fish community. There are several reasons why it is not likely to be effective in detecting anything but major changes in biotic integrity.

1. The RFI is an adaptation of the IBI approach of the Midwestern IBI and suffers from all of its weaknesses plus a few more. Widespread attempts at its application should not be construed as an indication of its actual effectiveness; it is what is available. The idea of using fish metrics as bio-indicators of ecosystem status is conceptually sound, hence the

widespread attempts at using the IBI approach, but the methodology applied to fish suffers from some serious weaknesses that render interpretation of results difficult for detecting anything but major changes in conditions. The metrics are often difficult to measure with accuracy and precision, and their interpretation can vary greatly with local habitat conditions.

2. First, the Kootenai analysis used six of the 10 indicators of Mebane et al. (2003): (1) Number of coldwater species (CNS), (2) Percent sensitive species (SNI), (3) Percent coldwater individuals (COLD), (4) Percent tolerant individuals (TOL), (5) Number of trout age classes, and (5) Number of coldwater individuals per minute of electrofishing (CPUE). Based on historical changes in the hydrograph and thermograph resulting from the environmental effects, especially Libby Dam, where colder, less nutrient rich waters have dominated much of the summer, are these metrics especially applicable to the altered Kootenai River? Colder water resulting from a highly artificial thermograph and water release policy may still favor cold water fish, but what does that say about ecological integrity?

3. Secondly, the metrics themselves are fairly crude indicators. The original Midwestern IBI indicators were also crude and often difficult to sample effectively, and these indicators for the Northwest do not promise to be any more sensitive or easy to sample for depicting habitat quality. Mebane et al. (2003) provide a general ecological basis for the metrics, but their sensitivity is not effectively analyzed for detecting small changes in habitat quality (integrity). They looked at coefficient of variation and signal to noise ratios, but over a wide range of conditions with large differences in so-called biotic integrity. The use of coefficient of variation and signal to noise ratio is fine when comparing very pristine habitats with those highly degraded, but the changes to be implemented in the Kootenai are unlikely to change the system to a level where the signal to noise ratio will be strong. It is asking a great deal to expect the metrics to detect changes in habitat conditions when a small fraction of the available habitat is being restored.

4. The original IBI was intended more for smaller streams whereas this application is for a large river, where fish sampling is even more difficult. How well the approach translates to large rivers needs to be determined.

5. Someone with extensive experience with electrofishing in large rivers might conclude that there are many factors that affect CPUE that are out of the control of those doing the sampling. Even with no habitat modifications, habitat changes from year to year will be significant, and as highly mobile organisms, fish will respond to those changes.

6. The ecological basis for combining the metrics with equal weighting when developing the RFI should be presented.

7. Under these circumstances, the use of the six metrics may be insensitive and inappropriate.

The Terrestrial IBIs

This section did make some attempts to address the index sensitivity issue. However, sensitivity of the Avian score (Figure 9-5, page 233) is only moderate, and sensitivity of the invertebrate score seems to be worse (Figure 9-11 Page 242). The approaches suffer from the same opacity as the other indices, i.e., how the component parts ultimately lead to a reliable Component Index and an overall IEI.

Fig. 9.1 could be improved by highlighting the differences between the two approaches.

Literature Cited

Barton, G. J. 2004. Characterization of channel substrate, and changes in suspended-sediment transport and channel geometry in white sturgeon spawning habitat in the Kootenai River near Bonners Ferry, Idaho, following the closure of Libby Dam. U.S. Geological Survey Water Resources Investigations Report 03-4324.

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