



**Independent Scientific Review Panel**

for the Northwest Power & Conservation Council

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# Review of the Columbia Habitat Monitoring Program (CHaMP) Protocols

Part of the Research, Monitoring, and Evaluation and Artificial Production Categorical Review of  
the Integrated Status and Effectiveness Monitoring Program (ISEMP; Project # 2003-017-00)  
and Columbia Habitat Monitoring Program (CHaMP; Project #2011-006-00)

ISRP 2011-10  
March 30-2011

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# ISRP Review of the Columbia Habitat Monitoring Program (CHaMP) Protocols

## Summary

CHaMP is an ambitious monitoring project that attempts to provide long-term habitat status and trend data needed to relate changes in fish populations to tributary habitat restoration actions over a large portion of anadromous salmonid habitat in the Columbia River Basin. It is an important companion to the ISEMP project, even though CHaMP and ISEMP sampling locations are not always the same.

The ISRP was impressed by many aspects of the CHaMP sampling protocols. However, we note that consensus among major habitat monitoring organizations with respect to the most effective protocols for tracking habitat attributes and metrics has not yet occurred. We recommend that the CHaMP team 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. We also suggest that 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.

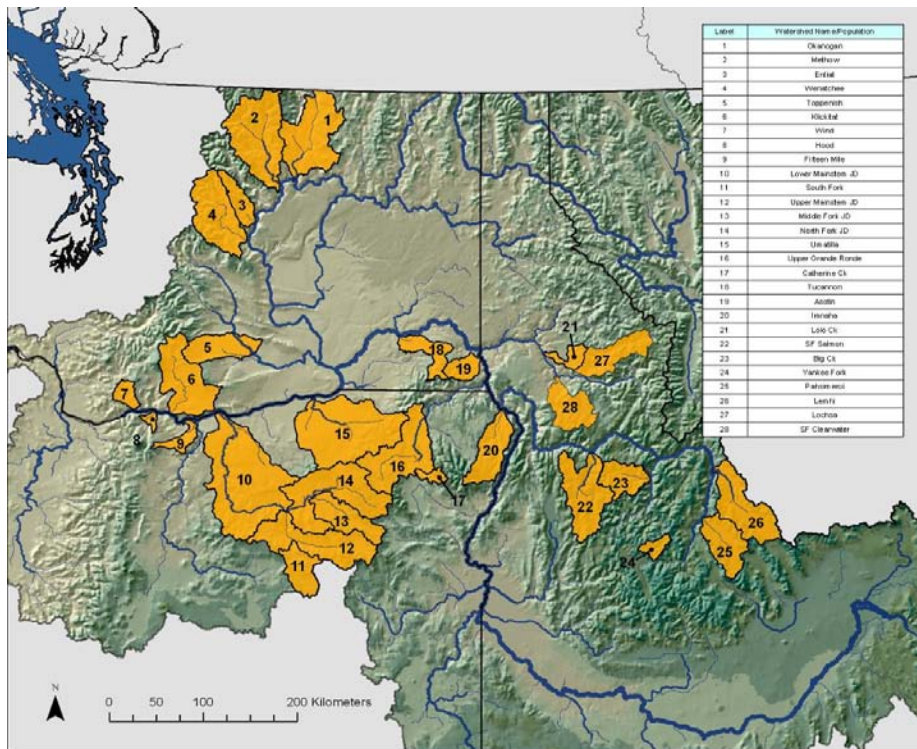
Additionally, simulations could be used to examine the properties and sensitivity of large-scale metrics of habitat change, as well as to compare and contrast the conclusions of CHaMP analytical tools (e.g., the SHIRAZ model) with other widely used habitat models such as EDT. The most pressing need, we feel, is to 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.

We believe that some CHaMP protocols need additional refinement and testing, and therefore recommend that project partners focus initial activities on 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 ISRP would like to review 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. In addition, we would like to review the ISEMP “lessons learned” report when it is released.

## Introduction

The Columbia Habitat Monitoring Program (CHaMP) began as a collaboration of federal, state, tribal, and private sector partners after release of the 2008 Biological Opinion for the Federal Columbia River Power System (BiOp), as modified by the 2009 Adaptive Management

Implementation Plan (AMIP).<sup>1</sup> The BiOp calls for habitat restoration in tributaries as a means of mitigating losses of salmon and steelhead through operation of the mainstem Columbia and Snake River hydroelectric system. The purpose of CHaMP is to provide a set of protocols for monitoring fish habitat status and trends throughout the portion of the Columbia and Snake River systems that are accessible to anadromous salmonids, or which affect the quality of habitat in those tributary systems inhabited by salmon and steelhead. CHaMP is closely tied to, but has a different emphasis than, the Integrated Status and Effectiveness Monitoring Program (ISEMP).<sup>2</sup> ISEMP was initiated by NOAA Fisheries in 2003 with the intent of developing a region-wide Research, Monitoring, and Evaluation (RME) program, with particular emphasis on monitoring selected populations of ESA-listed anadromous salmonids using a combination of status and trend analyses and experimentally manipulated, intensively monitored watersheds (IMWs). CHaMP habitat monitoring protocols are being used in some, but not all, of the sites currently being studied by ISEMP. The following map shows the location of the 26 watersheds for which CHaMP protocols are proposed for implementation.



The ISRP has reviewed the ISEMP program or components of this program on several occasions. However, 2010 was our first opportunity to examine CHaMP as part of the Categorical RME solicitation. In our review we complimented the CHaMP emphasis on developing standardized data collection methods and spatially balanced and randomized sampling to bring more consistency to monitoring efforts in the Columbia River Basin. However, details on sampling methods, site selection, and data management had not at the time been completely formulated. Therefore, the ISRP recommended the project with the following

<sup>1</sup> <http://www.nwr.noaa.gov/Salmon-Hydropower/Columbia-Snake-Basin/Final-BOs.cfm>

<sup>2</sup> <http://www.nwfsc.noaa.gov/research/divisions/cbd/mathbio/isemp/index.cfm>

qualification: “*The ISRP recommends that ISEMP organize a one-day workshop to discuss the CHaMP approach with the ISRP/ISAB and others. A draft of CHaMP should be circulated to the ISRP/ISAB before the workshop. Specific issues at the workshop should include how previously collected data can be or have been incorporated into CHaMP databases. It would also be useful to summarize how ISEMP priorities have evolved over the years, as well as a publication strategy.*”

On January 25, 2011, CHaMP partners completed a 2011 Working Version 1.0 Scientific Protocol for Salmonid Habitat Surveys within the Columbia Habitat Monitoring Program.<sup>3</sup> The protocols were sent to a variety of federal, state, and tribal habitat monitoring organizations for comments. On February 10, 2011, the CHaMP workshop took place in Portland with a group of ISRP members interested in habitat restoration, CHaMP partner representatives and interested parties, and two Council members and several Council staff. After the workshop, the ISRP received copies of comments on the CHaMP protocols from several state, federal, and tribal organizations with an interest in basinwide habitat monitoring.

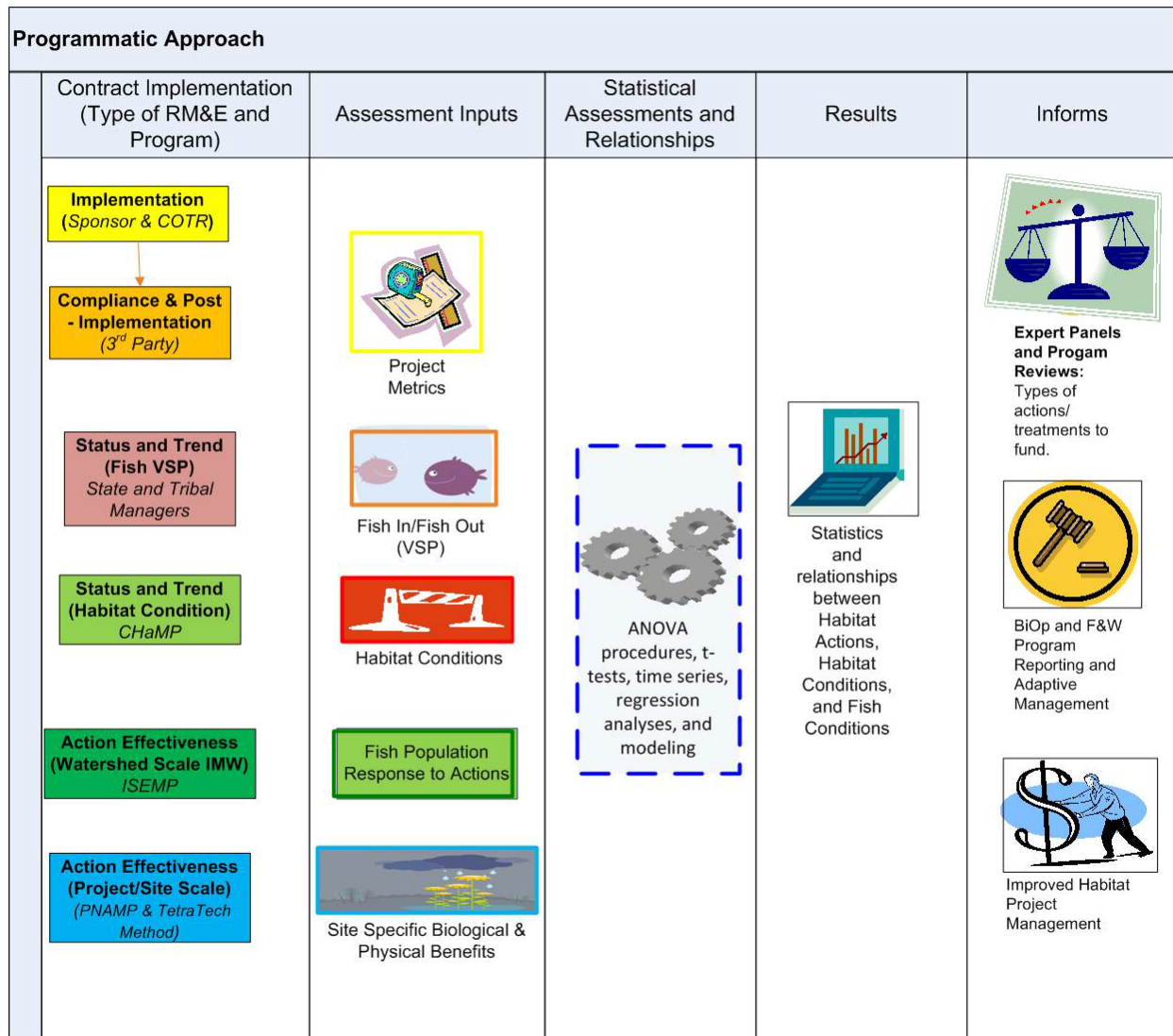
CHaMP is not entirely funded by BPA through the NPCC’s Fish and Wildlife Program. Some of the support for CHaMP is provided by the National Oceanic and Atmospheric Administration (NOAA) and Bureau of Reclamation (BOR). Nevertheless, the CHaMP program relies on BPA funding for a substantial portion of its implementation costs and therefore the goals of CHaMP should be aligned with the Council’s 2009 Fish and Wildlife Program as well as the reasonable and prudent alternative actions (RPAs) for tributary habitat monitoring in the 2008 BiOp. CHaMP is relevant to the following elements of the Council’s Program:

- Emphasizes implementation of fish and wildlife projects based on needs identified in locally developed subbasin management plans (these plans are included in the Fish and Wildlife Program) and also on actions described in federal biological opinions on hydropower operations, hatcheries, and harvest, Endangered Species Act recovery plans, and the 2008 Fish Accords signed by federal agencies, Indian tribes, and the states of Idaho and Montana
- Focuses on protecting and restoring habitat in order to rebuild healthy, naturally producing fish and wildlife populations
- Increases project performance and fiscal accountability by establishing reporting guidelines and using adaptive management to guide decision-making
- Commits to a periodic and systematic exchange of science and policy information
- Emphasizes a focused monitoring and evaluation framework coupled with a commitment to use the information obtained to make better decisions
- Calls for a renewed regional effort to develop quantitative biological objectives for the program

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<sup>3</sup> Scientific Protocol for Salmonid Habitat Surveys within the Columbia Habitat Monitoring Program (CHaMP)  
<http://www.pnamp.org/node/3141>

Perhaps the best way to visualize how CHaMP fits into a larger coordinated strategy for tracking and understanding the effectiveness of restoration projects is through the following diagram, which was presented at the February 10 workshop. The diagram displays the various elements of a basinwide effectiveness RME effort that is intended to achieve both the goals of the 2008 BiOp and the Council’s Fish and Wildlife Program. The CHaMP program is depicted in the green box under the Contract Implementation heading. What the diagram does not expressly depict, however, is the connection between CHaMP and ISEMP (including its network of intensively monitored watersheds) and the PNAMP effectiveness monitoring effort.



The purpose of this review is to summarize the ISRP’s comments on the February 10, 2011, workshop and on the 2011 CHaMP Version 1.0 protocols. It is clear from the comments of other organizations engaged in habitat monitoring that the CHaMP protocols for some field and analytical methods have not reached consensus status, i.e., there is still disagreement about the most effective way to locate, measure, or express certain physical habitat attributes. At this time the ISRP does not take a position on the methods of measuring physical habitat; however, we do

comment on other potentially limiting factors that might be overlooked (e.g., food webs, exposure to toxic compounds, and habitats downstream from CHaMP sampling locations, including the mainstem, estuary and ocean). Issues of accuracy, precision, and cost-effectiveness will eventually be resolved by field practitioners with ISRP advice where appropriate, and in any case new methods are constantly being developed and incorporated into monitoring programs. Rather, our objective is to provide assistance to CHaMP and other large-scale tributary habitat monitoring programs with respect to study design, coordination, data sharing and reporting, and use in adaptively managing restoration actions. Additionally, our review is intended to assist the Northwest Power and Conservation Council in evaluating how well the research, monitoring, and evaluation components of the Fish and Wildlife Program are being implemented in the field.

### **ISRP View:**

The CHaMP project originated in response to the need for a coordinated habitat monitoring program that would permit the assessment of habitat status and trends in subbasins where restoration actions are taking place. CHaMP objectives appear to be consistent with elements of the Council's Fish and Wildlife Program. However, CHaMP enters an arena already crowded with many large-scale habitat monitoring efforts, and full endorsement of CHaMP by other monitoring entities has not yet occurred. It may be unrealistic (or even undesirable) to expect that the CHaMP protocols will become the *de facto* monitoring approach throughout the Columbia River Basin; however, the ISRP applauds the CHaMP effort to bring more consistency to habitat monitoring, and to outline a program where status and trend information can be incorporated into restoration decision-making.

### **CHaMP protocols**

The following quotes were taken from an opening presentation at the February 10 workshop and provide additional background information on the current status of the CHaMP program:

*Pilot projects started in 2003 as ISEMP Wenatchee, Methow, and Entiat river basins in the Upper Columbia River, the Lemhi and South Fork Salmon river basins, and the John Day River Basin to pilot and test action effectiveness and status monitoring approaches.*

*These pilot projects became the IMW element of the program, which now covers 9 watersheds. A "lessons learned" report for 2003-2010 will be compiled and presented later this year to inform the management questions, demonstrate progress, and guide decision makers implementing offsite mitigation habitat projects.*

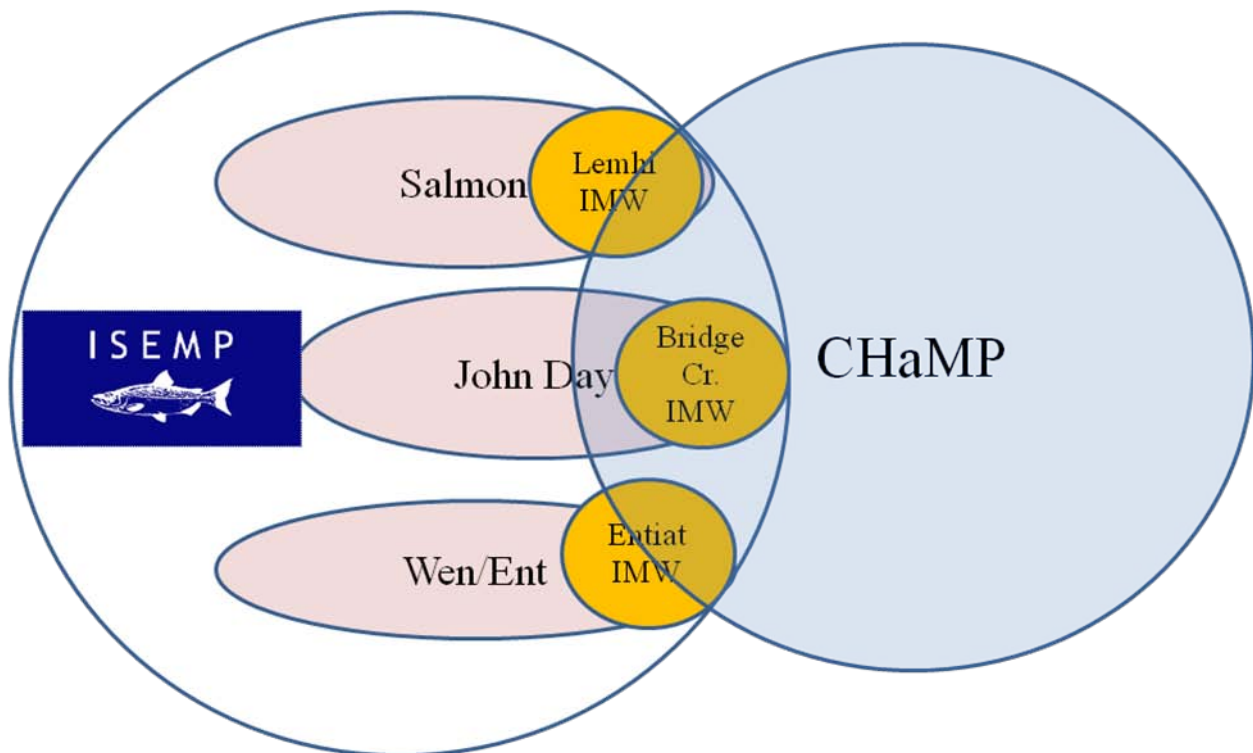
*CHaMP projects provide habitat status monitoring for an additional 15 watersheds, as identified in 2009 and 2010 BiOp RM&E Recommendations Reports and Skamania ASMS [Anadromous Salmonid Monitoring Strategy].*



*CHaMP complements the IMWs and uses the same habitat parameters and protocols, but with less intensity of effort.*

*Together, the IMWs and CHaMP projects will cover at least one population per [Major Population Group] MPG.<sup>4</sup> Parallel fish population monitoring for CHaMP watersheds is being implemented under other projects.*

The intersection between CHaMP and the ISEMP project is illustrated in the following diagram presented at the February 10 workshop. Note that the CHaMP protocols have been evaluated in a limited number of sites; at the workshop, the Bridge Creek site (John Day subbasin) was highlighted. The designation IMW is for intensively monitored watersheds.



**ISRP View:**

The conceptual linkage between CHaMP and ISEMP was outlined at the February 10 workshop, but the overlap between fish population status and trend monitoring, led by ISEMP and state and tribal organizations, and habitat status and trend monitoring, led by CHaMP, seems to be restricted to relatively few locations at present. Until there are more streams where population and habitat data are gathered concurrently, some of the assumptions in CHaMP about the relationships between VSP parameters (fish population abundance, productivity, spatial structure, and diversity) and habitat attributes will

<sup>4</sup> An MPG is a group of independent populations nested within a salmon ESU that serves as a management unit for salmon recovery.

remain unverified over a range of field conditions. We believe ISEMP intends to use intensively monitored watersheds to provide the basis for relating habitat restoration to changes in population characteristics, but the utilization of CHaMP in other (non-IMW) watersheds where fish populations are being monitored was not thoroughly explained, including whether the sampling protocols would facilitate an evaluation of restoration effectiveness on fish populations.

CHaMP watersheds were selected to represent at least one population within each steelhead and spring Chinook MPG, as opposed to using a stratified random procedure or some other method for selecting watersheds for monitoring. Given CHaMP's approach for selecting watersheds, it remains to be demonstrated how well the results obtained through the CHaMP project can be extrapolated to unmonitored watersheds within the interior Columbia River Basin.

It was not clear to the ISRP how ISEMP and CHaMP, in evaluating restoration effectiveness, propose to accommodate factors affecting fish populations downstream from CHaMP sampling locations (non-wadeable areas downstream of CHaMP sampling sites, including the mainstem, estuary and ocean). Factors such as hydrosystem operation, food web structure, and exposure to agricultural, industrial and urban chemicals could potentially confound determinations of restoration effects on productivity and spatial structure in a drainage system of interest. Each tributary will have a different suite of downstream influences that will add to the difficulty of generalizing effectiveness monitoring results from one area to another.

#### A. General observations on habitat survey protocols, and habitat metrics/indicators

The following habitat protocols and metrics will be obtained by 3-person field crews at each location identified in the GRTS (generalized random tessellation stratified) site selection grid discussed below. According to the CHaMP Version 1.0 protocols, all habitat attributes in the table below will be measured at each site in a 1-day period.

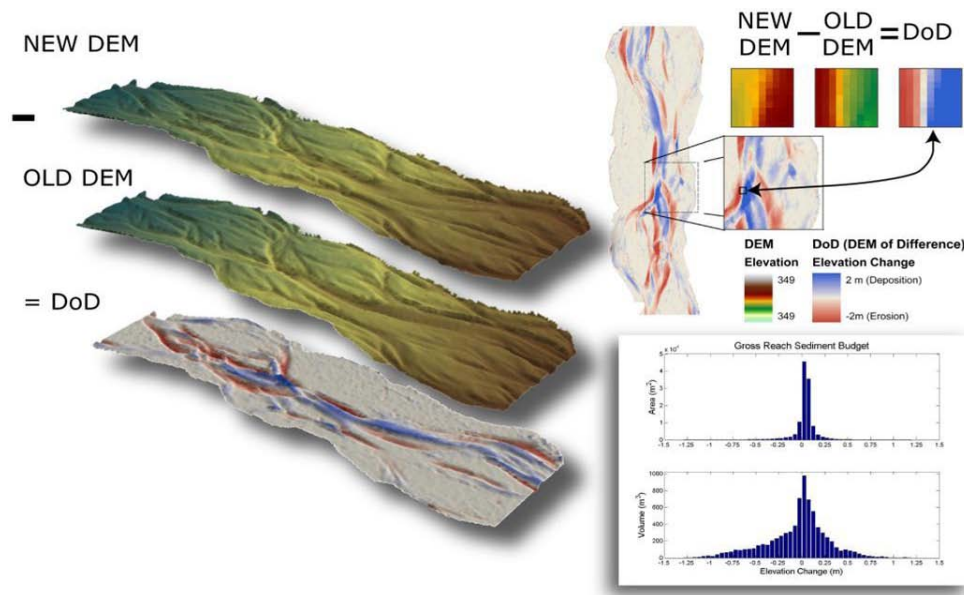
Table 1. The metrics and indicators used in the CHaMP protocol and the inference design underlying each indicator.

Indicator	Units	Inference Domain	Inference Design	Inference Method	Metrics	Indicator Generation Process	Software	Fish Response Category	Life Stage
Average Alkalinity	Milli-equivalent per liter	Survey frame	Mean, variance over inference domain, annually	Design-based	Site measurement of alkalinity	Estimated annually for entire survey frame with sampling design-based algorithm.	SP Survey	Survival	Parr to smolt
Average Conductivity	Micro-Siemens per meter	Survey frame	Mean, variance over inference domain, annually	Design-based	Site measurement of conductivity	Estimated annually for entire survey frame with sampling design-based algorithm.	SP Survey	Survival	Parr to smolt
Average pH	pH	Survey frame	Mean, variance over inference domain, annually	Design-based	Site measurement of pH	Estimated annually for entire survey frame with sampling design-based algorithm.	SP Survey	Survival	Parr to smolt
Growth Potential	Degree grams	Survey frame	Mean, variance over inference domain, annually	Design-based	Site measurement of drift biomass and temperature	Estimated annually for entire survey frame with sampling design-based algorithm for the product of drift macroinvertebrate biomass and temperature	SP Survey, Thermal Dynamic Model	Growth	Parr to smolt
Percent Below Summer Temperature Threshold	Percent	Survey frame	Total length estimated over survey domain, annually	Model-based	Year-round temperature logger data from sites	Model-based inference for all stream reaches in the watershed based on a continuous stream temperature model calibrated with site specific temperature logger data	Thermal Dynamic Model	Growth	Parr to smolt
Percent Above Winter Temperature Threshold	Percent	Survey frame	Total length estimated over survey domain, annually	Model-based	Year-round temperature logger data from sites	Model-based inference for all stream reaches in the watershed based on a continuous stream temperature model calibrated with site specific temperature logger data	Thermal Dynamic Model	Growth	Parr to smolt
Velocity Heterogeneity	Index	Valley type nested in survey frame	Mean, variance over inference domain, annually	Design-based	Modeled velocity heterogeneity at a site	Estimated annually for valley types nested in the survey frame with sampling design-based algorithm for variance Froude number across a site.	SP Survey, Hydrologic model	Growth	Parr to smolt
Embeddedness of Fast water Cobble	Percent	Valley type nested in survey frame	Mean, variance over inference domain, annually	Design-based	Average of site embeddedness measurements	Estimated annually for valley type nested in the survey frame with sampling design-based algorithm for riffle cobble embeddedness.	SP Survey	Survival	Eggs/Alevin

Indicator	Units	Inference Domain	Inference Design	Inference Method	Metrics	Indicator Generation Process	Software	Fish Response Category	Life Stage
Pool Frequency	Count per meter	Valley type nested in survey frame	Mean, variance over inference domain, annually	Design-based	Site measurement of pool frequency	Estimated annually for valley type nested in the survey frame with sampling design-based algorithm for pool frequency.	SP Survey, River Bathymetry Toolkit	Growth	Parr to smolt
Channel Complexity	Index	Valley type nested in survey frame	Mean, variance over inference domain, annually	Design-based	Site measurements of depth, width, and thalweg sinuosity	Estimated annually for valley type nested in the survey frame with sampling design-based algorithm for variance in depth, variance in width, and variance in thalweg sinuosity.	SP Survey, River Bathymetry Toolkit	Growth	Parr to smolt
Channel Score	Index	Valley type nested in survey frame	Mean, variance over inference domain, annually	Design-based	Site measurements of channel unit volume, LWD, and substrate	Estimated annually for valley type nested in the survey frame with sampling design-based algorithm metrics necessary for RP100 calculations as used by PIBO, AREMP, and EMAP.	SP Survey, River Bathymetry Toolkit	Growth	Parr to smolt
Residual Pool Volume	Cubic meter	Valley type nested in survey frame	Mean, variance over inference domain, annually	Design-based	Site measurement of residual pool volume	Estimated annually for valley type nested in the survey frame with sampling design-based algorithm for residual depth of all pools as given by the site DEM.	SP Survey, River Bathymetry Toolkit	Growth	Parr to smolt
Subsurface Fines	Percent	Valley type nested in survey frame	Mean, variance over inference domain, annually	Design-based	Site measurement of subsurface fines	Estimated annually for valley type nested in the survey frame with sampling design-based algorithm for subsurface fines.	SP Survey	Survival	Eggs/Alevin
Total Drift Biomass	Gram per square meter	Survey frame	Mean, variance over inference domain, annually	Design-based	Site measurement of total drift biomass	Estimated annually for valley type nested in the survey frame with sampling design-based algorithm for total drift biomass.	SP Survey	Growth	Parr to smolt
Bank Angle	Percent	Valley type nested in survey frame	Mean, variance over inference domain, annually	Design-based	Site measurement of bank angle	Estimated annually for valley type nested in the survey frame with sampling design-based algorithm for bank angle from site DEM and channel unit delineation.	SP Survey, River Bathymetry Toolkit	Growth	Parr to smolt
LWD Volume	Cubic meter	Valley type nested in survey frame	Mean, variance over inference domain, annually	Design-based	Site measurement of LWD Volume	Estimated annually for valley type nested in the survey frame with sampling design-based algorithm for LWD volume.	SP Survey	Growth	Parr to smolt



The digital elevation maps (DEMs) created by the surveys can be used to track habitat changes and sediment movements over time at a very fine scale, and they can be linked sequentially together to generate a topographic map of an entire stream system. CHaMP and ISEMP are partially supporting refinement and application of a “River Bathymetry Toolkit” that can be used to summarize changes in channel morphology over large areas. The toolkit can use remotely sensed high resolution data (e.g., green LiDAR) that can substitute for ground surveys, thus saving time and expense. The following graphic illustrates how sequential DEMs can be compared to display changes over time (DOD stands for DEM of Difference in channel form over two surveys).



### **ISRP View:**

The CHaMP habitat protocols and metrics represent a very ambitious set of measurements that will require careful training of field crews and implementation of quality control measures to ensure data accuracy and precision. At the workshop, CHaMP personnel stated that a 3-person crew could sample a site per day on average. We think this may be optimistic for sites that are located in roadless areas or sites that are otherwise difficult to access, given the large number of habitat attributes and the time required for digitizing channel morphology. The ISRP notes that all surveys will be conducted during the period of summer low flows. This will provide a detailed picture of summer habitat conditions but may be inadequate for characterizing habitat during other seasons. When questioned about the possibility of dropping indicators that might not yield useful information, thus saving time and expense, the CHaMP staff indicated they would be willing to do so.

The rationale for not adopting existing monitoring protocols (e.g., EMAP, PIBO, ODFW’s Aquatic Inventories Project) could have been made more apparent by the CHaMP team. Presenters at the workshop indicated that existing habitat assessment

protocols have different objectives than CHaMP and so would not be applicable, but they did not explain clearly why other protocols were insufficient to meet CHaMP objectives. It seems likely, given the scope and objectives of large habitat monitoring efforts, that CHaMP surveys and surveys by other monitoring organizations may take place in the same watershed. If this occurs, we encourage CHaMP and those organizations to share data for the purpose of comparing results, increasing replicate samples, and establishing a basis for habitat variability during the period of summer low flow.

It was also unclear how much flexibility would be allowed in implementation of the protocols to deal with possible field constraints such as limited time available for sampling, problems posed by weather conditions, and logistic difficulties in sampling particular sites. Will all the measurements proposed by CHaMP be expected to be made at all sites in CHaMP watersheds, or will surveyors have some discretion based on local conditions? Are all the measurements and commensurate metrics equally important, or are some more important than others? What procedure will be given to prioritizing measurements and metrics, identifying those that are most essential and should be collected at all sites? Although briefly mentioned, it would have been useful to have had additional discussion of methods that will be used to compare data collected under CHaMP with legacy (historical) data collected following different protocols than CHaMP.

We are still not sure how habitat status and trend monitoring data will be related to (integrated with) status and trends of fish population data within CHaMP watersheds to evaluate the effectiveness of specific restoration strategies or general restoration effectiveness in a geographic area (e.g., are the co-managers in a given subbasin successful in restoring stream habitat in their area?). It was unclear which entity or entities will be responsible for conducting fish status and trends monitoring at CHaMP sites, what kinds of fish data would be collected (e.g., site/reach-specific abundance sampling or fish in- fish out), and what kinds of analytical methods will be used to relate fish status and trends to habitat status and trends. CHaMP indicated that fish population surveys are not being carried out simultaneously with the habitat measurements, although it was their hope that ISEMP and other cooperators would be able to provide fish demographic data that could be associated with the habitat surveys. The linkage between fish and habitat monitoring in CHaMP watersheds requires development.

The ISRP understands that a primary objective of CHaMP is to track status and trends in stream habitat condition over large areas using a spatially balanced sampling approach and that this objective does not, by itself, require corresponding fish population data. However, the corollary objective of determining habitat restoration effectiveness *does* require fish demographic data in order to establish a causal link between habitat change and fish performance. Establishing this connection, we believe, is the primary purpose of intensively monitored watersheds. However, in those CHaMP watersheds where restoration actions are taking place, but which do not have experimentally controlled restoration treatments as in the IMWs, the ISRP feels that there is still great value in collecting both habitat and fish data at as many sites as possible in order to verify assumptions about relationships between habitat conditions and fish populations.

The ISRP believes that the description of life stages influenced by various habitat measurements could be more refined. In many cases, the life stage affected by a given habitat attribute was identified as “parr to smolt.” However, we believe this may be too coarse. Where possible, seasonal or age class effects could be noted, and this would help illuminate how some restoration actions are influencing VSP parameters.

It is unclear how the results obtained from monitoring individual sites within a watershed can be “rolled up” to the entire watershed to advance generalizations about status and trends in habitat condition for the watershed as a whole. In addition to its role in restoration effectiveness monitoring, CHaMP provides an opportunity to assess future habitat degradation, which is largely ignored at this time. Evaluation of how other results obtained from monitoring individual sites within a watershed can be “rolled up” to a landscape scale should be considered (see O’Neill et al. 1997<sup>6</sup>; Ruiz-Jaen and Aide 2005<sup>7</sup>; Urban 2005<sup>8</sup>).

The habitat and fish modeling workshop (February 8 and 9, 2011) which preceded the CHaMP workshop at the Council offices in Portland, served to display the capabilities of current practitioners and the potential of simulation modeling as a planning, predictive, and analytical tool for evaluating restoration effectiveness, as CHaMP portends. Practitioners agreed there is room for improvement in development and parameterization of habitat and fish population models. Habitat-based prediction of fish population capacity and productivity, as well as the potential responses to restoration treatments, was demonstrated in several presentations.

However, it was also evident that these results can be confounded by several factors, including, for example:

- the presence of hatchery fish (which affect wild fish productivity and capacity and display different VSP values than wild fish)
- variable composition of the fish community
- non-native fishes (introductions and invasions)
- factors outside of the watershed (e.g., ocean survival and growth, in-river passage), and
- climate change.

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<sup>6</sup> Explores landscape approaches to environmental monitoring with a focus on biotic diversity, watershed integrity, and landscape stability. Combines remote imagery, GIS, and landscape ecology principles to monitor landscapes. “Monitoring environmental quality at the landscape scale.” O’Neill, R.V. et al. 1997, *BioScience*.

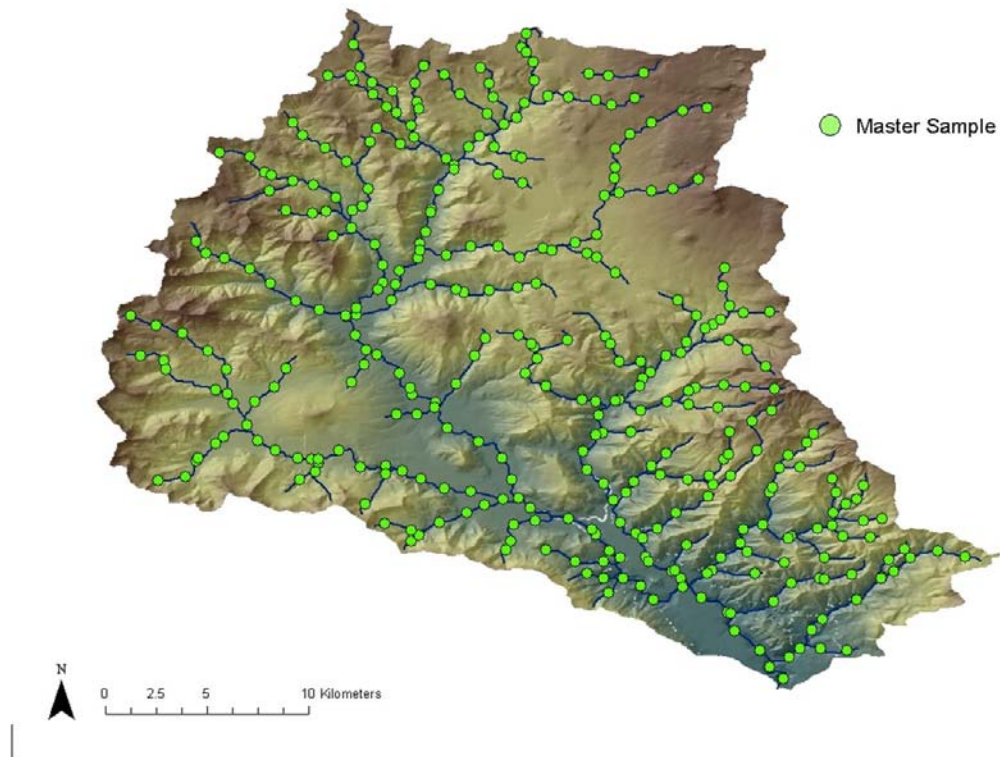
<sup>7</sup> Reviews how restoration success has been evaluated in restoration projects and compare these results with attributes identified by the Society of Ecological Restoration International that should be considered when evaluating restoration success. Three ecosystem attributes identified: diversity, vegetative structure, and ecological processes. “Restoration success: How is it being measured?” Ruiz-Jaen, M.C. and Aide, T.M., 2005, *Restoration Ecology*.

<sup>8</sup> Uses simulation modeling to relate fine scale ecological processes to large-scale management and environmental policy. Intent of modeling is to simplify the model while retaining details essential for larger-scale applications. Uses graph theory, hierarchical perspective, and meta-models. “Modeling ecological processes across scales.” Dean Urban, 2005, *Ecology*.

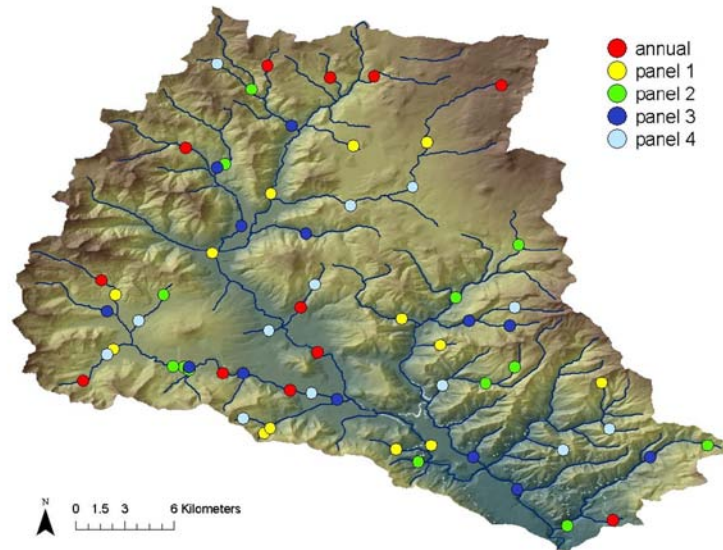
All of these factors require further exploration in theory and in the field, and affect the number of years and watersheds that shall be required in an experimental treatment-control setting to establish proof of concept. Despite the progress and promise of simulation modeling, the protocols and application of CHaMP will be very much challenged by these limitations.

## B. Sampling design and site selection

CHaMP employs a spatially balanced, probabilistic design – GRTS, the method used in EPA’s EMAP and ODFW’s habitat programs – which allocates sampling sites in watersheds possessing at least one population within a MPG of spring Chinook or steelhead. Potential sampling locations include all stream segments in wadeable, perennial channels below natural impassable barriers to migration. CHaMP will sample 25 sites, selected from a larger number of candidate locations, annually in each watershed. In some watersheds the same 25 sites will be sampled each year; in others, some of the sites will be sampled annually and the balance will be sampled every few years on a rotating basis. The following maps of the Wind River watershed depict hypothetical candidate sites in the drainage system (top) followed by color coded locations of selected sampling locations using a GRTS rotating panel design (bottom). The four color-coded panel sites will be sampled in sequential years.







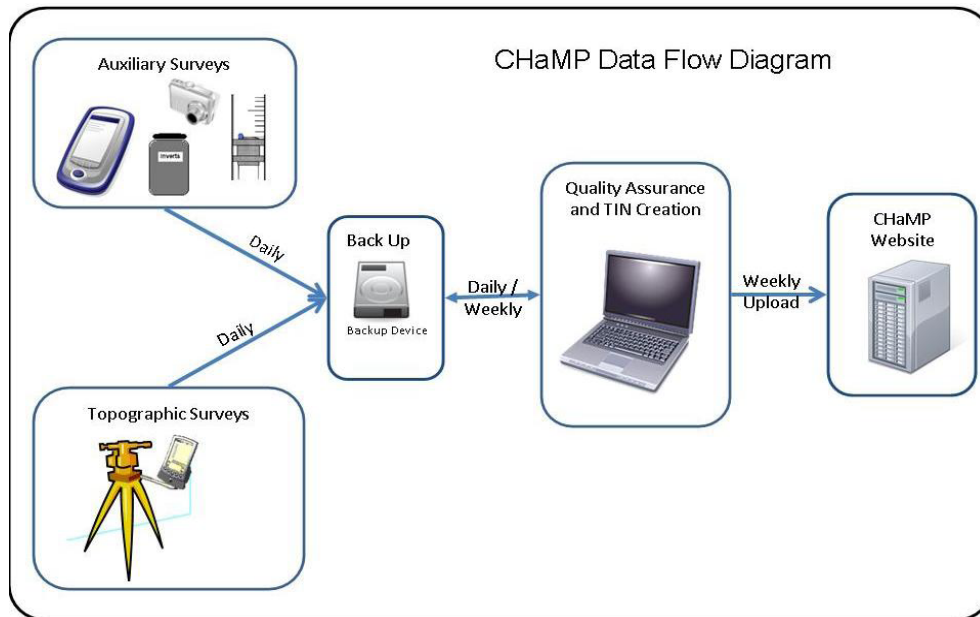
ISEMP is currently developing a field manual giving protocols for site evaluation and is planning to finish the work in spring 2011, and then site selection in all 26 watersheds will be completed.

**ISRP view:**

We think the GRTS spatially balanced probabilistic approach to site selection and the use of the latest technology in digital terrain mapping uses methods accepted in large-scale data collections. There was some debate at the February 10 workshop over whether improved information on habitat status and trends could be derived from sampling more than 25 sites per watershed at a lower intensity per site, relative to the 25 proposed sites at which all of the attributes and indicators in Table 1 are measured. At present the ISRP is not aware of any reports or publications that can answer this question with certainty. However, we acknowledge that the question of whether more, but less intensively sampled, sites may be more informative than fewer, more intensively sampled sites is legitimate. We therefore suggest that CHaMP re-visit the issue of number of sites, perhaps by designing a study that compares long-term monitoring results from paired CHaMP watersheds with more, less intensively sampled sites versus fewer, more-intensively sampled sites. We also suggest that CHaMP provide a clearer description of how site selection is influenced, if at all, by proximity to ongoing instream or riparian restoration actions.

**C. Data management and quality assurance**

The data management plan for CHaMP relies on a variety of field data collection methods – most recorded digitally – that are fed daily into backup drives to prevent data loss, followed by weekly quality assurance checks and uploading to the CHaMP website. The following diagram from the Working Version 1.0 protocol shows the steps in the process.



Data management activities are scheduled according to pre-season (statistical design, site evaluation), field season (data capture, quality assurance, data archival), and post-season (completeness of data, derivation of metrics) reviews.

**ISRP view:**

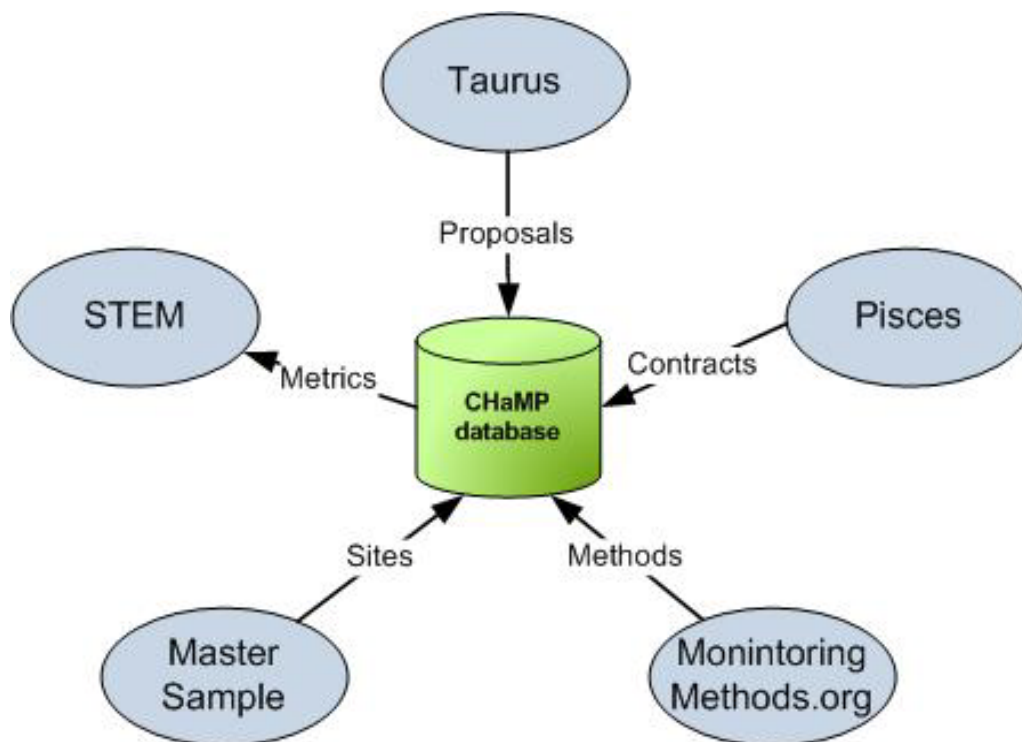
CHaMP monitoring will produce large and complex data sets. It is not clear at this point in time how the data will be analyzed for long-term habitat status and trends, and whether CHaMP personnel or collaborators will perform the analyses. Apparently personnel involved with CHaMP are developing analytical procedures, but the details of these procedures and the entities that will develop them (CHaMP personnel or collaborators) remain unclear. Nevertheless, CHaMP has a well thought-out plan for data management. Although the ISEMP team has an excellent record of issuing timely progress reports, we feel that more information should be published in peer-reviewed journals. CHaMP is a young program, but the results will be of interest to restoration practitioners throughout the region and in other major river basins. We hope that publication of annual progress reports and peer-reviewed papers will be included in data management goals.

**D. Data sharing with other large habitat monitoring efforts (AREMP/PIBO, PNAMP, EMAP, CRITFC, other)**

CHaMP is quick to point out that its objectives differ slightly from those of other large monitoring programs:

*“The stream habitat data generated by CHaMP will be used in conjunction with salmonid growth, survival, abundance and productivity to estimate fish-habitat relationships across the Columbia River Basin. The CHaMP protocol is fish-centric, i.e., measuring habitat relevant to salmonids of interest under the BiOp. As such, it differs from other programs like the Aquatic and Riparian Effectiveness Monitoring Program (AREMP), which was designed to assess the condition of aquatic, riparian, and upslope ecosystems under the jurisdiction of the Northwest Forest Plan (Gallo 2001), or the PACFISH/INFISH Biological Opinion (PIBO) protocol, which was designed to determine whether a suite of biological and physical attributes, processes, and functions of upland, riparian, and aquatic systems are being degraded, maintained, or restored, particularly in reference to livestock grazing and other federal land management practices (<http://www.fs.fed.us/biology/fishecology/emp/>), or the Environmental Monitoring and Assessment Program (EMAP) protocol, which was designed by the Environmental Protection Agency (EPA) to produce unbiased estimates of the ecological condition of surface waters across a large geographic area (or areas) of the West (Peck et al. 2001).”*

However, data collected by CHaMP will be made available to interested collaborators through the CHaMP database. The following diagram shows the input and output pathways for the database:



Although habitat information in the CHaMP database will be made available to others, there appear to be no formal data sharing agreements with other large monitoring programs. Nevertheless, the single-source website will include standard query and data sorting tools for interested users. In addition, many attendees of the February 10 workshop agreed that periodic

(perhaps annual) data sharing workshops involving CHaMP, AREMP, PIBO, EMAP, and large state and tribal habitat programs would be beneficial.

### **ISRP View:**

For a young program, CHaMP has developed the web tools and taken reasonable steps to make data available to others in a timely manner. Data archiving appears to be one of CHaMP's strong suits. The ISRP encourages the periodic exchange of habitat status and trend data and analyses through annual meetings of those organizations engaged in collecting both habitat and fish population information. Periodic (annual or 2-year) habitat workshops would be a useful forum for information exchange between monitoring organizations, particularly with respect to questions about which protocols are and are not working effectively.

### **E. Critique of CHaMP protocols by other monitoring entities**

The ISRP received comments from many other monitoring entities regarding the CHaMP protocols. In general, those organizations commended the intent of CHaMP and its goal of linking tributary habitat status and trends to changes in fish population demographics. Overall we were impressed with the detail with which these organizations examined the CHaMP version 1.0 document, and perhaps not surprisingly there were detailed comments on the suitability of the protocols. As previously stated, the ISRP does not address in this review whether one habitat monitoring approach is better than another (e.g., is benthic macroinvertebrate sampling more informative than drift sampling?), but we did note several themes that were common to the critiques:

- CHaMP methods and analytical tools remain somewhat untested, in the view of some monitoring organizations.
- The CHaMP protocols seem more appropriate for intensively monitored watersheds than to a large-scale approach to monitoring watershed health (the ISRP notes, however, that CHaMP is admittedly fish-centric and not focused on tracking watershed functions).
- The links between survey protocols and factors that are causing habitat degradation could be clearer.
- Land ownership (public and private) may cause an imbalance in site selection, especially where focal species tend to inhabit private lands and access to those lands is restricted.
- There was moderate to strong disagreement over which habitat attributes would be most informative and useful for tracking habitat status and trends, not only between other organizations and CHaMP but also among the other programs themselves. The condition of food webs supporting fish production, for example, is not adequately addressed by CHaMP.

## **ISRP View:**

While CHaMP metrics are, in general, similar to those in other habitat monitoring approaches, the integrative methodologies using those data (modeling) are in many cases very sophisticated and in various stage of development, and we do not yet see consensus among the large habitat monitoring organizations with respect to analytical tools (e.g., use of the SHIRAZ vs. EDT models). A broadly based buy-in to the CHaMP program seems critical if CHaMP is to fulfill its BiOp objectives. One factor affecting regional acceptance is "enfranchisement." In this regard, there is a sharp contrast between the high level of technical proficiency of some of the people speaking to us at the February 10 workshop and the frequent shortage of such expertise among some on-the-ground collaborators, as pointed out in some of our RME project reviews.

It seems important to the ISRP that if CHaMP is to be used effectively and widely accepted for monitoring, it should include effective *information transfer, technology transfer and perhaps expertise transfer*. Basic training in habitat measurement is one thing; transferring the ability to understand and apply the entire suite of protocols and tools to cooperators is another. It will be difficult to achieve a broad level of enfranchisement until major points of disagreement regarding the protocols have been resolved. It was not completely clear if the potential cooperators with CHaMP (agencies, tribes, regional NGOs, etc.) are to be mainly data collectors or if it is anticipated that the cooperators themselves will eventually have the staff expertise not only to collect the data using established protocols but to effectively understand and use the modeling programs and other analytical tools to support and document the benefits of their habitat restoration programs. If CHaMP included a long-term plan for enfranchising other habitat monitoring efforts, differences over the protocols and their analyses and interpretation might be more easily resolved.

## **Other Conclusions**

### **A. ISRP recommendations for evolution of the CHaMP effort**

We are impressed with the quality and amount of material that the CHaMP team has created in a short amount of time. They seem to have a clear picture of the overall goals and have devised an approach that is supported by statistical design and analysis considerations, while implementing promising newer technologies. The issue of how much standardization of field protocols is possible and/or desirable is complex and contentious. On the one hand, standardization contributes to data sharing and opens possibilities for answering questions about habitat status and trends at a larger scale, while on the other hand too much standardization limits creativity and a diversity of approaches that might be beneficial. Of course, the underlying issue of turf comes into play during these considerations, as we saw at the February 10 workshop. Prior to extensive implementation of CHaMP, a cautionary approach might be to initiate several modestly sized CHaMP protocol tests (focused, for example, on a range of watersheds across the Columbia Basin where both habitat and fish population monitoring efforts are occurring) in

which different approaches to design, data collection, data storage, and data analysis, can be compared to provide a test of the efficacy of scaling up from past efforts while still allowing and encouraging other promising, or well proven, efforts to continue.

#### B. Suggested role for the ISRP in future reviews of the program

Although the purpose of the workshop and ISRP review was to evaluate CHaMP protocols, the larger question, of importance to both the BiOp and the Council's Fish and Wildlife Program, is whether habitat restoration actions in a watershed improve fish performance and survival as well as VSP criteria. The following were listed as Tributary Habitat Questions at the workshop:

- Are tributary habitat actions on track to achieve expected performance standards and targets?
- What are the relationships between tributary habitat actions, habitat changes, and fish survival and productivity changes?
- What actions are most effective?
- What are the limiting factors or threats preventing the achievement of desired habitat or fish performance objectives?

CHaMP alone does not address all of these questions. In theory the questions surrounding the effectiveness of restoration actions are being addressed by a combination of ISEMP studies, the Intensively Monitored Watershed projects proposed for implementation or currently being implemented in numerous basins, and information from CHaMP on habitat status and trends. The ISRP believes CHaMP's role in addressing the questions above is not yet completely clear. In an important sense, CHaMP cannot be reviewed comprehensively independent of ISEMP and the existing and newly proposed IMW's as they pertain to the central question of habitat restoration effectiveness. The intersection of these three efforts needs further examination and refinement to ensure that, collectively, these projects can provide answers to the tributary habitat questions.

The ISRP recommends that a comprehensive review of this suite of projects (ISEMP, IMWs, CHaMP) be undertaken to determine if indeed they, as a whole, are sufficient to provide status and trends monitoring of habitat and fish and are capable of answering the central question of whether habitat restoration actions are achieving desired objectives. We suggest this, in part, because several new IMW projects were proposed in the recent RME/AP project solicitation. The ISRP had concerns about the design and conduct of some of these new projects, especially concerning comparisons of treated and untreated (reference) watersheds. Furthermore, the ISRP has reviewed ISEMP favorably in the past but never in the context of an integrated RME program. Even after the February 10 workshop the ISRP was uncertain how CHaMP intersected with ISEMP's activities, including those areas designated (or proposed) as IMWs. As well, we are interested in comparing how habitat modeling efforts are informing restoration decisions. For example, EDT was used extensively during the subbasin planning process, but the preferred

model in CHaMP is SHIRAZ. How do model outputs from these two tools compare, and how will they be used in restoration planning?

The ISRP would be interested in learning more about the efficacy of different approaches to establishing the relationships between fish performance and habitat condition and would like to review CHaMP, ISEMP, PNAMP and other effectiveness monitoring efforts in one to two years. Future reviews of CHaMP can help reveal approaches that produce the most generally useful information. For example, at the February 10 workshop three approaches currently being employed in the Columbia Basin were mentioned but not discussed in detail:

- Formal, experimental manipulation of stream habitat with fish responses monitored at the population level (this is primarily used in IMWs).
- Model projections of population benefits of restoration actions based on per project change in habitat quality/quantity, habitat status, and fish response to habitat condition.
- Correlation analysis of habitat quality/quantity and fish abundance across a gradient of actions and potentially confounding covariates.

The GRTS design may not address the habitat restoration effectiveness question because the site selection process is random and does not target specific areas where restoration actions are ongoing or planned. However, it will give an indication of large-scale trends in habitat condition, tracking habitat degradation as well as improvement. As the project progresses, we will be interested in seeing how well CHaMP achieves the dual objectives of tracking overall changes in habitat condition and helping to establish restoration effectiveness.

### C. Water quality

The habitat quality and quantity indicators in the CHaMP protocol have been designed specifically to evaluate the features of stream habitat critical to juvenile salmonid survival from egg to smolt life stages (2011 Working Version 1.0, page 8). Table 2 in the Working Version provides the reason why toxic compounds (low feasibility) and benthic macroinvertebrates (low information content) were not included in the CHaMP protocols. Yet, there are numerous literature references in the ISAB Food Web Report<sup>9</sup> about concerns for an adequate food supply and exposure to toxics (and not just in the natal stream). Lack of information about food availability and toxics exposure can cause great confusion when attempting to interpret fish population responses based on physical habitat data alone.

Two water quality issues, in particular, should receive additional consideration by CHaMP.

1. Agricultural pesticides. Potential exposure information is available, even on a pesticide-by-pesticide basis, for the various locations in the Columbia Basin (from USGS National Water-Quality Assessment Program, National Synthesis Project, see Food Web Report

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<sup>9</sup> <http://www.nwcouncil.org/library/isab/2011-1/>

Fig. C.7.3). This information may provide a good indication of the exposure patterns to these toxic chemicals in some of the watersheds included in the CHaMP program.

2. Pharmaceuticals, personal care products, and flame retardants. An important source for these chemicals is wastewater treatment plants. Nearly all of the treatment plants in the Columbia Basin are shown in the ISAB Food Web Report, including average discharge (millions gallons/day) and the river flow at each site. A recent paper<sup>10</sup> shows a strong correlation between a simple dilution index (Wastewater Treatment Plant discharge/River Flow) and PBDE egg concentrations for fish-eating osprey. A similar type of calculation could provide a rough indication of fish exposure to these chemicals in CHaMP watersheds (including exposure downstream from CHaMP sampling sites, which could be very important to survival). Furthermore, the Washington State Department of Ecology has reported PBDE flame retardant concentrations in fish and water from throughout Washington.<sup>11</sup> General patterns of exposure to toxic compounds (as listed above) may be very important in further interpreting ISEMP/CHaMP results and could possibly be used in an exposure risk stratification scheme that could help identify sites where potentially toxic chemicals could be included in habitat surveys. To address this issue, macroinvertebrate drift samples could be stored for toxic compound analysis, should the situation warrant it.

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<sup>10</sup> Henny CJ, Grove RA, Kaiser JL, Johnson BL, Furl CV, Letcher RJ. 2011. Wastewater dilution index partially explains observed polybrominated diphenyl ether flame retardant concentrations in osprey eggs from Columbia River Basin, 2008-2009. *Ecotoxicology* DOI 10.1007/s10646-011-0608-2 (On Line February 2011).

<sup>11</sup> Johnson A., Seiders K., Deligeannis C., Kinney K, Sandvik P, Era-Miller B, Alkire D. 2006. PBDE flame retardants in Washington rivers and lakes: concentrations in fish and water, 2005-06. Washington State Dept. Ecology, Publ. No. 06-03-027, Olympia, 102 pp.