Independent Scientific Review Panel

Habitat Research, Monitoring, and Evaluation Review

- Integrated Status and Effectiveness Monitoring Program (ISEMP) (Project #2003-017-00)

- Columbia Habitat Monitoring Program's (CHaMP) (Project #2011-006-00)

- Action Effectiveness Monitoring of Tributary Habitat Improvement (AEM)

ISRP Habitat RME Review - ISEMP, CHaMP, and Action Effectiveness Monitoring
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ISRP Habitat RME Review - ISEMP, CHaMP, and Action Effectiveness Monitoring

Contents

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Background

In response to the Northwest Power and Conservation Council and Bonneville Power Administration's January 10, 2013 request, the ISRP reviewed documents describing three related programs intended to provide a basinwide approach to habitat monitoring and evaluation. These three documents include:

1. **Integrated Status and Effectiveness Monitoring Program (ISEMP): Lessons Learned Synthesis Report 2003-2011 (July 6, 2012) (Project #2003-017-00).** ISEMP is a "research and development project to test and develop fish and habitat monitoring methods, data management tools, and data analysis methods for general use by Fish and Wildlife monitoring projects across the interior Columbia River Basin." The lessons learned report summarizes work completed by the program from 2003-2011. This work was conducted in several watersheds across the Columbia Basin over the past decade.

2. **Columbia Habitat Monitoring Program's (CHaMP): 2011 Pilot Year Lessons Learned Project Synthesis Report (March 31, 2012) (Project #2011-006-00).** This report summarizes data and results from 2011, which was the first year of implementation for the CHaMP pilot level program. CHaMP's purpose is to "implement a habitat monitoring protocol for fish habitat status and trends throughout the portion of the Columbia Basin that is accessible to anadromous salmonids using a programmatic approach to standardized data collection and management that will allow effective data summarization at various spatial scales important for the management of fish and habitat."

3. **The Action Effectiveness Monitoring (AEM) of Tributary Habitat Improvement: a Programmatic Approach for the Columbia Basin Fish and Wildlife Program (January 2013)**. This document was developed to respond to ISRP and Council recommendations to move toward a standardized, programmatic approach to evaluate the effectiveness of habitat restoration actions. This paper provides many of the details of how BPA proposes to move to implement a standardized program in phases beginning as early as 2013.

The ISRP was also provided Bonneville and the U.S. Bureau of Reclamation's "Columbia Basin Tributary Habitat Improvements: A Framework for Research, Monitoring and Evaluation" to give context and background for the three documents submitted for scientific review. Bonneville staff and the project leads for CHaMP, ISEMP, and the action effectiveness monitoring approach briefed the ISRP and ISAB on January 11, 2013. The presentations were excellent and greatly aided the review process.

The intent of these documents and this review is to address the Council's recommendations related to programmatic issues with habitat effectiveness monitoring and evaluation that were placed on numerous projects as part of the Research, Monitoring, and Evaluation and Artificial Production Category Review in June 2011.[1]

[1] See Programmatic Issue #2, pages 10-19, in the Council's final decision document for the Research, Monitoring, and Evaluation and Artificial Production Category Review, June 2011: www.nwcouncil.org/fw/budget/2010/rmeap/2011_06decision.pdf

Although the ISRP led this review effort, critical input was provided by ISAB members Kurt Fausch, Laurel Saito, Bruce Rieman, and Kate Myers. The ISEMP, CHaMP, and AEM documents and presentations were very useful context for the ISAB's review of the 2009 Fish and Wildlife Program, demonstrating progress on habitat research, monitoring, and evaluation (ISAB 2013-1).

Past Reviews of ISEMP and CHaMP

The ISRP has reviewed the Integrated Status and Effectiveness Monitoring Program (ISEMP) and components of the program numerous times over the past decade. The ISRP first reviewed the project as part of the 2003 Mainstem and Systemwide project selection process. The Council's and BPA's recommendations for funding this project included a provision that the M&E plans for three different watersheds – John Day, Wenatchee, and Upper Salmon – be reviewed by the ISRP before implementation. The ISRP reviewed the Wenatchee (see ISRP 2003-6[2] and ISAB&ISRP 2004-1[3]) and Upper Salmon study plans (ISRP 2006-1[4]). Overall, the ISRP thought that studies would yield valuable data for use throughout the Basin. Subsequently, the ISRP reviewed the project in 2006 for 2007-09 funding and found it "Fundable (Qualified)."[5] The qualification was that four questions related to the proposal's technical background, integration among components, and objectives needed to be explicitly addressed. A response to these qualifications and a study plan for habitat restoration work in Bridge Creek in the John Day was reviewed in 2007 (ISRP 2007-8[6]). The ISRP found that the project met scientific review criteria and commented that the ISEMP team provided a detailed response to the ISRP's questions that included well-reasoned explanations of how the ISEMP effort was integrated into existing John Day monitoring programs and a reasonably complete study plan for the Bridge Creek Intensively Monitored Watershed (IMW) study. The ISRP noted that the project results should be very helpful in designing restoration programs for other streams in semi-arid subbasins, particularly where land management practices had resulted in incised channels, elimination of habitat complexity, and loss of pool habitat.

The ISRP most recently reviewed the project in the Research, Monitoring, and Evaluation and Artificial Production Category Review (ISRP 2010-44[7]). The ISRP also reviewed an important component of ISEMP – the Columbia Habitat Monitoring Program (CHaMP) – as part of the ISEMP proposal review in the RME and AP review process. The review was expanded to include an in-depth follow-up review and a workshop with the CHaMP team, Council, and regional habitat monitoring practitioners held February 10, 2011 (ISRP 2011-10[8]). By the time of the workshop, the CHaMP component of the project was

[2] ISRP Review of Revised Mainstem Systemwide Proposals for Research, Monitoring, and Evaluation: www.nwcouncil.org/library/isrp/isrp2003-6.pdf

[3] ISAB and ISRP Review of the Draft Research, Monitoring & Evaluation Plan for the NOAA-Fisheries 2000 Federal Columbia River Power System Biological Opinion: www.nwcouncil.org/library/isab/isab2004-1.pdf

[4] ISRP Review of Salmon Subbasin Pilot Projects Monitoring and Evaluation Plan: www.nwcouncil.org/library/isrp/isrp2006-1.htm

[5] www.cbfwa.org/solicitation/components/forms/Proposal.cfm?PropID=563 or see ISRP 2006-6.

[6] Review of John Day Study Plan for Project 2003-017-00, Integrated Status and Effectiveness Monitoring Program (ISEMP). ISRP 2007-8. www.nwcouncil.org/library/isrp/isrp2007-8.pdf

[7] Final RME and Artificial Production Categorical Review Report. ISRP 2010-44. www.nwcouncil.org/library/report.asp?d=27

[8] Review of the Columbia Habitat Monitoring Program (CHaMP) Protocols. ISRP 2011-10: www.nwcouncil.org/library/report.asp?d=53

removed from the ISEMP proposal (#2003-017-00) and managed as a stand-alone project (#2011-006-00). In its review, the ISRP found the ISEMP and CHaMP proposals met scientific review criteria (qualified).

Based on information from the proposal, response, and 2011 workshop, the ISRP recommended:

- CHaMP continue its dialog with other monitoring groups to resolve differences in approaches and that consideration be given to designing rigorous field tests of various protocols.
- CHaMP devote additional attention to case-by-case inclusion of "non-standard" metrics (e.g., agricultural chemicals) and to developing and testing methods of scaling up site-specific habitat conditions to watershed- and subbasin-scale indicators of habitat quality. The latter could be evaluated in a few pilot subbasins where both habitat and fish populations are well sampled.
- Use simulations to examine the properties and sensitivity of large-scale metrics of habitat change, as well as to compare and contrast the conclusions of CHaMP analytical tools (e.g., the SHIRAZ model) with other widely used habitat models such as EDT.
- Develop robust, accurate relationships between VSP parameters for target fish species and changes in habitat condition that are related to restoration, or continued habitat degradation, in CHaMP watersheds.
- Implement at a pilot scale. The ISRP believed that some CHaMP protocols needed additional refinement and testing, and therefore recommended that project partners focus initial activities on a subset of CHaMP watersheds at geographically diverse locations in the Columbia Basin where restoration was occurring and where both habitat and fish population monitoring were sufficiently developed so that CHaMP could build on existing strong RM&E efforts, such as in intensively monitored watersheds.
- An ISRP review of CHaMP after one to two years of data collection to see how field and data management protocols have been modified and how monitoring results are being incorporated into establishing restoration priorities.
- An ISRP review of the ISEMP "lessons learned" report when it is released. In addition, the ISRP asked the ISEMP sponsors to summarize how priorities have evolved over the years and describe a publication strategy.

Questions for the ISRP Review

The ISRP received three documents for review: (1) the ISEMP Lessons Learned Synthesis Report covering the period 2003-2011, dated July 6, 2012, (2) the CHaMP 2011 Pilot Year Lessons Learned Synthesis Report, dated March 31, 2012, and (3) a Programmatic Approach to Action Effectiveness Monitoring Report, dated January 8, 2013. The latter report (Action Effectiveness Monitoring – AEM) was authored by staff from NOAA, BPA, and a private consultant, and proposed an RM&E framework for past, current, and future tributary habitat restoration actions. The ISRP, with ISAB and Council staff input, developed a series of review questions for each report:

<u>ISEMP</u>

1. Has ISEMP yielded useful information about sampling designs for assessing habitat and fish population status and trends?
2. Has ISEMP advanced our ability to monitor and evaluate adult and juvenile salmonid populations in the Columbia River Basin?

3. Are Intensively Monitored Watersheds (IMWs) delivering on the promise of establishing cause-effect relationships between habitat restoration and improvements in fish populations?
4. Is the analytical framework in ISEMP up to the task of evaluating the field data and making results available to managers and restoration practitioners?

CHaMP

1. Has CHaMP identified and addressed the right questions with regard to tributary habitat status and trends?
2. Has CHaMP provided satisfactory answers to the ISRP's and Council's questions and concerns (see attachment)?
3. Does the CHaMP synthesis report adequately address the lessons learned from pilot studies? In particular, has CHaMP provided useful information about what worked and what did not work in implementing the habitat surveys?
4. Has the CHaMP team adequately described how they will analyze the data collected?
5. What suggestions does the ISRP have for CHaMP as the project goes forward?

Habitat Action Effectiveness M&E Approach

1. Is this a scientifically sound approach for evaluating the effectiveness of habitat actions?
2. Does this approach build on past, current, and planned habitat actions and associated monitoring to test action effectiveness?
3. Does the document describe how information on project or site-level effectiveness will be used by efforts, such as IMWs and ISEMP, to evaluate the effectiveness of the Basin's collective habitat work in realizing improvements at the fish population and watershed level?

Overall Question

In sum, do the documents, Action Effectiveness Monitoring of Tributary Habitat Improvement, Columbia Habitat Monitoring Program (CHaMP) Lesson Learned, and Integrated Status and Effectiveness Monitoring Program (ISEMP) Lessons Learned, describe a cost-effective, standardized, and statistically valid method for evaluating project-level effectiveness that improves on the habitat M&E currently implemented by individual projects?

ISRP Comments

Executive Recommendations

ISEMP

Meets Scientific Review Criteria (Qualified)

- ISEMP has become one of the most important monitoring programs in the Columbia River Basin. Because it employs a variety of novel techniques, it is essential that ISEMP collaborate with other large-scale monitoring efforts to maximize data sharing and opportunities for learning.
- To facilitate coordination and collaboration ISEMP, along with other major monitoring organizations, should promote annual meetings to exchange results and lessons learned.
- The ISRP should continue to review ISEMP progress reports as they become available.
- The ISRP continues to support Intensively Monitored Watersheds as venues for establishing relationships between habitat restoration and fish populations. New watersheds to be designated as IMWs should meet strict criteria for experimental design, including well-situated treatment and control sites, statistically sound sampling regimes, careful selection of response metrics, and commitment to long-term evaluation.

CHaMP

Meets Scientific Review Criteria (Qualified)

- CHaMP should continue its efforts to consolidate and streamline habitat measurements, as well as eliminate metrics that do not provide useful information. Excellent progress has been made, and additional work will result in a set of protocols that can be employed in a wide variety of locations.
- We recommend that CHaMP be open to inclusion of metrics that go beyond the characterization of physical habitat, such as additional measures of food webs and the condition of watersheds outside the boundaries of streams and their immediate riparian areas.
- The ISRP suggests that CHaMP look for opportunities to improve collaboration with other habitat monitoring efforts to improve sampling efficiencies and promote coordination with organizations having similar interests (e.g., PACFISH/INFISH Biological Opinion Effectiveness Monitoring Program [PIBO] and the Aquatic and Riparian Effectiveness Monitoring Plan [AREMP]; water quality monitoring programs).
- The ISRP finds that CHaMP's pilot phase has shown sufficient progress that potential expansions of the suite of sites visited is justified, but with caution as sampling protocols continue to be refined and funding for field crews grows.
- As with ISEMP, the ISRP would like the opportunity to review CHaMP progress reports as they become available.

AEM

- The AEM framework should be more explicit about how the approach can be integrated into the ISEMP, CHaMP, PIBO, Pacific Northwest Aquatic Monitoring Partnership (PNAMP), and Salmon Recovery Funding Board (SRFB) monitoring programs.
- We recommend that the AEM include a more complete discussion of how preferred experimental designs can be modified to fit particular situations and restoration questions. We

know that the authors do not mean to advocate rigid one-size-fits-all approaches for different restoration categories, but restoration practitioners would appreciate more discussion about how monitoring can be tailored to unique circumstances.

- The ISRP recommends that the AEM include consideration of alternative analysis techniques, including Bayesian methods.

ISEMP

The information presented in the ISEMP report clearly reflects the extraordinary effort that has been associated with this project over the last decade. The coordination of monitoring protocols across multiple watersheds and the sophisticated methods that have been developed to summarize, analyze, and interpret habitat and fish population data will greatly enhance the effectiveness of restoration efforts in the Columbia Basin in the future. Improved coordination and collaboration with other habitat RM&E efforts sponsored by other organizations, particularly federal land management agencies are needed and would benefit ISEMP even more.

1. Has ISEMP yielded useful information about sampling designs for assessing habitat and fish population status and trends?

The Integrated Status and Effectiveness Monitoring Program is about a decade old and, based on the information provided in the Lessons Learned Synthesis Report, has achieved significant advances in assessing fish habitat and monitoring fish population status and trends in the Columbia River Basin. The growth of the project, its increasing network of partners, its willingness to consider suggestions for improvements, and its creativity in tackling monitoring problems that have faced restoration practitioners for decades all speak well for the overall progress of ISEMP. The Synthesis Report is an important milestone in ISEMP's evolution and is one that the ISRP has been anticipating since we requested it in our last review. We compliment ISEMP staff on their thoroughness in documenting the progression of this highly complex and important M&E project. We also appreciate the roadmap to completion of ISEMP in the three pilot subbasins in 2018 and are confident that this target completion date will be achieved.

We found the analyses of variation in habitat parameters useful, and the determination of the number of sites per watershed (45 sites over 9 years, comprised of 3 rotating panels each sampled at 3-year intervals) for CHaMP sampling purposes represents an important step in balancing monitoring information against monitoring cost, based on actual field data. A staircase approach (Table 5) to the Generalized Random-Tessellation Stratified (GRTS) design has been in use for a while. It seems appropriate for application to very large areas such as 5th-order watersheds in the Columbia River Basin. Presentation of variance partitioning for different habitat attributes in the Wenatchee River subbasin (Figure 6) was a good example of using a case study to make the point. We hope similar analyses are carried out in other subbasins.

The list of candidate metrics presented in Table 7 is quite large and does a good job of capturing various attributes of physical habitat, but we are a little concerned that parameters related to condition of aquatic food webs are somewhat under-represented among the suite of environmental variables that are tracked. Food web attributes are often ignored in fish habitat assessments but are nevertheless

important in regulating fish distribution and abundance (ISAB 2011-1[9]). Of the metrics included in Table 7, only three (total drift biomass, benthic macroinvertebrate density, and nutrients) can be directly related to food web condition. Little is made of these three parameters in either the ISEMP or CHaMP reports, leading us to suspect that the protocols may not capture information about the trophic condition of sites very well (see additional comments below). Likewise, we understand the reluctance of ISEMP to include pesticides and heavy metals in routine sampling, but there may be instances where determining the importance of chemical pollution is entirely appropriate, and in fact, relating chemical contamination to food web condition may be quite revealing. The ISRP strongly urges that ISEMP and CHaMP seriously consider including additional sampling of pesticides, metals, and aquatic invertebrates at those sites where the potential for contamination is obvious. Alternatively, arrangements could be made for water quality agencies to collect and analyze samples, but this sampling should be conducted in a manner compatible with the data being collected in the ISEMP and CHaMP programs. We are not sure if the habitat databases maintained by ISEMP are sufficiently general such that inclusion of water quality measurements collected by other organizations could be easily done or if redesign of the databases would be needed.

The status and trends monitoring appears well designed for both habitat and fish. As noted below in the comments on CHaMP, more habitat variables than are necessary are likely included in the assessment. The process being used to cull those metrics and indicators that are found to be difficult to measure consistently or are not closely associated with fish response should make the monitoring process more efficient in the future; however, increased transparency in how those decisions will be made is needed. It does seem that this culling process could proceed more rapidly. Several points for the project sponsors to consider:

A. The classification criteria that are being used (shown in Figure 9 through 14) are treated as if they are independent when there are clearly correlations among several of these criteria. For example, there is a very probable association between ownership class (federal or private) and valley type (source, transport, depositional). One would expect depositional channels to occur more frequently on private lands simply because these lands are typically located lower in drainages. However, it appears that the CHaMP process has used valley form as the primary stratification criteria. This choice seems most appropriate given the large influence valley form can have on channel habitat attributes.

B. The metrics being employed to represent trophic productivity of the monitored sites are likely insufficient to provide a reliable indication of this system attribute. The ISRP acknowledges that there is no easy method available to rapidly index trophic productivity. Yet stream productivity may be a key factor in fish population growth and survival, and a habitat assessment would be incomplete without some way to gage productivity. Various studies have shown that half of the energy budget for stream salmonids on an annual basis can come from terrestrial insects that fall into streams, and typically half of the summer diet is also terrestrials, although this input is often episodic and variable.[10] Terrestrial invertebrate inputs usually peak mid-day or afternoon, so drift samples may capture them, but a pan-trap sample over several days would be better to reduce variability. Unfortunately, we also do not know enough about how important these

[9] ISAB Food Web Report: http://www.nwcouncil.org/fw/isab/isab2011-1

[10] Nakano, S. and M. Murakami. 2001. Reciprocal subsidies: dynamic interdependence between terrestrial and aquatic food webs. Proceedings of the National Academy of Science, U.S.A., 98, 166-170.

Saunders, W.C. and K.D. Fausch. 2007. Improved grazing management increases terrestrial invertebrate inputs that feed trout in Wyoming rangeland streams. Transactions of the American Fisheries Society 136:216-1230.

inputs are as stream width increases, and in-stream secondary production of aquatic insects likely becomes more important to fish in streams >10 m wide. The importance of terrestrials also varies with riparian forest/grassland type and season, some of which has been studied. For example, terrestrials peak in mid-summer through early fall. The use of Net Energy Intake is a start at integrating the terrestrial and aquatic inputs and their effects on fish, although we are not sure the drift nets are placed to capture surface drift of terrestrials, that is, the nets must extend above the water surface. A reasonable approach for ISEMP to take would be to use the IMWs to evaluate the relationship between primary and/or secondary aquatic productivity and metrics that could be measured within the CHaMP protocols. Soil type and chemistry, geology, riparian condition, temperature regime, nutrient concentrations, and agricultural or wastewater treatment chemicals in stream water are possible variables that might provide some indication of system productivity. There may also be clearly apparent habitat alterations caused by non-native species (for example the plants *Fallopia* and *Didymosphenia*), and an indicator of percentage native fauna/flora could be informative.

The use of staircase and panel designs, along with the GRTS sampling, should serve as a model for future restoration projects (more details are given in CHaMP). Rotating panel sampling designs are often not used effectively, and good examples of successful implementation would be useful for future projects. One aspect of the sampling design that was not fully addressed in the report is that staircase designs often assume conditions do not change at sites not yet treated, and these sites can serve as controls. But conditions at these sites may change as a result of various types of disturbances, including anthropogenic changes. An evaluation of some of the implicit assumptions in the staircase and GRTS designs and the implications of failure of these assumptions for long-term monitoring would be very useful. Similarly, most designs consider changes in the mean response over time, for example, step changes or regression type changes. One of the suggested impacts of climate change is increased variability in weather events, which might force higher variability in watershed conditions and aquatic habitats. Can this variability also be detected? How do sampling designs need to be modified to account for these types of effects?

GRTS sampling designs are complex to implement. Some important questions include: What are the limitations to a more widespread adoption of a GRTS approach; that is, will widespread GIS and geospatial consultant support be needed? Suppose simpler designs were used. Could habitat and fish status and trends still be adequately characterized?

The assessment of crew/measurement effects is helpful. We encourage more effort to reduce inter-crew measurement variability. Is there an expectation that methods for measuring certain metrics will be changed to reduce this noise? If variation among crews is inevitable, as we suspect, what are the risks of introduced bias?

2. Has ISEMP advanced our ability to monitor and evaluate adult and juvenile salmonid populations in the Columbia River Basin?

Collaboration of ISEMP with tribal co-managers and state agencies, such as ODFW has been productive. Evaluation of the accuracy of different adult salmon and steelhead escapement techniques, especially redd counts and PIT-tag detections, will eventually facilitate improved estimates of the ratio of smolts to spawners. When correlated with habitat data, these estimates will make it possible to track trends in anadromous salmonid productivity as restoration actions are implemented. We believe such estimates constitute one of the most important needs in evaluating assumptions of the BiOp regarding the ability

of tributary habitat restoration to mitigate for mainstem hydrosystem operations, as well as the overall effectiveness of habitat-based actions in the Council's Fish and Wildlife Program. We also applaud ISEMP for incorporating genetic identification into the adult PIT-tagging program.

The fish monitoring program associated with ISEMP is comprehensive and represents a major improvement over the methods that have been employed in tributary systems to date. The innovative use of PIT tags and the extensive network of PIT tag detectors are notable improvements. The thorough evaluation of the accuracy and precision of various methods that have been employed to monitor adult, juvenile, and out-migrant abundance should help to standardize historical data sets and provide a template for measuring these population parameters in the future. It is clear that ISEMP favors PIT-tagging and mark-recapture sampling as the most accurate methods of determining juvenile standing crop and emigration, and their data support this conclusion. That snorkel survey efficiency was rather low did not surprise the ISRP, but we were surprised that multiple-pass electrofishing was not part of the comparison to single pass mark-recapture sampling. Techniques involving multiple-pass electrofishing combined with depletion rate population estimates are in widespread use;[11] however, we infer that ISEMP felt that multi-pass electrofishing was too time-consuming to be considered a viable sampling method. Provided funding is available for PIT tag purchase, tags are correctly implanted, and detection arrays are properly installed in streams, ISEMP has made a strong case that PIT-tagging is a preferred method. It is encouraging to observe statistically significant correlations between juvenile estimates obtained by PIT-tagging with those obtained by snorkeling and by electrofishing. These relationships offer some hope that correction of population density estimates obtained through snorkeling and electrofishing might be possible using an appropriate conversion. The ISRP would caution that the high r^2 values of the regressions are likely based on 3-5 points with high densities that have high leverage. Therefore, further evaluation of these relationships would be required to have confidence in any population density estimate correction, since it certainly will vary as a function of many variables, such as width, depth, species, type of electrofishing gear, crew makeup, and experience.

There were several minor questions related to PIT-tagging that were raised by the report:

A. PIT-tagged juvenile salmon and steelhead are used to estimate survival. However, fish must exceed a certain size to accommodate a PIT tag. Were all fish captured for tagging of sufficient size to receive a tag or were only larger individuals tagged? If the latter, survival estimates could be biased if fish size influences survival. How will this bias be addressed?

B. Juvenile abundance sampling sites were selected using the GRTS procedure. The claim is made in the report that fish captured and PIT tagged at these sites provide an indication of relative survival at restored and unrestored locations. It is unclear how the site selection system ensures that enough restored reaches are included in the sample panels to enable this comparison to be made.

The ISEMP synthesis report provided a thoughtful discussion of the pitfalls of using rotary screw traps in watersheds prone to high flow variations. The admonition regarding careful use of mark and recapture methods to calibrate screw traps, especially over a range of flows, is appropriate.

[11] Saunders, W.C., Fausch, K.D., and G.C. White. 2011. Accurate estimation of salmonid abundance in small streams using three-pass removal electrofishing and program MARK: an evaluation using marked fish. North American Journal of Fisheries Management 31: 403-415.

We suggest that ISEMP consider adding one or more metrics of fish condition during the sampling procedures. As stated above, the overall ISEMP protocols could be improved with inferences about the relative abundance of food resources, and one of the best ways to do this is by sampling the fish themselves. Measurements could be as simple as condition factor:

$$(1) \quad K = \frac{W \times 100}{L^3}$$

where K = condition factor, W = weight (grams), and L = fork length (mm) or it could involve collection of tissue samples for assessing physiological health. We understand that length and weight are currently being recorded, so calculation of condition could be accomplished without much extra effort. Such information could supply useful data about recent food consumption and the general trophic status of the population. Additionally, if chemical contamination is suspected, tissue samples can be collected for pesticides, metals, or persistent organic pollutants and stored for later analysis.

One of the more important products from ISEMP is data management and protocol development. In the past, data management was rather *ad hoc* because most projects were "local," small, and "in house." However, with large scale projects, data management becomes crucial for success. The ISRP is pleased that careful attention was been placed on keeping data collection methods consistent, reporting methods consistent, and complete descriptions of protocols used are archived and easily available. This should speed future monitoring work in the Columbia Basin, as protocols will no longer have to be newly developed for each project.

The analytical evaluation is fairly sophisticated, as re-enforced in comments below. However, it is not clear how well integrated the models being used in the analyses are with the database. For example, do the models perform a query of the database to extract the information and then process it, or must these be manually extracted and entered into the models? In the latter case, the linkage between data and models can be disconnected such that as data are updated, the models are not automatically updated with the latest data. Is there also a standard protocol for extracting the data from the databases for not only these models but also the simpler models such as standard regression and analysis of variance?

3. Are Intensively Monitored Watersheds (IMWs) delivering on the promise of establishing cause-effect relationships between habitat restoration and improvements in fish populations?

ISEMP has chosen intensively monitored watersheds as venues to examine restoration effectiveness at the population level. Three watersheds – Lemhi River, Bridge Creek, and Entiat River – are the locations of major IMW effort over the last few years. Restoration projects have varied in each watershed. The Lemhi River restoration focuses in reconnecting small tributaries with the main stream. The Bridge Creek Restoration aims to restore channel structure created by beaver dams and to reduce livestock damage through riparian fencing, and the Entiat River restoration involves engineered in-stream structures that increase channel complexity. Both the Lemhi River and Bridge Creek studies have been ongoing for several years, while the Entiat River restoration work is just beginning. ISEMP staff members have taken an innovative approach – digital elevation model differencing before and after restoration – to measuring changes in stream channel morphology, and their graphical displays of results are useful for interpreting habitat alterations at this spatial scale, for example, Figure ES10 showing areas of scour and

deposition in a reach of Bridge Creek. Even more significantly, the grazing exclosure study in Bridge Creek has shown that measureable improvements in riparian vegetation have occurred, but those improvements have not yet been translated into increases in fish populations. This finding has important implications for riparian fencing projects in general, which represent a major category of habitat restoration actions in the interior Columbia River. ISEMP suggests that additional time will be needed to establish the long-term effect of riparian fencing on Chinook and steelhead focal species.

Preliminary results from the Entiat River in-stream restoration work suggest that one of the focal species, steelhead, actually grew better at locations with engineered habitat structures. There was no explanation for this result, again reinforcing the idea that additional examination of food web attributes could help shed light on fish performance.

The ISRP continues to believe that IMW studies, while time-consuming and expensive, provide some of the most direct evidence of the effects of habitat restoration on focal species. However, one conclusion that seems to be emerging from IMW monitoring is that definitive answers to restoration efficacy questions requires time. This is particularly evident in projects that involve the restoration of ecological processes such as riparian succession to achieve desired habitat conditions. A more complete understanding of watershed landscape scale conditions and trends would also be helpful in interpreting results. This would provide additional insights into watershed processes that could be altered by land use, such as agriculture, road construction, as well as natural disturbances, such as wildfire, storms, and droughts (ISAB 2011-4[12]). It would be helpful for ISEMP to develop estimates of the time needed to evaluate the results of IMW experiments, based on findings to date. We suspect that this has already been attempted based on the observation that the only two tasks in Figure ES2 extending beyond 2019 are IMW-related. Because managers are anxious to know "How long will it take to find an answer?" even coarse estimates of study and evaluation time would help frame the IMW work and demonstrate the importance of commitment to long-term monitoring and evaluation in a few carefully controlled locations. We realize that some categories of restoration may take longer to evaluate than others.[13]

Although the IMW sites have only been in place for a relatively short period of time, they do appear to be providing the type of information that this study approach was intended to deliver. The ISRP has encouraged restoration practitioners in the basin to employ an empirically-based method for estimating fish benefits from restoration actions for over a decade. The information being generated by the IMWs finally provides the data on which such an estimate can be based. The example from the Lemhi provided at the end of the report clearly indicates the IMW data can be used in conjunction with a fish population model to provide estimates of egg to smolt survival improvements with a given suite of restoration actions or even the benefit in terms of returning adults. As more data are collected at the IMW sites, the model can be modified to better reflect the actual response of the population to habitat restoration. The development of protocols to extend results beyond IMWs will ultimately provide a powerful tool for assessing what is achievable with habitat restoration. The ISRP does have the following comments on specific IMWs:

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[12] Using a Comprehensive Landscape Approach for More Effective Conservation and Restoration: http://www.nwcouncil.org/media/95047/isab2011_4.pdf

[13] White, S. L., C. Gowan, K. D. Fausch, J. G. Harris, and W. C. Saunders. 2011. Response of trout populations in five Colorado streams two decades after habitat manipulation. Canadian Journal of Fisheries and Aquatic Sciences 68:2057-2063.

Gowan, C., and K. D. Fausch. 1996. Long-term demographic responses of trout populations to habitat manipulation in six Colorado streams. Ecological Applications 6:931-946.

A. An example of an assessment being done in the Entiat River was provided in the report (Effectiveness Monitoring chapter), evaluating Chinook and steelhead response to in-stream structures. The assessment found higher steelhead growth rates at the structures than at reference sites but lower density. The report suggests that the structures had a positive influence of steelhead growth. However, it could be possible that higher growth was simply an outcome of lower density rather than a direct response to the log and rock weirs.

B. Some discussion of the relationship, or lack thereof, of results of the project assessment in the Entiat River with the results obtained using the boosted regression tree analyses in the Analytical Framework chapter, would have been useful and would help tie the report together. The fact that two of the four habitat indicators found to be related to steelhead abundance in the boosted-regression tree analysis were related to water depth would suggest that the Entiat River structures should have resulted in increased density of steelhead. The fact that this response was not observed, despite increased water depth, seems important to note and deserves some discussion as to why this apparent discrepancy arose.

C. A project effectiveness monitoring effort in the John Day examined the effect of riparian fencing on streamside vegetation and channel characteristics. This assessment was long overdue, given the resources dedicated to this type of restoration over the last two decades. However, it is unclear why the variable chosen to reflect the effect of fencing on riparian condition was "wetland indicator status." Not all riparian areas would be expected to develop wetland features after the exclusion of livestock. It would seem that a variety of vegetation metrics would be more appropriate for gauging riparian response. Comparison of species diversity, community composition, and structural characteristics of vegetation at fenced and unfenced sites may have provided a better indication of system response. The scientific literature relating riparian vegetation metrics with trout should be considered.[14] Although there was no channel response detected as a result of fencing, this method may still have value for enhancing riparian wildlife habitat. Even though this may not be a very effective method for rapidly restoring aquatic habitat and fish populations, it still may be a viable option for achieving other goals.

The ISRP has some concern that there is a lack of comprehensive assessment of watershed condition and dominant ecosystem processes likely responsible for impaired habitat conditions in the IMWs. Such considerations are an important part of a landscape-scale approach to strategic restoration recommended in ISAB 2011-4. It seems particularly appropriate to incorporate watershed condition into IMW projects. Determinations of watershed condition currently exist for many watersheds in the Columbia River Basin, at least on federally-managed lands[15] and this information could be of real value to ISEMP, as well as CHaMP and AEM. Additionally, it would be helpful to see some discussion of the causes for impairment of ecosystem processes in the IMWs, whether damage is still occurring, and what

[14] Saunders, W. C., and K. D. Fausch. 2007. Improved grazing management increases terrestrial invertebrate inputs that feed trout in Wyoming rangeland streams. Transactions American Fisheries Society 136:1216-1230.
Saunders, W. C., and K. D. Fausch. 2012. Grazing management influences the subsidy of terrestrial prey to trout in central Rocky Mountain streams (USA). Freshwater Biology 57: 1512-1529.

[15] Watershed conditions: http://www.fs.fed.us/publications/watershed/ ; also see
Lanigan, S.H., S. N. Gordon, P. Eldred, M. Isley, S. Wilcox, C. Moyer, and H. Andersen. 2012. Northwest Forest Plan—the first 15 years (1994–2008): watershed condition status and trend. General Technical Report PNW-GTR-856. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

actions might be possible to mitigate problems as part of watershed-scale restoration. Focusing solely on active treatment of the channel and floodplain/riparian area may provide a limited understanding of whether effective, long-term restoration has occurred. More information was also needed relating to connectivity of habitats within the watersheds, particularly associated with road crossings, irrigation diversions, and push-up dams within some of the IMWs.

There did not appear to be a clear provision for considering the potentially confounding benefits of watershed restoration activities that may be occurring in upslope locations in IMWs, out of the stream channel and valley bottom. Activities such as road decommissioning, severe wildfire reduction measures and forest stand management are some examples where substantial work has occurred in some IMW watersheds.

With respect to establishing a causal relationship between restoration and population performance in IMWs, the "cause-and-effect" outcome is still temporally distant because the results based on empirical data are mostly correlational. It may take several iterations of actual experiments to infer the cause-and-effect.

The authors indicate that they hope to expand their models to other watersheds, but it was not clear how much of an effort this will be. It appears that the models are fairly generalizable, but just how much customization has taken place for these particular IMWs is not clear. If a new watershed was to be added to the IMW network, is there a guide on how to do this? How much effort is required to set up new IMWs?

4. Is the analytical framework in ISEMP up to the task of evaluating the field data and making results available to managers and restoration practitioners?

The ISRP appreciates the innovative approaches that ISEMP is using to define the relationships between salmonids and their habitats. The partial dependence plots of juvenile Chinook density over ranges of environmental gradients in Figure 65 are quite interesting and illustrate the often sudden transition from favorable to unfavorable conditions, and the ordering of habitat attributes according to strength of influence on abundance represents genuine progress in identifying important and unimportant factors. For example, based on the analysis of habitat variables from the Wenatchee River subbasin, we see that water velocity is very influential on juvenile Chinook while substrate embeddedness is relatively unimportant. This is somewhat surprising but nevertheless useful, as it suggests what types of restoration actions could have the most significant impact. Scaling habitat data up to larger areas also allows habitat managers to identify general locations of risk, such as the thermal impairment risk for the John Day River subbasin shown in Figure 73.

The life-cycle based salmonid production modeling effort is intriguing, but based on the information in the Synthesis Report is still rather early in development. From the description in the report, this model appears to use a SHIRAZ-like architecture. Application of the prototype model to predicting Lemhi River Chinook returns in Figure 76 was interesting, but it will be difficult to assess the model's assumptions and limitations until model parameterization is clearer.

ISEMP has made important strides in data management. The data archiving system seems well designed. Considering the quantity and diversity of data being stored, the development of automated data storage

and retrieval tools, and the commitment to QA/QC data checking, the ISRP is confident that sufficient effort has been expended toward data management.

The analytical approach being applied to status and trends monitoring data produced by IMW research and project effectiveness assessments is innovative and should be capable of providing useful information to managers in the basin. The methods being used to relate habitat to fish response are sound but some care should be taken in the application of these analyses to identify limiting factors:

A. Habitat factors identified in the boosted regression tree analyses as being associated with Chinook or steelhead abundance seem to be treated as independent when many of them may be related. For example, the channel variables identified as significant for Chinook (gradient, fast water, gravel, number of pools) are correlated. Lower channel gradient is usually associated with more pools, finer substrate, and slower water velocities. The discussion about "how much habitat is enough" seems to imply that these correlated attributes are the equivalent of limiting factors. However, it may be a subset of the significant habitat indicators that the fish are actually responding to; the others are significant only because they are correlated with the relevant attributes. Perhaps a multivariate method can be used to develop one or two independent variables that are linear combinations of the rest. Therefore, care should be taken in interpreting the boosted regression tree results so the focus of restoration is not directed to habitat characteristics that are not really influencing fish population dynamics.

B. The habitat impairment classification method does provide some indication of how good and poor habitat conditions are distributed across the basin, but care should be taken in using this type of coarse-grain analysis to determine where restoration would be most fruitful. The report seems to suggest that habitat restoration would be most beneficial if applied within the watersheds predicted to have poor conditions. Clearly, the feasibility of correcting habitat deficiencies at these sites also needs to be a consideration. In many cases the actions that would be required to restore severely degraded sites may not be socially or economically acceptable. This classification scheme does not seem to incorporate any consideration for the intrinsic potential for a HUC to support the fish species of interest. Inclusion of intrinsic potential would provide an indication of both general level of impairment and potential gain with restoration. Intrinsic potential is used in the temperature evaluation for the John Day presented in this section of the report. The inclusion of intrinsic potential in the impairment classification would enable this tool to provide a much better indication of sites where restoration might be most beneficial.

Parts of the analytical framework will likely need additional refinement before valid conclusions can be reached on the framework's adequacy to meet program needs and budgets. Development of a "key set of management support products" will encourage use of information from ISEMP. Further focusing of some of these tools and their application would be useful. An example is the section on Classification of Habitat Impairment, page 82. Additional indicators should be considered for use. Some of these could include number of road crossings, percent forest vegetation or vegetative cover by type and age class, land ownership groupings, and erosion risk classes of landforms or soil types. Additionally, potential uses of information would be helpful. It is suggested that identification of reaches with the poorest conditions provides a basis for targeting highest priority restoration sites, but there are a variety of important questions and considerations that are not addressed. Some of these include: Are the factors that caused the poor habitat conditions in these areas still occurring? What is the overall condition and trend of the watershed upstream from these reaches? What is the likelihood of a positive ecological

response, especially in areas that have been seriously damaged and may require intensive treatments and long time frames before a positive response is likely?

IMWs would be candidate locations to examine possible correlations between overall watershed condition rankings that have that have recently been completed. The Forest Service has completed such rankings at the 6th field HUC scale for all watersheds with national forests in the Columbia Basin (see footnote 10 above). Additionally, in the Wenatchee subbasin, more intensive monitoring of watershed status and trend on federally managed lands, using a decision support system, has been operational for several years and could provide for additional evaluation.

ISEMP and CHaMP have used sophisticated methods in the analysis of the data collected such as Structural Equation Modeling, Bayesian Hierarchical models, Boosted Regression Trees, and Variance Decomposition models. While these seem appropriate, the rationale for the choice of these methods versus simpler and more traditional approaches is seldom explicitly stated. Brevity is explainable by space limitations and the rationale for methods can be discovered if one is able to go the primary literature on each method. However, many readers may not be familiar with some of these methods so a brief primer would be helpful. This would be a useful product in its own right, to give interested parties, for example agency personnel and the public, information about what is being done rather than relying on an unspecified approach.

In some cases, the data populating the database are locally produced, e.g. the smolt estimates. It was not clear if some quality control was performed on these to account, for example, the concern by managers that the reported standard errors are too small.

Some care is needed not to overstate results. For example, the plots (Figure 65, on page 76) correctly indicate that these are marginal effects (that is, changing one variable at a time and holding other variables fixed), but the description does not discuss limitations in the interpretation. The reader is left with the impression that changing multiple habitat variables must be better than changing only one variable. Similarly, the presentation of the Bayesian results (Figure 63, page 73) is not clear. The report indicates that the plot shows the "probability that a negative or positive trend is detectable" or that the analysis reveals the "shape of the parameter." Both of these conclusions are incorrect as stated. The easiest interpretation for Bayesian posteriors is that these are reflection of updated beliefs about the trend. The prior captures the initial belief about the trend size that is updated with data to the final posterior. To think of a probability of a trend really makes no sense … both the prior and posterior reflect a willingness to conclude that there really is a trend with the mode of the posterior the best guess for the actual value of the trend. In the case of the variance decomposition, it is not clear what the implications of the some of the results are. It is important to know if a site variance component is responsible for 80% of the total variance, but it is not clear how this information will be used to make management decisions.

The life-cycle model is especially valuable because it has the potential to show if improvements in one aspect of habitat are actually not influential because of a bottleneck in another area. One product from this model that appears to be missing is a sensitivity analysis. That is, how much does an improvement in one component affect the final response metric and more importantly, how much variability is there in this result. A sensitivity analysis can identify the most important components for improvement by considering both the magnitude of improvement and the variability or uncertainty associated with that improvement.

CHaMP

CHaMP, like ISEMP, represents an ambitious effort to establish standardized salmonid habitat assessment protocols and analytical tools that can be used in a cost-effective manner throughout the Columbia River Basin. The CHaMP program has also achieved significant progress in data archiving and in identifying factors limiting fish production. The ISRP urges users of CHaMP results to recognize the basic limitations of CHaMP information. Surveys are focused primarily on stream habitat attributes sampled during the summer. Other biological, chemical, or seasonal factors potentially limiting production are not included in the protocols.

1. Has CHaMP identified and addressed the right questions with regard to tributary habitat status and trends?

The Columbia Habitat Monitoring Program (CHaMP) is designed to answer the following management questions with respect to tributary spawning and rearing habitats for anadromous salmonids:

- What are the tributary habitat limiting factors or threats preventing the achievement of desired tributary habitat performance objectives?
- What are the relationships between tributary habitat actions and fish survival or productivity increases, and what actions are most effective?
- Which actions are most cost-effective at addressing identified habitat impairments?

The focus of CHaMP is on stream habitat; however, the project is tightly coupled to the ISEMP project, which attempts to understand the relationship between aquatic habitat and fish populations. CHaMP grew out of a need to track the status and trends in habitat conditions in order to support data needs in the BiOp, and also to help determine progress in achieving the goals of the Council's Fish and Wildlife Program. CHaMP also arose from the need to bring greater consistency to habitat measurements, as habitat sampling programs throughout the Columbia River Basin have often differed according to organizational requirements and traditions – a situation that often made comparison of habitat data gathered by different organizations problematic. The need for improved habitat measurement standardization was noted in several scientific conferences and workshops held in the Columbia Basin in 2008-2009.

The ISRP believes that CHaMP has done an excellent job of developing standardized protocols for addressing the key management questions identified above. The list of habitat metrics is quite extensive (78 habitat attributes in total), and there is, by CHaMP's admission, redundancy among some of the parameters. However, CHaMP acknowledges that the protocols are still in development and the final protocols will likely take several years to refine. In an earlier review of CHaMP, the ISRP expressed some concern that completing an assessment of some sites could take a three-person crew more than a day. CHaMP staff has taken this comment seriously, has worked hard to streamline its data collecting tools, and is now confident that the one-site-per-day goal is generally achievable. In 2011 they were able to survey 338 sites, consisting of combined CHaMP and ISEMP study locations, for a total of about 1,000 person-days in the field. In 2012, the total number of BPA-funded site surveys increased to 344, according to the January 11, 2013 presentation.

Under the overall leadership of NOAA, CHaMP has made extensive use of consultants to carry out field work and data analyses. They have also entered into partnerships with state agencies, tribes, and universities. By partnering with a variety of organizations and stakeholders CHaMP gains the added

benefit of hearing their concerns and ensuring that their particular habitat questions are addressed in the field protocols.

The ISRP notes that CHaMP, like ISEMP, is primarily focused on aspects of the physical environment of tributary habitats (Table 4). While these aspects are surely important and can be influenced by anthropogenic land and water uses, they still represent a subset of the overall suite of environmental conditions facing spawning and rearing salmon and steelhead. Other habitat factors such as food web conditions, invasive species, and chemical contaminants can, in some locations, exert a strong influence over the distribution and abundance of focal species. We recommend that CHaMP be alert to situations where other aspects of the stream and riparian/floodplain environment can act as potentially important limiting factors and consider developing or adopting existing survey protocols for those locations where additional measurements could help explain departures from expectations based on physical habitat measurements alone.

The preliminary data analyses presented in the report clearly indicate the potential value of CHaMP's framework. The various correlative and modeling approaches being employed to associate habitat condition with fish abundance is a particularly strong aspect of this approach. The ISRP has suggested multiple times in past reviews that there is great value in utilizing various modeling and analytical approaches in exploring the relationship between habitat and fish production, but this is one of the few programs that have actually taken this advice. The use of the individual-based-model approach (NREI) is an especially innovative way to examine this linkage. This method is attractive in that it explicitly considers trophic productivity as an element of salmon habitat. One concern with the use of this approach is that CHaMP habitat metrics may not adequately reflect food availability, as stated above. Drift samples are collected but only on a single occasion during midday. These samples may not accurately reflect actual food availability, especially if terrestrial invertebrates are not sampled. Directing some effort towards identifying metrics that provide a better indication of food production and are compatible with CHaMP data collection procedure would be valuable. The IMWs, where both habitat and detailed information on fish responses are available, would be good locations at which to conduct such an evaluation.

The ISRP suggests that the ecosystem functions influencing upslope processes, such as wood and sediment delivery, should be more carefully examined as well as factors affecting the longitudinal and lateral connectivity of the stream network. This is important everywhere, but particularly so in watersheds prone to rare but often very large disturbances. Understanding the ecological context of sites provides important clues into what is and is not possible to restore without frequent, expensive intervention. Although CHaMP does not currently assess conditions outside the channel and its riparian area, data from other sources are often available and can be potentially helpful.

2. Has CHaMP provided satisfactory answers to the ISRP's and Council's questions and concerns (see attachment)?

CHaMP explicitly addresses key management questions (KMQs), ISRP questions, and Council Principles in the Lessons Learned section. Overall, the report does an excellent job of explaining why decisions were made with respect to various implementation questions, and in general we have no additional questions at this time. CHaMP staff gives their rationale for excluding non-standard metrics. If addition of these measurements is believed to be cost-prohibitive, perhaps agreements can be reached with partnering organizations to obtain the measurements while the crews are on site, for example water

quality agencies could sample for contaminants or arrange for the CHaMP crew to collect water samples. With regard to the concern that landowners would deny access to sites based on fears that, for example, chemical sampling could expose them to regulatory exposure, we acknowledge that this concern is justified but note that it could also apply to some of the attributes in the standard sampling protocols such as sediment-related parameters. In the end, we would hope that landowners would put environmental stewardship above regulatory fears, especially if partnering organizations demonstrate a willingness to work with them to minimize problems. See discussion point C below on this issue.

The first section of the report is organized to explicitly address the ISRP and Council questions generated during the first review. This structure makes it transparent how CHaMP addressed each concern. The responses were generally complete and appropriate for the issues raised. The ISRP has several observations:

A. The report notes that some sites were problematic in terms of completing data collection within the 2-day limit, as anticipated by the ISRP. However, relatively few sites fell into this category. The abbreviated topographic data collection method used at the problem sites did not generate the quality of information that the full topographic survey provided. Developing a method that ensures that the data collected at these complex sites is comparable to that collected at other sites would seem a priority.

B. The ISRP suggested that CHaMP establish regular meetings among habitat monitoring programs in the basin to exchange information and help to ensure that protocols are as consistent as possible. One attempt at a workshop was held in late 2011, but it was poorly attended. It appears that efforts beyond the workshop were minimal; not surprising given the size of the task undertaken by CHaMP. But there would be great value to bringing additional consistency and coordination to the habitat monitoring efforts in the region. The ISRP suggests that CHaMP evaluate additional options for achieving this goal. Perhaps working with PNAMP to hold periodic meetings would be a fruitful approach.

C. The report listed several reasons why chemical contaminants were not sampled as part of the CHaMP protocol. The fact that measurements of contaminants are not compatible with the CHaMP habitat sampling approach appears to be correct; it would not be reasonable to rely on a single grab sample during the summer to represent potential chemical exposure for the fish. But contaminants may be limiting fish population response in some systems and some process for developing an understanding of this parameter is critical in order for CHaMP to achieve its ultimate objective of identifying limiting factors for salmon and steelhead.

D. The report indicates that progress on Theoretical Interpretations of the CHaMP data was expected by April 2012, but this information is not included in the report. Was this work completed? The report also indicates a roll-up of the habitat data to the subbasin scale was to be completed by spring 2012. Was this task accomplished?

E. Although the ISRP is not in a position to evaluate the cost-efficiency of proposed new CHaMP policies and the use of time-intensive sampling methods such as the electronic total station surveys, we encourage CHaMP staff to continue to investigate ways of streamlining the equipment purchasing and maintenance, crew training and management, field sampling, and data archiving procedures.

It was not clear if the current data management software keeps protocol information associated with the data, or does it assume that, for example, that data on large wood debris (LWD) is collected using a single method all the time? What happens if, for example, technological change comes up with a more accurate, less expensive way to measure an attribute? Does the archiving current system include a way of tracking changes on technique, and how new and old measurements can be cross-correlated?

There is a provision to incorporate probabilistically chosen sites from other studies, but for some restoration work, as outlined in the AEM, control sites are much more deliberately chosen and certainly not in a probabilistic fashion compatible with the GRTS approach. We encourage CHaMP to examine the difficulties and potential benefits in incorporating *ad hoc* data when trying to extrapolate to other areas. Perhaps two versions of analyses can be programmed where all data are used compared to a probability sample, to see if there is a large difference.

3. Does the CHaMP synthesis report adequately address the lessons learned from pilot studies? In particular, has CHaMP provided useful information about what worked and what did not work in implementing the habitat surveys?

In each section of the Lessons Learned Project Synthesis Report the conclusions to date have been concisely summarized in sidebars, and in the Implementation Review section, limited to 2011 pilot year surveys, there are useful summaries of what did and what did not work. We were impressed with CHaMP's ability to continually look for sampling and cost-efficiencies, for example, the increased use of digital data logging devices and the employment of a quartermaster to coordinate, maintain, and purchase equipment. The CHaMP Camp training session approach seems to have been successful, although we wonder if some of the attendees might encounter conditions for which they were not fully trained as they disperse to remote locations in the basin. The map-based graphical displays in Figures 2-8 of habitat condition in different watersheds were helpful.

The methods used to decompose variability in habitat status data were innovative and represent an important contribution of CHaMP to tracking habitat trends. The sidebar on page 35 gives a good summary of the lessons learned about variance according to different types of habitat measurements. In addition, the discussion of variability among field crews on pages 39-41 was quite informative and helps to suggest ways in which intra-crew variability can be minimized. One issue that we found difficult to check was what changes are being proposed in future years to deal with things that did not work. There is a list of recommended changes for the 2012 survey, but sometimes it was not clear how the changes would fix some of the problems encountered.

A vast array of possible habitat metrics was evaluated for information content, repeatability, and logistical feasibility. One issue that was not addressed, but seems important moving forward, is the efficiency that could be gained by streamlining the data collection process. The report does identify a number of metrics that either have little relationship to fish abundance or cannot be collected consistently such as high among team or within season variation. Nonetheless, the CHaMP program proposes to keep all these metrics in the sampling protocol because some of these metrics might be useful in detecting temporal trends. It seems unlikely that a metric that cannot be measured consistently by multiple measurement teams would be useful in this regard; if a parameter cannot be consistently measured on the ground, it is not clear how it can be sensitive to temporal changes. It would seem that more streamlining of the sampling protocol would be desirable if it would enable sites

to be completed more rapidly or provided some flexibility to incorporate new metrics. Some mention was made in the report that the enormous workload impacted team morale in 2011.

4. Do they adequately describe how they will analyze the data collected?

The Synthesis Report does a good job of describing analytical methods, even though some are still in the developmental stage. The structural equations modeling technique in Figure 28 allows CHaMP investigators to examine the influence of a single habitat variable apart from the broader suite of attributes on salmonid populations, and it also gauges interactions between attributes that are known to have significant effects on fish. The boosted regression tree modeling in Figure 30 allows for the ranking of habitat variables according to the strength of their effects. The caveat on page 49 that boosted regression tree rankings may differ among subbasins is well taken, and we suspect that annual changes in the relative importance of different attributes occur too. We agree with CHaMP that additional years are needed to establish habitat-fish population relationships that can be used with confidence by managers. The combination of structural equation and boosted regression tree modeling represents a new approach to answering questions about the efficacy of restoration actions, and the ISRP encourages more work along these lines.

The energy availability and carrying capacity modeling (NREI) relies on site-specific measurements of temperature, discharge, stream morphology, and macroinvertebrate drift. While this is a potentially useful technique, the availability of food resources, estimated from drift samples, requires accuracy that may be beyond the limited sampling capacity of the CHaMP drift protocols. Drift densities are notoriously variable and salmonids are known to feed opportunistically on temporarily abundant food items. We suggest that CHaMP test the assumption that one or a few drift samples at a site gives an accurate representation of food abundance for modeling purposes as noted in comments above. Other macroinvertebrate sampling issues are discussed on pages 64-65.

There are several instances where some additional caution should be exercised in interpreting results from these analyses. For example, the boosted regression tree analyses of relationships between habitat metrics and fish abundance identified a relationship between juvenile Chinook density and conductivity. Based on this observation, the report states that a reasonable restoration objective would be to reduce conductivity to less than 30 umhos/cm. However, no ecological mechanism for this relationship is provided to explain how this increased conductivity negatively impacts Chinook salmon. It may be that conductivity is simply correlated with another attribute that is the factor to which the fish are responding.

The classification of 5th-Code HUCs by degree of degradation provides another example of limits to interpretation of results from the analyses. The report suggests that this classification could be used to prioritize restoration by focusing efforts on the most degraded sites. However, that may not be the most efficient way to provide long-term benefits to aquatic and riparian habitats and to generate improvement in fish population metrics. At some sites aquatic habitat may be so degraded that the re-establishment of conditions suitable for anadromous fishes may not be possible. Highly urbanized environments could be an example of such a situation. Also, the potential of a site to support fish after restoration should be as important in making decisions about priority restoration locations as the degree of degradation of a given site. While the array of data analysis techniques that are being explored by both CHaMP and ISEMP is impressive, and are likely to prove very valuable, some caution is warranted in extrapolating results of these analyses. Contextual information in the form of land

ownership considerations, land uses and likely future developments, and projected watershed condition should be considered.

A full description of the data analysis approaches would be too detailed for a lessons learned review document; however, the current level of detail is generally acceptable for this document. For example, although the structured equation model example provides insufficient information for a statistician to see if the analyses are appropriate, it provides sufficient information for a general reader to get an overview of the final product. The materials on other statistical analysis methods provide an overview but are too limited for thorough scientific review. Eventually CHaMP will need to provide a much more detailed explanation of how the analyses are carried out, and several supplementary documents will be needed to more fully detail the analyzed. Also needed is a management question by analysis method matrix to give the reader or future user of the system a guide to what methods can be used to answer what types of questions. That is, which questions are amenable to regression-type analyses, which to structural equation modeling, etc?

5. What suggestions does the ISRP have for CHaMP as the project goes forward?

Overall, CHaMP has done an outstanding job of refining field techniques and developing sampling and analytical protocols to characterize summer habitat conditions. The ISRP is impressed with the scope of the work, the coordination, and working relationships between CHaMP and other organizations, and the willingness of CHaMP to make adjustments for procedures that do not work well. We encourage CHaMP to continue to refine and streamline the list of habitat variables and to explore novel analytical approaches. The CHaMP web site is well designed and facilitates data input and sharing.

The ISRP remains reluctant to give up on the need to monitor non-standard variables at some sites, especially where these factors have the potential to obscure the benefits of habitat restoration. CHaMP has made a good argument for not including these variables in its sampling arsenal. Perhaps there is an opportunity to sample and analyze non-standard variables at selected CHaMP sites on an ad-hoc basis using the resources of cooperating organizations.

It was not always clear how decisions were made with regard to acceptance, rejection, or modification of protocols. We strongly encourage CHaMP to be explicit with respect to criteria used to evaluate field and analytical methods for retention and to publish those criteria in subsequent reports.

One possibility mentioned in the report was the establishment of an executive team to interface with policy and management processes in the basin and to help with outreach. Given the complexity and size of the CHaMP effort, the establishment of such a committee should be given serious consideration.

On occasion CHaMP, PIBO, and other surveys have been conducted in the same drainages without survey teams being aware of each other. We encourage better coordination with other habitat monitoring efforts to provide greater efficiencies when gathering data.

Habitat Action Effectiveness M&E Approach

The AEM report provided a useful overall action effectiveness monitoring framework.

On an editorial note, the document would have greatly benefited from a thorough proof-reading. There were numerous typographical errors in the report, some severe enough to make interpretation difficult.

1. Is this a scientifically sound approach for evaluating the effectiveness of habitat actions?

Overall, the Action Effectiveness Monitoring (AEM) approach appears operationally reasonable and scientifically sound. It has been developed, in part, to reduce the need for monitoring habitat restoration effectiveness at all sites and to focus on a subset of sites where conclusions about restoration effectiveness can be extrapolated to similar locations and circumstances. The AEM approach calls for improved coordination among organizations engaged in restoring tributary habitat, and it also proposes a standardized set of effectiveness metrics and reporting procedures. It also calls for greater consistency in analytical methods. The authors of the AEM report have drawn heavily from the Washington Salmon Recovery Funding Board's (SRFB) reach-scale effectiveness monitoring program. The AEM proposes to look at the effectiveness of habitat actions over many projects rather than focusing in on specific projects. This is long overdue because individual projects are likely to have poor statistical power to detect effects, but by "pooling" over multiple projects the ability to detect responses is greatly enhanced and information can be shared.

One of the most important parts of the report is a recommended set of monitoring designs, including before-after, before-after control-impact, and extensive post-treatment designs, for specific categories of restoration actions. For example, the authors suggest that a multiple BACI approach is appropriate for monitoring streambank stabilization projects, while extensive post-treatment surveys are appropriate for engineered logjams and other in-stream structures. The report does not explain, statistically, how these conclusions were reached. Although we tend to be in agreement with the majority of the recommendations, we believe that blanket one-size-fits-all monitoring prescriptions for particular restoration categories may not always be appropriate, and that some discretion should be given to the monitoring organization to select an alternative approach if local conditions dictate that a different approach could work better. Likewise, we think the sample sizes and post-treatment sampling frequencies given in the table on page 17 should be viewed as guidelines, subject to modification if appropriate.

Stratification of sites selected for monitoring is absolutely necessary to deal with variability in habitat and fish response to restoration actions. Stratification is proposed by action type, region or ESU, and bankfull channel width. However, site variability might be better addressed by using the channel type classifications being employed in CHaMP rather than simple channel width. The channel type classes are likely to be more indicative of how a channel will respond to the addition of wood, bank armoring, or realignment than channel width. Use of the classification scheme being used by CHaMP also will provide some consistency between the data collected by these two programs.

Increased resolution and stratification of treatment types may be needed for the table that is provided on pages 13 and 14 of the report. For some actions, such as In-stream Structures, information on habitat objectives, structure designs, structure complexity, and materials will likely be needed to refine monitoring plans and improve interpretation of results. Discussion of methods of examining

combinations of treatments is also needed where stream reaches receive several types of restoration, for example combinations of in-stream structures (LWD/pool complexity), off-channel/floodplain reconnection (channel re-meandering) and riparian improvement (riparian fencing and/or planting). Although challenging, integrated treatment combinations are a common approach to achieving effective, long-term results and should be considered in the design of monitoring programs.

The emphasis about standardized reporting including the raw data presented on pages 7 and 8 is appreciated. One item not mentioned is that while the results and data are stored and presented in a standardized fashion, there is no mention of also retaining the various analyses in raw forms as well. In some cases, the results look puzzling and readers are unable to recreate the results. By having the actual analysis also stored, the results are truly reproducible in the future. BPA may also wish to provide some sample analysis templates, for example in R scripts, for use in future analyses in addition to specifying the hand computations as seen in the web-link to the example in the Appendix.

In Table 2 the AEM states that BACI is able to detect a long-term response. It is implicitly assumed in BACI that there is step response to treatment and that the step change remains constant over time. If the response is, for example, a short term increase followed by a decline towards the pre-treatment mean, the BACI design may not be suitable. Similarly, a long-term gradual change, for example a 3% improvement per year, is unlikely to be detected using BACI. The sample sizes presented at the bottom of Table 2 are somewhat misleading because the number of projects needed is not presented until Table 4. The values should not be construed as the time period needed by individual projects. This is particularly true for the one to three year time interval as cited for EPT – this requires a large number of projects to be replicated so that spatial replication replaces temporal replication.

Monitoring designs that deal with one of the potential impacts of climate change, that of increased variability in local weather resulting in more extreme disturbance events are needed. The designs in the AEM all basically look for changes in the mean response but do not look for increased variation. For example, increased variation in juvenile survival rates, even if the mean is constant over time, can have undesirable consequences, because one bad year could result in the loss of the entire cohort. The document needs to consider what monitoring designs might be used to detect increased variability in fish responses over time.

Some of the responses in Table 5, Key Measurements, may require further refinement. For example, to estimate juvenile fish growth, two measurements on the same fish are needed. Similarly, for the vegetation metrics, some plants are not visible at certain times of the year. While the proposed methods are sound, some care will be needed when combining multiple projects. An implicit assumption is that the change in the means will be roughly equal across the projects, that is, an additive effect where the absolute change is the same across all projects. The report did not mention multiplicative effects (that is, where productivity doubles at different sites starting from different baselines) or use of Bayesian models where the effect sizes are allowed to vary across projects but where effect sizes are centered about a common value. Bayesian analyses are a useful way to integrate findings over multiple projects without having to assume that the effects are equal.

2. Does this approach build on past, current, and planned habitat actions and associated monitoring to test action effectiveness?

The plan does indicate the approach that will be used to examine the effectiveness of existing habitat projects and those that will be implemented in the future. The design to be used will differ for existing and future projects, but the proposed designs are appropriate for their purpose. The inclusion of both new and existing habitat restoration actions in the monitoring design is a strong point of this plan.

While the approach considers most of the major restoration categories currently being undertaken in the Columbia Basin, we think two additional habitat restoration categories merit inclusion. The approach includes fish passage as an action category, but the authors seemed to have road crossings, irrigation screens, and push-up dams primarily in mind. We think there is another action that is worthy of a separate category – large dam removals. These projects are rare occurrences, but the potential for very significant increases in salmonid production suggests that dam removal deserves special consideration for monitoring. Examination of existing monitoring programs associated with dam removal projects – Marmot Dam, Hemlock Dam, Condit Dam, and even the Elwha Dams in northwestern Washington – can be used to help design monitoring efforts to accompany future tributary dam removals.

The second restoration action that may deserve its own category is food web manipulations, specifically the addition of salmon carcasses, carcass analogs, and inorganic nutrient additions to streams and lakes. Nutrients are included under in-stream structures in Table 1, but the report does not specify on page 14 the source of nutrients and instead recommends that nutrient manipulations should be monitored as part of IMWs. We are unaware of any IMWs at present that include nutrient manipulations among their monitored restoration actions, but carcass or carcass analog additions have been used in a number of Columbia Basin locations where they are believed to benefit aquatic food webs. However, the list of key measurements in Table 5 does not include habitat attributes that would serve as metrics of ecosystem response to nutrient manipulations, and therefore additional metrics would be needed in such situations.

Discussion is needed regarding ways to identify differences in treatment effectiveness that may be related to variation in design, placement and/or the intensity of treatment in a given area. Some differences can include things like the use of single versus multiple trees in LWD enhancement, anchoring versus no anchoring for in-stream structures, or use of stream simulation design versus hydraulic design for road crossing improvement.

The report noted that considerable information can be obtained by using post-treatment or retrospective study designs to evaluate restoration actions. Contextual information is likely to increase the information value of monitoring data if there is consideration of factors such as how long the treatment has been in place; projected or planned design life; determination if maintenance was planned and whether it has been performed; general notes on major disturbances to individual areas such as fires, floods, wind storms and anchor ice; and other non-BPA sponsored or major upslope restoration work, for example road improvements and thinning, and any major changes in water or resource management practices that may have occurred subsequent to restoration treatment.

The report needs to acknowledge the wide variation in design, treatment intensity, and placement relative to the channel thalweg. This is especially needed for “Fish passage” (structure modification, replacement or removal), “LWD/boulders/pools and complexity,” and “Engineered log jams/structures.”

It would also be helpful to address design life (durability and longevity) of treatments over time. It is likely that the effectiveness of certain restoration treatments diminishes over time, especially if there is no regular maintenance or replacement. This can have significant implications to costs and benefits over 15-20 years. Information from other effectiveness monitoring programs can be helpful. Examples include road restoration and sediment delivery monitoring program being conducted by USFS Rocky Mountain Research Station (it has extensive Columbia River Basin coverage and is providing very useful quantitative data) and the national fish passage effectiveness monitoring program which is currently being developed by the San Dimas Engineering Technical Development Center.[16]

The ISRP suggests that an integrated Bayesian approach could be a part of the AEM portfolio such as in the ISEMP document. As data are collected over time, better and better information will be available on the effectiveness of projects. In particular, use of a Bayesian method would lead progressively to a naturally defined "indicator" of an action's success from "unsure" to "some, but not strong evidence of effects," "good evidence of an effect," to "conclusive evidence of an effect." Then, monitoring effort can be shifted toward project categories in which the jury is still out, rather than continuing to monitor actions for which sufficient data have been collected to deem them generally successful or unsuccessful. This is illustrated in Figure 63 of the ISEMP report.

3. Does the document describe how information on project or site-level effectiveness will be used by efforts, such as IMWs and ISEMP, evaluating the effectiveness of the Basin's collective habitat work in realizing improvements at the fish population and watershed level?

The AEM document does not go into detail about how this effort would be linked or otherwise integrated into ISEMP and IMW efforts. It relies heavily on SRFB and Pacific Northwest Aquatic Monitoring Partnership (PNAMP) protocols, and the report does not provide a crosswalk between SRFB, PNAMP, ISEMP, or CHaMP even though those programs share many common monitoring objectives. More complete information about how data would be collected, by whom, how monitoring data would be analyzed and archived, and what organization would serve as the central data clearinghouse, would be very helpful.

The action effectiveness monitoring results that were described in the ISEMP and CHaMP reports are not mentioned in the AEM proposal. It would seem that an emphasis should be placed on ensuring that the AEM program is fully coordinated with CHaMP/ISEMP, but there is relatively little description in the AEM plan about coordination among these programs. The AEM results would be very useful for informing the status and trends information generated through CHaMP and the more detailed IMW-based research results generated by ISEMP if the monitoring methods and metrics among these three programs are consistent. CHaMP and ISEMP do intend to use the same habitat monitoring protocols. However, AEM plans to use methods developed by the SRFB monitoring program. There is insufficient detail provided in the AEM proposal to judge how compatible the SRFB methods are with those being used in CHaMP/ISEMP. At a minimum, a thorough crosswalk between the CHaMP/ISEMP metrics and methods and those for AEM/SRFB should be conducted prior to implementing the AEM effort. There also may be some synergies that could be maximized by using the same data archiving system for the

[16] Road restoration monitoring: http://www.fs.fed.us/GRAIP/downloads/case_studies/LegacyRoadsMonitoringStudies.shtml; also see http://www.stream.fs.fed.us/fishxing/index.html

three programs ISEMP, CHaMP, and AEM. Use of comparable analysis techniques, as appropriate, also would enhance the value of the data being collected by these efforts.

It is unclear whether sites selected for inclusion in the AEM program will include sites in IMWs. If all restoration actions in IMWs are being monitored as part of the ISEMP program, then focusing AEM outside these watersheds makes sense. However, if there are habitat restoration actions within IMWs that are not being monitored, it might be beneficial to include these sites in the AEM program. Embedding AEM sites in an IMW provides the opportunity to assess both site-scale responses and the contribution of restored sites to overall watershed productivity.

Some of the apparent disconnect between AEM and ISEMP/CHaMP may be related to the different sampling schemes used by the two approaches. For example, CHaMP used a GRTS site selection procedure and evaluates only habitat. AEM employs treatment and control sites, but these are more deliberately sampled. Perhaps if one/both of the sites are close to a GRTS point, that location should be considered as a site in the AEM approach.

The ISRP has some page-specific questions and suggestions:

A. We were unsure what year 0 sampling meant in Table 4. It was not until it was stated in one of the monitoring protocols that year 0 is the year before the project is done. As with dates labeled as BCE or CE, there should not be a year 0, except perhaps for the year when the alteration is done and little monitoring is done because no response is thought to have happened.

B. Page 16, line 8 - Should sites be spatial replication rather than temporal replication?

C. Page 35 – The discussion of estimates of precision and power analysis of the data sound like a retrospective power analysis, which may have limited use here.[17]

D. Page 35 - Confidence limits for data should read “confidence limits on parameters.” Projects should submit a copy of the code used to analyze the data, e.g. R script, JMP script, SAS script, etc.

E. Page 38 – The citation list needs to be re-checked.

[17] See Gerard, P., D.R. Smith, and G. Weerakkody. 1998. Limits of retrospective power analysis. Journal of Wildlife Management 62:801-807.

Summary Question

In sum, do these three documents describe a cost-effective, standardized, and statistically valid method for evaluating project-level effectiveness that improves on the uncoordinated habitat M&E currently implemented by individual projects?

The ISRP appreciates the hard work that has gone into ISEMP and CHaMP. Together, these companion projects have achieved major gains in the collection of habitat data, the elucidation of relationships between fishes and their habitats, and the effectiveness of tributary habitat restoration actions. We also appreciate that both ISEMP and CHaMP are works in progress, and that their organization, analytical tools, and data archiving will evolve as learning occurs. Without ISEMP and CHaMP, it is likely that uncoordinated habitat monitoring will continue and learning from our successes and failures will be hindered. The AEM plan provides a useful general framework for stratifying action effectiveness monitoring, but more details are needed, especially with regard to the integration of the AEM approach into ISEMP and CHaMP objectives.

Assuming AEM will collect data compatible with the CHaMP/ISEMP programs, these three efforts should provide valuable information on the productivity gains that can be achieved through habitat actions. This understanding has been lacking for the Columbia Basin, and elsewhere in the Pacific Northwest, and has likely severely hampered the effectiveness of restoration efforts over the last thirty years.

Other Comments

The ISRP continues to be concerned about the apparent lack of meaningful engagement and coordination with large monitoring and habitat effectiveness evaluation programs taking place on federal lands (PIBO and AREMP). More than half of the remaining accessible habitat for anadromous fishes in the Columbia River Basin is found on these lands. And federal land managers have a primary responsibility to conserve and restore riparian and aquatic habitat, including defining key management questions, identifying potentially complementary information from other organizations (for example, habitat data, watershed condition assessments, habitat condition/trend monitoring, or watershed-scale fish passage improvements at road crossings), opportunities for cost sharing, and potential needs and benefits of restoration called for by revisions to national forest management plans. Note that this is ongoing for northeast Washington and for northeast Oregon.

Some of the work done by both ISEMP and CHaMP collaborators represents novel and creative approaches that would be of interest to the broader restoration community. Publication of this information in peer-reviewed journals should be encouraged.

Attachment: Excerpt from Programmatic Issue #2 in the Council's final decision document for the RME and AP Review (pages 16-19)

Council recommendation: The recommendation is based squarely in the ISRP review conclusions. The Council supports, as did the ISRP, the concept of a coordinated, standardized approach to monitoring habitat characteristics and evaluating the effects of changes in those characteristics. We know the federal agencies are working, in the aftermath of the ISRP review and other comments and developments, to reshape the implementation plan for the CHaMP project (and possibly the related ISEMP research effort) and to make additional progress on the other elements of the habitat effectiveness monitoring and evaluation framework. In the best example, at the Council's Fish and Wildlife Committee meeting in Hood River, Oregon, on May 10, NOAA Fisheries staff presented at length on the "Implementation of the FCRPS BiOp Tributary Monitoring and Evaluation Framework." With some obvious differences (especially about the pace of the implementation of the CHaMP project), much of what NOAA presented is consistent with the principles recommended below by staff. The Council expects continued benefits from continued cooperation and communication between NOAA and the Council on this issue.

The Council calls for the federal agencies to follow or incorporate the following principles in this effort:

- Revise the CHaMP project and implementation plan and further develop the other elements of the habitat monitoring and evaluation effort consistent with the ISRP's review conclusions *and* do so *in collaboration with* the ISRP and the Council and its staff, as well as the basin's other participants in habitat monitoring and evaluation. This cannot be simply a federal agency effort imposed on the Fish and Wildlife Program, even as the Council is also sensitive to the federal agencies' need to meet Biological Opinion requirements. An overarching goal should be that what is developed and implemented is a cost-effective, standardized, independent, statistically valid approach for evaluating habitat effectiveness. Decisions regarding the implementation and sequencing of CHaMP should be driven primarily by how well the scientific review issues have been addressed and not by other considerations.

- Implement the CHaMP project through an incremental approach, consistent with the ISRP's review conclusions. This means:

    - Begin by implementing the CHaMP project *only* in "a subset of CHaMP watersheds at geographically diverse locations in the Columbia Basin where restoration is occurring and where both habitat and fish population monitoring are sufficiently developed so that CHaMP can build on existing strong RM&E efforts, such as in intensively monitored watersheds." The federal agencies should consult with the Council and others before deciding in which basins to initiate the incremental effort. The basins chosen should allow for the best opportunities to relate, align and integrate the habitat status and trend monitoring data with the monitoring of the status and trends of fish population characteristics. If possible, the chosen basins should also

provide good opportunities for exploring how to coordinate the CHaMP approach with the existing habitat monitoring efforts of other entities.

- Implement the monitoring protocols in the subset of the basins in such a way as to:
  - flexibly and rigorously field-test the proposed sampling methods and the appropriateness or value of the habitat characteristics chosen for monitoring;
  - include some monitoring of "non-standard" (in CHaMP terms) metrics and methods to evaluate their value;
  - continue the dialog with other monitoring groups to resolve as much as possible the differences in approaches to habitat monitoring, including the use of side-by-side field comparisons of various protocols as part of the pilot effort;
  - develop and assess the relation of the habitat monitoring to the fish status and trend monitoring in the same basin;
  - as part of developing and assessing the pilot basin approach, develop and test methods of scaling up site-specific habitat conditions to watershed- and subbasin-scale indicators of habitat quality;
  - explore whether monitoring more sites less intensively may be more valuable than monitoring fewer sites more intensively;
  - develop to a satisfactory level the methods for the transfer of information, technology and expertise to the people and entities participating in CHaMP; and
  - clearly identify the roles for the various cooperators in the CHaMP effort (e.g., data collection only, responsible for producing analysis of the monitoring effort either separately or as part of a collective effort, etc.)

- The CHaMP project sponsors, working with their agency partners, should develop a "lessons learned" report based on the experience in the pilot subbasins that includes any proposed revisions to the protocols and methods based on what has been learned; a review of how well the habitat and the population monitoring has been linked or integrated; and any proposals to ramp up the implementation of CHaMP. The ISRP and then the Council should review this report and the proposals for future work favorably *before* the federal agencies ramp up the implementation of CHaMP into other basins. Decisions on whether to continue or ramp up implementation of the CHaMP monitoring effort will also depend on progress made in developing and reviewing the other elements of the habitat effectiveness framework (*see* below).

- As the federal agencies implement the CHaMP project in an incremental fashion, Bonneville should work with the Council, NOAA and other participants on a transition plan as to how to implement and/or phase out separate projects involved in the monitoring and evaluation of habitat characteristics. Projects involved in the monitoring of fish population status and trends should, as a general matter, be implemented for the time being, with the possibility of reshaping those projects as needed upon further experience with the implementation of CHaMP and its relation to fish population monitoring.

- During the initial pilot phase, Bonneville and NOAA Fisheries will meet at least quarterly with the Council's Fish and Wildlife Committee to report on progress with

field testing monitoring protocols, techniques and methodologies as implementation in the pilot subbasins is carried out.

- Within one year, NOAA and Bonneville, working with other relevant participants, should further develop the analytical, evaluation and reporting elements of the habitat effectiveness monitoring and evaluation effort to accompany the CHaMP monitoring, consistent with the ISRP's review conclusions. The agencies should then produce a clear statement about those elements for the ISRP and Council to review. The statement should include:

    - A description of the analytical methods and models to be used to evaluate the monitoring data relevant to habitat effectiveness and how these methods and models will be used so as to incorporate or respond to the ISRP's review conclusions. Include an evaluation of how the different models and methodologies compare, such as SHIRAZ and EDT and the use of expert panels, and how the output of these methods and models will be used in further decisions on the implementation of habitat actions.

    - Explain how, within these analytical methods and models, the habitat status and trend monitoring data will be related to and integrated with the status and trends of fish population data in order to evaluate the effectiveness of specific restoration strategies or general restoration effectiveness in a geographic area. Explain how the analysis will develop robust, accurate relationships between the VSP parameters for target fish species and changes in habitat condition that are related to restoration, or continued habitat degradation, in the CHaMP watersheds.

    - Explain how the results of the ISEMP Intensively Monitored Watershed research efforts will be integrated into this analysis. Consider whether and to what extent it is important to continue the distinct IMW effort and at what scale.

    - Explain how the evaluation results will be regularly and publicly reported and used to guide decisions on the implementation of habitat actions in the future.

    - During the development phase, Bonneville and NOAA Fisheries will meet at least quarterly with the Council's Fish and Wildlife Committee to report on progress with developing the analytical, evaluation and reporting elements of the CHaMP monitoring protocols.

- All projects involved in this review that are part of the overall habitat effectiveness monitoring and evaluation effort will receive implementation recommendations consistent with these principles, allowing for significant reshaping of the projects as the elements are better developed and reviewed. The Council expects the main focus of any reshaping to be primarily on CHaMP and other habitat monitoring projects.

- With regard to the monitoring and evaluation of how effective specific habitat projects are at obtaining and sustaining targeted changes in habitat characteristics (project effectiveness): Within the year Bonneville and its partners should develop for ISRP

review a proposal to transform that effort away from monitoring work elements on individual projects into a cost-effective, independent third-party, standardized, and statistically valid method for evaluating project-level effectiveness. This transformation should be ready in time for the geographic review of habitat actions. Also, the development and review of analytical methods and models called for above should include consideration of how to use information on project or site-level effectiveness in the overall evaluation of the effectiveness of our collective habitat work in realizing improvements in habitat and fish characteristics at the population and watershed level.