



Independent Scientific Review Panel
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MEMORANDUM

ISRP 2004-16: November 18, 2004

- TO:** Doug Marker, Fish and Wildlife Division Director, Northwest Power and Conservation Council
- FROM:** Rick Williams, ISRP Chair, and ISRP subcommittee of William Liss, Susan Hanna, Lyman McDonald, Brian Riddell, and William Smoker
- SUBJECTS:** 1) Lower Columbia River Ecosystem Monitoring and Data Management, Project 2003-007-00 (Proposal #30015), and
2) Final draft of the “Plan for Research, Monitoring, and Evaluation of Salmon in the Columbia River Estuary,” August 2004

This memo includes ISRP recommendations and comments on two separate but related documents: 1) Lower Columbia River Ecosystem Monitoring and Data Management, Project 2003-007-00 (Proposal #30015), and 2) final draft of the “Plan for Research, Monitoring, and Evaluation of Salmon in the Columbia River Estuary,” August 2004 (Estuary RME Plan). The first is a project for habitat monitoring in the Lower Columbia River. The second is a plan intended to provide a strategic framework to conduct a research, monitoring, and evaluation program in the Columbia River estuary. The habitat-monitoring plan is based in part on the Estuary RME Plan. To place the review of the habitat-monitoring project in the proper context, Bonneville and the Council requested that the ISRP review the draft plan. The ISRP has reviewed both the documents before and a focus of this review is to determine how well the authors addressed the ISRP’s concerns. Further background on previous reviews and final recommendations on the documents are provided below starting with the habitat-monitoring project.

Before delving into the individual documents, the ISRP reiterates its support for a monitoring and evaluation plan for the Lower Columbia River Estuary. The estuary provides important habitats for downstream migrating salmon. Some scientific analyses have shown that restoration of estuarine habitats may be one of the principle means for increasing survival of downstream migrants. In addition, the 2000 Biological Opinion places emphasis on the estuary, calling for a monitoring and evaluation program to assess progress toward estuarine restoration. Unfortunately, despite its likely importance for salmon, little is known about how salmon use the estuary, the potential sources of mortality and reduced growth, and how habitats will respond to restoration efforts. Recent research is beginning to provide badly needed understanding of the importance of the estuary for salmon. For all of these reasons the ISRP supports establishment of a comprehensive, scientifically sound estuary RME program.

Habitat Monitoring Project

Background

This proposal was first submitted by the Lower Columbia River Estuary Partnership (LCREP) in December 2001 for funding consideration in the Lower Columbia River and Estuary Provincial project selection process. In its review of the original M&E proposal, the ISRP rated it fundable, contingent on a more comprehensive and detailed explanation of the proposed monitoring program and database. On September 11, 2002, in its recommendations for the Lower Columbia River and Estuary provinces¹ the Council supported the ISRP's recommendation by requiring that a more comprehensive description of the monitoring plan be provided as a condition of funding. In response to this condition, LCREP submitted two proposals for Council and ISRP review -- the Scope of Work for Habitat Monitoring and Water Quality Monitoring in the Lower Columbia River and Estuary. On May 6, 2004, the ISRP completed a review of the proposals (ISRP 2004-9)² recommending that the habitat-monitoring component not be funded because it was too vague and general to be reviewed for scientific merit and benefits to fish.

At the June 2004 Council meeting, the Council recommended to Bonneville that the water quality section of the project be implemented and the concerns raised by the ISRP be addressed in contracting. The Council further recommended that the habitat monitoring implementation be postponed until a future favorable ISRP and Council review. The Council staff requested that the sponsor not only submit the completed habitat monitoring plan for review, but also submit the additional detail requested by the ISRP in the water quality plan as a courtesy to the ISRP. On August 31, LCREP submitted the revised habitat-monitoring plan that is the subject of this review.

ISRP Findings

The Habitat Monitoring Plan is a significant improvement over the previous draft reviewed by the ISRP (ISRP 2004-9). It provides a logical, scientifically sound procedure for establishing a monitoring program in the Columbia River estuary and as such is fundable. The ISRP expressed a number of serious concerns about the proposal in its previous review. Below we identify the ISRP's major concerns and discuss how well the current plan has addressed them. In general, most of the concerns have been addressed reasonably well. However, the ISRP makes several recommendations to improve the plan that should be addressed as the plan moves to implementation.

¹ <http://www.nwcouncil.org/fw/province/cascade/2003finalrec.pdf> - Columbia Estuary Issue 3, page 14.

² www.nwcouncil.org/library/isrp/isrp2004-9.htm

1. The proposal lacked detail on the proposed classification scheme, sampling design, habitat performance indicators, and methods of analysis.

Classification Scheme

The plan proposes to develop a hierarchical classification system that delineates estuarine habitat at a variety of spatial scales. The approach is consistent with other scientifically valid estuarine and freshwater habitat classification schemes. Although the classification is not fully developed at this point, the planners provide an excellent discussion of the approach that will be taken for classification and an example that clearly demonstrates the methodology. The planners propose to use the classification as a basis for designing a sampling program, specifically for selecting sample sites.

In addition to hierarchical delineation of habitats, procedures for assessing the spatial arrangement of the habitats on the landscape need to be developed. For example, the habitat accessibility aspect of habitat connectivity is in part a function of the spatial arrangement of habitats. Crucial habitats that are close together often will provide greater ease of access to fish than the same habitats when they are far apart. Lakes and wetlands that are off-channel but that are accessible to migrating fish should be considered in defining habitat complexes.

Sampling Design

Although the sampling design is more clearly defined than in the previous draft, the ISRP has a number of technical concerns. We agree with the plan to collect data in Phase I and use the resulting information on spatial variation to develop long term monitoring in Phase II. One technical recommendation is that the sponsors consider use of spatially balanced sampling sites selected by the EPA-EMAP generalized random tessellation stratified design (GRTS), instead of pure randomly selected sites within the Level 3 strata identified in Figure 2.1. Use of this design should meet the objectives with a state-of-the-art site selection procedure. An exception to this recommendation would be if the sponsors are planning to use and potentially expand existing EPA-EMAP 1999-2004 monitoring sites (see the Estuary RME Plan and our review below). It would also apparently improve the coordination with the companion Estuary RME Plan for salmon-related monitoring activities where use of EMAP sampling procedures has been proposed. Finally, when possible, sampling sites should be collocated between the companion estuary RME plan, the habitat monitoring plan, and other long term status and trend monitoring, e.g., EPA-EMAP. There are limits to the amount of collocation of sampling activity that can be conducted without having undesirable effects on site, but the collection of field data on different parameters associated with a given site eliminates much of the difficulty of modeling relationships between habitat and salmon abundance or presence or absence of salmon in a habitat.

One aspect of the plans for Phase II that should be clarified is whether future selection of sampling sites will be within strata (habitat classes) defined by the new classification system or if the sponsors plan to continue sampling within the fixed strata defined in Figure 2.1. The best strategy for long term status and trend monitoring may be to continue to sample within the fixed level 3 strata defined in Figure 2.1, or to use a more

systematic sampling plan over the entire estuary, followed by domain estimation (i.e., “post-stratification”) for smaller regions (classes) whose boundaries will change with time (Cochran 1977). This is apparently the strategy being adopted by EPA-EMAP in the Columbia Estuary. In general, the ISRP is concerned about basing a long term status and trend monitoring plan on habitat classes whose boundaries may change over time as new information becomes available. The habitat classification system developed in Phase II of this plan likely will be modified over the next 25 or 50 years and new types of problems are likely to arise. For all these reasons the ISRP cautions against stringently adhering to a sampling design based entirely on a fixed habitat classification scheme.

The proposal implies that private property access will be difficult, so that if randomly selected sites are privately owned in too large a proportion, alternative data collection methods will need to be developed. Without more detail on expected difficulties in obtaining access, it is hard to know whether this is a realistic concern. Regardless, the sponsors should rethink their plans in dealing with inaccessible sample sites. In general, inaccessible sites introduce missing data into a sampling design and the statistical inferences are limited to accessible sites. We strongly recommend that the sponsors maintain their basic sampling design even if a majority of sites are “private,” however, sample size could be increased in the “accessible” stratum to improve precision in that part of the estuary. The plans to estimate the missing values by correlation/regression methods using remotely sensed data on accessible sites is a reasonable strategy, but it is a way of estimating missing data, not a substitute for data collection.

We encourage the planners not to back away from private sites without putting some effort into a positive approach to gaining owner permission. Gaining access to these sites may not be as bad as feared, and landowner cooperation would be a good way to vest the affected public in the activity of monitoring and the goal of restoration.

Habitat Performance Indicators

The plan includes a table of attributes that will be measured and a brief statement of the data acquisition methods. Little or no detail is provided on the specific metric that will be used to describe each attribute. For example, what metric will be used to describe the occurrence of large woody debris in the estuary? What metric(s) will be employed to assess life history composition of fish?

The plan proposes to classify attributes as they relate to salmon habitat and populations. The general classification categories are habitat capacity, habitat opportunity, and realized function. The plan does not, however, associate the attributes listed in Table 3.1 with any of these broad classes. Thus, it is unclear whether the attributes adequately account for capacity, opportunity, and function.

Methods of Analysis

The plan does not describe specific methods of analysis of the data. The types of data that will be collected, metadata, data sharing and dissemination, quality control, and data archiving are briefly described. In particular, the plan states that “standard protocols”

will be followed to ensure quality control and assurance without any indication or referencing of these protocols.

2. There is no inclusion of fish in the monitoring tasks and protocols

The plan falls woefully short of addressing the ISRP's concern. The ISRP believes that monitoring salmon distribution and abundance should be a principle focus of an RME effort. Indeed, the RPA actions that justify development of the RME plan are predicated on salmon recovery. Although the plan is directed toward habitat monitoring, it should make strong and clear connections to salmon monitoring in the Estuary RME Plan (see below). The plan should indicate how ongoing salmon research and monitoring in the estuary and tidally influenced river sections fits with the habitat-monitoring program.

Specific Comments

Goals and Objectives

The goal and objectives in the plan should define what the plan intends to accomplish. A properly worded goal statement will serve as a useful reminder of the end purpose of monitoring, and well-specified objectives will provide benchmark outcomes to target. The goal statement in the plan focuses on actions, not outcomes, and the objectives statements read like tasks, repeating what is in the goal statement. The goal should back away from "actions" and focus on what the effort is intended to achieve. Why is the habitat monitoring being done? What is the desired accomplishment?

Similarly, the objectives statements should move beyond "task" statements to express a desired outcome. Objectives 1 and 2 are fine, but objectives under "Action effectiveness research" just describe activities, not what is intended as an outcome.

Management Implications

This section is fairly theoretical – here's how the habitat monitoring data could be used – rather than a specific description of how it will be used, by whom, and how it will be provided. For example, how will all the entities producing data on elements of "ecosystem health" come together to produce a single assessment? Is the assessment of ecosystem health mandated under the National Estuary Program sufficient? How often is this done? What are its components? How will it be usable to Columbia Basin managers? The same comment applies to the other topic areas in this section: move the discussion away from how the data could be used to a specific discussion of who will use the data, and how they will use it for management decisions. The section presently contains no specific plan for use or delivery of the data into the management arena.

Literature Cited.

Cochran, W.G., 1977. *Sampling Techniques, Third Edition*. John Wiley and Sons, NY.

Estuary RME Plan

Background

The Estuary RME Plan is part of the Action Agencies' comprehensive RME effort in the Columbia Basin and has been incorporated into the Estuary Subbasin Plan in the Council's Fish and Wildlife Program. The ISRP and the ISAB reviewed the September 2003 draft of the Estuary RME Plan during their review of the Action Agencies/NOAA Fisheries RME Plan in fall 2003.³ The ISRP/AB found that the overall structure of the draft plan was reasonable and provided a good framework within which to develop a plan, though fundamental pieces were missing and the organization of the document needed to be reworked. To assist in the development of this draft section into a completed plan for the Columbia River estuary and plume, the reviewers provided extensive comments by section. The ISRP/AB's main message was that the plan needed to state the clear, specific objectives of the RME program and construct the program to meet those objectives. In addition, the ISRP/AB recommended that the Action Agencies and NOAA Fisheries needed to conduct and present an assessment of information needs, existing information, critical gaps, and priority of identified critical uncertainties.

In response to this review, the Action Agencies et al. significantly revised the document to produce the current final draft of the Estuary RME Plan. This document was submitted for ISRP review in August 2004.

ISRP Findings

The Estuary RME Plan establishes RME goals and objectives for salmon-related activities in the estuary; develops performance indicators and monitored attributes that are responsive to the objectives; identifies methods to obtain and analyze data on the monitored attributes; and uses project and program level assessments to make recommendations as part of a phased action plan for estuary RME. It does not, however, provide detailed statistical and sampling designs or standardized sampling protocols. The Action Agencies envision this level of detail to be established by projects performing RME, such as the LCREP proposal.

The Estuary RME Plan is a significant improvement over the draft Estuary RME plan previously reviewed by the ISRP (ISAB/ISRP 2004-1). The Estuary RME Plan, however, is still "a plan to develop a plan", a discussion about the desired elements of a plan, rather than a plan itself. Much work needs to be completed before a workable plan can be implemented.

It is unfortunate that the RME plan was not more closely integrated with the Habitat Monitoring Plan. It is unclear what the role of the Habitat Monitoring Plan is within the overall RME framework and how the sampling scheme proposed for estuarine habitat fits with the RME sampling design. The hierarchical concept of estuarine habitats proposed in the Habitat Monitoring Plan would prove useful in structuring objectives, selecting

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

research and reference sites, and choosing scale appropriate methods. It would also be crucial in development of a conceptual model in that different processes would operate at different spatial scales.

The ISRP is concerned that the principle emphasis of the RME will be on the lower estuary and less attention will be paid to the part of the estuary extending from RM 46 to Bonneville Dam. Little mention was made of the problems posed by urban development in the City of Portland. Portland is a superfund site and a possible source of substantial mortality for downstream migrants from the Willamette and Columbia. The RME should have devoted more attention to explaining how urban areas would be dealt with in the RME. In addition, no mention was made of the populations of chum and chinook salmon spawning below Bonneville Dam, even though chum are a listed species. Finally, numerous off-channel habitats (e.g., wetland, lakes) exist in the upper estuary that could provide important rearing habitat and refugia for downstream migrants. Many of the off-channel habitats are being actively restored and monitored independent of the estuary RME.

The ISRP expressed a number of concerns about the plan in its previous review. Below we identify the ISRP's major concerns and discuss how well the current plan has addressed them. A general concern was that the previous plan -- described as a work in progress -- lacked performance targets, a sampling design, methods for data collection and analysis, methods for monitoring, a conceptual model, a plan for data management, and a coordination plan. The current version of the plan has addressed some of these deficiencies, but significant ones remain and are discussed below.

1. The plan provides no clear indication that it meets the requirements under the Reasonable and Prudent Alternatives that address the estuary in the 2000 Biological Opinion

The plan provides a general discussion of how RPA actions pertaining to the estuary can be addressed by the estuary RME. The plan could have provided a more effective connection to the RPA's by linking specific objectives to individual RPA actions. This approach would have provided a clear logic pathway from RPA actions through objectives to performance indicators and attributes, and would help considerably in assessing whether the RPA actions were adequately addressed by the RME plan.

2. The plan needs to state clear, specific objectives expressed in measurable terms where possible.

Problems with the plans objectives persist. The overall structuring of objectives in the plan could be improved to provide a more logical progression from the goal to monitoring attributes. The Plan defines a broad goal entailing restoration of estuarine habitats and population viability, which are then followed by monitoring objectives. These objectives describe or determine status and trends of various ecosystem attributes. The plan lacks program level objectives that would provide a bridge between the goal and the monitoring objectives. Thus, it is unclear what the monitoring objectives are attempting to specifically accomplish. Program level objectives should deal more specifically with habitat restoration and viability than does the goal. Examples of

program level objectives, with respect to habitat, could be to increase the amount of tidal marshes and swamp or wetlands by a certain amount and reduce amount of shallow water habitats, to set aside or purchase areas for reserves or for restoration, or the objectives could identify priority areas within the estuary for protection and restoration. These kinds of objectives would provide better direction for monitoring efforts.

The plan's objectives differ considerably in specificity. Status monitoring objective SM1 is broadly stated as "Describe the status of estuary ecosystem in terms of habitat conditions, habitat connectivity, and fauna..." Other status monitoring objectives such as objectives SM4, SM5, SM6, and SM7 are more specific and refer, respectively, to water quality, spawning and rearing habitat, invasive species, and river hydrology and ocean conditions. Objective SM1 would be more useful if it had been broken down into individual objectives similar to SM4-7, perhaps referring to specific kinds of habitat conditions that will be described, elements of connectivity, and types of fauna (are all fauna going to be described?). In fact, SM1 is so broad that it actually encompasses SM4, SM5, SM6, and SM7. The SM objectives should be expressed at the same level of generality and in a way that gives them some structure as a set. Also, some are worded in terms of activities, rather than achievements.

The lack of specificity is especially apparent in the action effectiveness and uncertainties objectives. These objectives are so general that it would be difficult to determine whether they had been met. The uncertainties objectives are so broad as to be of limited utility in providing direction for research. In other words, based on these objectives, it would be difficult to prioritize research activities and the objectives will provide little help in selecting research projects for funding.

A critical shortcoming is lack of prioritization of objectives and actions. Table 9 is a useful compilation of ongoing projects related to estuary RME. It would be helpful if this information were used to develop an assessment of critical information gaps and priorities for work. Where do resources need to be targeted? This assessment would not be a list of projects, but rather a discussion of what is known and not known. The plan could use more depth in terms of identifying what is needed, and indicating how all the knowledge from various projects will be synthesized and communicated.

The lack of a spatial context makes interpretation of objectives and methods difficult. For example, objective SM2 calls for assessment of spatial distribution and migration pathways. Does spatial distribution apply only at the scale of the whole estuary, that is, the large scale movement of fish downstream along their migratory pathway through the estuary, or does it also apply to smaller scale movements, say, between the main estuary and a wetland, or from the main estuary into a river bay, or to even smaller scale movements within a particular habitat such as a wetland? The same point could be made for migratory pathways. The scalar issue also applies to the assessment of connectivity and several other indicators.

3. A better plan for coordination throughout the basin is required.

The ISRP believes the Plan is correct in cooperating with the EPA-EMAP monitoring in the Columbia Estuary, and other monitoring programs. We agree that strong, central coordination is essential to the successful implementation and evaluation of this program. Although the plan makes many statements about the value of coordination, it is not specific or clear as to how the coordination will be done, that is, how the research, monitoring, and evaluation will be tied together and linked with the habitat-monitoring program. The coordination and implementation section is very general, and does not contain explicit discussion of what will be coordinated and how. Similar comments apply to the sections on data management and analysis, information reporting, and program evaluation. These sections are all very hypothetical.

4. A conceptual model is needed

A conceptual model would help move this document toward a viable plan. The planners make the point that development of a conceptual model at this point is not possible because of the lack of understanding of how the estuarine ecosystem works. They assert that not enough information is available to construct a conceptual model, then go on to discuss pieces of information and elements of a conceptual model in ways that suggest such a model could indeed be developed, at least to the extent of identifying “here’s what we know, here’s what we don’t know, and here’s what we think would be the most important things to learn first.” Further, the authors could build on the extensive conceptual models presented in the Assessment chapter of the Lower Columbia and Columbia Estuary Bi-State Subbasin Plan reviewed by members of the ISRP in the summer of 2004. The apparent disconnect between this RME plan and that Bi-State plan deserves some explanation.

If development of the model is postponed for very long, the program will have developed inertia, sampling and data analysis will be well underway, and it is problematic how much effect on monitoring and evaluation a conceptual model will have. The planners should have proposed a model based on available information. The model would have aided identification of knowledge gaps (this is why it is incomplete), perhaps leading to more specific uncertainties objectives than are proposed currently.

5. Confusion over performance standards and objectives

There appears to be some inconsistency in the definitions of the terms objectives, indicators, and monitoring attributes, and how these terms are actually applied in the plan. Indicators are defined as characteristics of the ecosystem that are relevant to the objectives. In fact, the indicators given in the plan are lifted directly from the objectives and add nothing new. The indicators do not clarify the objectives nor do they lend any additional specificity to them. For example, the indicators for objective SM1 are habitat condition, connectivity, and fauna, a simple repetition of the elements in the objective itself. This pattern is repeated for all status objectives. The specific meanings of the terms used in the objectives and as indicators (e.g., habitat condition, connectivity) are not made clear until the monitoring attributes are discussed. A monitoring attribute is defined as a “metric” or variable measured to assess system response. In fact, many of the attributes listed in the plan (e.g., temperature, bathymetry, temporal distribution) do not

have the specificity of a metric as called for in their definition. Most of the listed attributes really could function as indicators.

Specific Comments

Sampling Design

The ISRP strongly supports the Plan's proposed use of standard methods for status monitoring and action effectiveness research throughout the estuary to the extent possible to facilitate estuary-wide and basin-wide evaluations. The Estuary RME and Habitat Monitoring Plans should coordinate and clarify the basic structure that they are recommending for their sampling designs. The ISRP also agrees with the plan to conduct a pilot study. The ISRP's comments on the use of habitat classification as a basis for sampling design in the Habitat Monitoring Plan (see above) are also pertinent to the estuary RME plan.

The estuary RME plan refers to the EPA-EMAP 1999-2004 sampling sites in the Columbia estuary that are apparently systematically selected (maybe on a 2-dimensional grid). These sites are then to be "post-stratified" into domains for analysis. The ISRP supports this basic strategy, perhaps sampling within the level 3 strata defined in Figure 2.1 of the Habitat Monitoring Plan for design of long-term status and trend monitoring.

While there are advantages to using existing EMAP sampling sites, the planners should have provided better justification that these sites would be sufficient to accomplish the RME objectives, that all the appropriate attributes would be measured, and that the sampling techniques would be appropriate for RME purposes. The EMAP sites seem to be appropriate for monitoring at the scale of the entire estuary. However, the EMAP sites alone may not be suitable for monitoring changes in connectivity and ecosystem changes at smaller spatial scales. Monitoring changes at these scales may be better accomplished under more short-term, research-oriented projects.

The planners have considered the difficult issues of data sharing and dissemination, quality control and assurance, and data archiving, although we anticipate that modifications in their plans will be necessary as the region moves toward more consistent and cooperative monitoring programs for the entire Columbia Basin. In particular, it will probably be necessary to limit the number of indicator variables in the long term status and trend monitoring plan to create a cost-effective plan that will be fundable for the long run.

Program Evaluation

Evaluation of the effectiveness of restoration actions is left rather vague as to who will do the evaluation, when it will be done, and how the evaluation will be undertaken. The program will be evaluated by EMECC and the Action Agencies but the process, at least at this point, appears to be subjective and poorly defined. EMECC and the Action Agencies will be "asked to determine if projects collectively meet program goals." To what goals are the planners referring, and how will the determination be made? If clear

and specific objectives were defined, then progress toward these objectives could be evaluated. But the current goals and objectives are so broad that just about any positive change could be construed as adequate progress and any estuarine project as contributing to the progress. More specifics on evaluation should be presented – to develop a reasonable data collection program that will allow evaluation of action effectiveness requires that some information about types of actions and methods of evaluation be known in advance.

Reference Conditions

It is unclear why “pre-European settlement conditions” were chosen as a reference point, if it is indeed a point. How will the planners treat the variability that obviously existed pre-settlement, and how will representative conditions or a range of conditions be chosen? Additionally, instead of pre-settlement/present day comparisons, it may be more useful to try to determine gradations of change that may have been caused by successive installation of dams or other large-scale factors. Some discussion of the limits of core sampling to answer these questions would be very helpful.

Coordination

The proposal contains more detail than previously on coordination among ongoing projects. However, much more detail could be provided as to specifically how the project is coordinated with other efforts of USACE, EPA, OWEB, etc. Many of the statements regarding coordination are of a “to be determined” or “it could be done” nature rather than “here are the programs, here’s what we will coordinate, and here’s how we will do it.” Coordination is described in a rather passive tone – e.g. the coordination could happen, rather than an active tone – here’s how and where it will happen. More detail on the coordination process is warranted. The annual information-sharing meeting sounds like a good idea, but can more be done to move toward consistent data collection protocols or coordinated sites so that the efforts are more seamless and data utility is enhanced? It sounds as if more could be done to reconcile the separate projects.

Invasive Species

Invasive species are major problem in the estuary and are likely to become an even greater problem in the future. At this point in time, we barely understand their impacts on native species and habitats and, for many invasive species, effective control measures have not been developed. The plan should discuss more thoroughly what is currently being done to assess abundance and distribution of invasive species and how to control them.

Measurement of Indicator Variables

The planners need to further consider what biological indicators will be measured annually. They refer to assessing life history diversity, spatial distribution, growth and survival. How will these indicators be measured annually and does each have to be annually assessed? How would you differentiate life history diversity from spatial distribution, and is growth sampled by habitat type or just an annual average by stock? Some of these sampling questions need further thought. Is it affordable, or even practical,

to measure these indicators each year, and for what population unit will they be measured?

The ISRP is concerned that for a number of their indicators this plan is reliant on other programs that may or may not be currently funded. If this plan is the core RME plan for the estuary, should it be reliant on other programs, or should the other programs be integrated and coordinated with this plan? The latter would seem preferable. If there is a long-term commitment to a RME plan, then this should be the core program and other projects supplement the information.

Life History Diversity

The ISRP continues to have serious concerns about what the planners mean when they refer to life history diversity. They seem to be implying genetically based life history types that will be expressed if the habitat is restored. But what evidence is there that this type of habitat use has a genetic basis as opposed to just the phenotypic expression of animals using habitats made available to them? There are important implications to these alternatives that still need clarification. Is the supposition that juvenile salmon would not utilize a habitat if it is restored because the genetic basis has been lost?