Independent Scientific Review Panel
for the Northwest Power & Conservation Council
851 SW 6th Avenue, Suite 1100
Portland, Oregon 97204

An ISRP Retrospective Report

Review of the 2010 Draft Annual Report: Evaluation of Cumulative Ecosystem Response to Restoration Projects in the Lower Columbia River and Estuary

(March 2011 draft)

A U.S. Army Corps of Engineers Columbia River Fish Mitigation Program Project

ISRP 2011-24
November 14, 2011

Richard Alldredge	Colin Levings	Greg Ruggerone
Robert Bilby	Eric Loudenslager	Dennis Scarnecchia
Peter Bisson	Kate Myers	Bruce Ward
Charles Henny	Tom Poe	Bill Pearcy, PRG

Table of Contents

ISRP review of the 2010 Draft Annual Report: Evaluation of Cumulative Ecosystem Response to Restoration Projects in the Lower Columbia River and Estuary

A. Executive Summary

In response to a request by the U.S. Army Corps of Engineers and the Northwest Power and Conservation Council, the Independent Scientific Review Panel (ISRP) reviewed the final report for the project, "Evaluation of Cumulative Ecosystem Response to Restoration Projects in the Lower Columbia River and Estuary" (project EST-P-02-04), herein called the Cumulative Effects study. The study, established in 2004, was conducted for the Corps' Portland District by a collaboration of research agencies led by the Pacific Northwest National Laboratory. This is an ISRP Retrospective Review that examines the results reported for this seven-year (2004-2010) study. Although the report reviewed by the ISRP was subtitled, "Draft Annual Report," this is the ISRP's final review of the study.

The primary goal of the study was to develop a methodology to evaluate the cumulative effects of habitat restoration actions in the lower Columbia River estuary. Objectives included (1) developing monitoring protocols; (2) developing the theoretical and empirical basis for a cumulative effects methodology; (3) designing and implementing evaluation of the cumulative effects methodology; and (4) developing an adaptive management process to coordinate and coalesce restoration efforts.

Following literature review in 2004, the study was implemented in phases between 2005 and 2010. Field work was conducted primarily at four restoration sites. Reference sites were included to match each restoration area. Marsh and swamp habitats were the focus of the study, and particular emphasis was placed on the forested swamp habitat, which had not been studied before. In addition to biological sampling, extensive work was conducted on topography and hydrology of the areas. Models were developed to estimate habitat availability for salmon, macrodetritus flux and export, and cumulative net ecosystem improvement. An adaptive management process was custom-designed for the Columbia Estuary Ecosystem Restoration Program (CEERP) during 2006 and 2007.

The ISRP concludes that the study produced some excellent empirical data and results. An estuary sampling protocol manual (Roegner et al. 2009) for monitoring and evaluation developed by the study should be particularly useful. Many of the data produced deal with biophysical aspects of the ecosystem such as hydrology, geomorphology, and vegetation mapping. The cumulative effects of restoration projects were summed over a variety of these biophysical ecosystem processes. While these ecosystem studies are important to advance understanding of how the estuary responds to restoration efforts, the ISRP concludes that much more information is needed on how restoration activities affect use and survival of salmon in the lower Columbia River estuary. The Cumulative Effects study could then be more useful for planning further work, implementation of estuary restoration in support of salmon recovery and the BiOp, and informing adaptive management under the Corps' program and the Council's Fish and Wildlife Program.

The Cumulative Effects study was a preliminary attempt to systematically select, develop, design, and test, in a limited way, an approach to effectively evaluate cumulative ecosystem response to habitat restoration projects. The outcomes of objectives 3 and 4, however, will only be as effective as the success in addressing objectives 1 and 2, i.e., development of optimal on-the-ground protocols and methodologies. In addition, the protocols could have been more comprehensive, e.g., by relating observations back to the salmon population level to the extent possible.

Finally, the ISRP provides suggestions to the authors for improving the format and content of the final report of the Cumulative Effects study, as well as detailed comments on Chapters 2 through 4 and Appendices A through J. In general, Chapter 2 provided a good synthesis of field work to date; however, reporting of fish results was limited. Chapter 3 provided carefully crafted suggestions for adaptive management phases, roles, and responsibilities for specified groups, and resulting work products. The authors clearly stated that for adaptive management to be successful cooperation is required among the primary funding agencies, stakeholders, and monitoring/research agencies. With respect to management considerations (Chapter 4), all critical uncertainties listed in the report were related to information gaps in estuarine ecology of juvenile salmonids relative to ecosystem restoration and habitat function. The ISRP advises that it is very important to address these critical uncertainties. Given the current gaps in information, future Cumulative Effects research and development recommended by the authors might fail to achieve the goals of CEERP.

B. Background

On October 4, 2011, the U.S. Army Corps of Engineers and the Northwest Power and Conservation Council asked the ISRP to review the Draft Annual Report[1] for the project *Evaluation of Cumulative Ecosystem Response to Restoration Projects in the Lower Columbia River and Estuary* (project EST-P-02-04), herein called the Cumulative Effects study. This request was in response to our earlier reviews of this project (ISRP 2010-6 and 2010-34) in which we deferred a recommendation on the project and requested that we review a final report summarizing the project's methods and results.

The Pacific Northwest National Laboratory (PNNL) and the National Marine Fisheries Service (NMFS) implement this project through the Corps' Columbia River Fisheries Mitigation (CRFM) Program, specifically the Anadromous Fish Evaluation Program (AFEP). ISRP review of projects under this program was directed in the 1998 U.S. Congress Senate-House conference report for the fiscal year 1999 Energy and Water Development Appropriations bill. The ISRP's review responsibilities are also incorporated in the Council's 2009 Fish and Wildlife Program.

Part of the ISRP's overall review charge is to look at the results of prior year expenditures. The ISRP provides findings on these results in "Retrospective Reports." Because this is a review of the results of this project's seven years (2004-2010) of implementation, this report is an ISRP retrospective review.

The Cumulative Effects study was established in 2004 and was conducted for the Corps' Portland District by a collaboration of research agencies led by the Pacific Northwest National Laboratory. The primary goal of the study was to develop a methodology to evaluate the cumulative effects of habitat restoration actions in the lower Columbia River estuary. The proponents describe the conglomeration of restoration projects in the estuary as follows: "A major portion of the effort, herein called the Columbia Estuary Ecosystem Restoration Program (CEERP[2]), is coordinated, funded, and evaluated by the federal Action Agencies, primarily the Bonneville Power Administration (BPA) and the USACE." The products of this research were intended to provide CEERP decision-makers a way to 1) evaluate the ecological performance of the collective habitat restoration effort in the lower Columbia River estuary and its effects on listed salmon, and 2) apply scientific knowledge from ongoing monitoring within a formal adaptive management framework to prioritize cost- and ecologically-effective restoration projects in the future.

[1] www.nwp.usace.army.mil/environment/docs/afep/draft/CE_2010_Annual_Report_draft.pdf

[2] This does not appear to be a formal program. The authors recommend (see below) that BPA, USCAE, and others doing restoration in the estuary (e.g., CLT, CREST etc) formalize their associations in an MOU.

The Cumulative Effects study had four main objectives:

1. Develop monitoring protocols;
2. Develop the theoretical and empirical basis for a cumulative effects methodology;
3. Design and implement evaluation of the cumulative effects methodology; and
4. Develop an adaptive management process to coordinate and coalesce restoration efforts.

Following literature review in 2004, the Cumulative Effects study was implemented in phases between 2005 and 2010. Field work was conducted primarily at four sites. Pre- and post-construction sampling was conducted at Kandoll Farm/Grays River, Washington (dike breaching), Crims Island (channel excavation), and Vera Slough, Oregon (tide gate replacement). Only post construction sampling was completed at the Julia Butler Hansen Wildlife Refuge, Washington (tide gate replacement), and some naturally breached sites were also sampled. Reference sites were included to match each restoration area. Marsh and swamp habitats were the focus of the study and particular emphasis was placed on the forested swamp habitat which had not been studied before. In addition to biological sampling, extensive work was conducted on topography and hydrology of the areas. Models were developed to estimate habitat availability for salmon, macrodetritus flux and export, and cumulative net ecosystem improvement. An adaptive management process was custom-designed for the CEERP during 2006 and 2007.

The proponents provided a series of annual reports for each year of implementation of the Cumulative Effects study. The 2010 draft report includes results from the last year of implementation and syntheses results from all years of the project. As noted by the authors, however, the 2010 draft report is not a standalone summary of all Cumulative Effects study research. Four primary papers and a NOAA Technical Memorandum have been published by members of the study group, and additional manuscripts are in revision (1) or preparation (9).

There are three major components to the 2010 Cumulative Effects study draft annual report. The first deals primarily with juvenile salmonid use of the habitats before and after restoration, the second presents a proposed detailed adaptive management process specific to agencies working in the estuary and the last component describes restoration lessons and provides research and management recommendations. There are also ten appendices.

C. General Conclusions and Comments

The Cumulative Effects study produced some excellent empirical data and results, some of which have already been published in primary journals. The proponents should be complimented for their efforts to disseminate data to estuary restoration practitioners. The estuary sampling protocol manual for monitoring and evaluation should be particularly useful (Roegner et al. 2009). Limited data were produced on fish use of forested wetlands in the tidal creeks of the estuary, a habitat type which is understudied. Information on fish use of marsh recovered by dike breaching generally confirmed results from similar projects in other estuaries such as the Salmon River, Oregon (Gray et al. 2002).

Many of the data produced deal with structure and function of biophysical aspects of the ecosystem such as hydrology, geomorphology, and vegetation mapping. The cumulative effects are summed over a variety of these ecosystem processes (with weighting), all of which are presumed to have led to increased salmon survival. While these ecosystem studies are very important to advance our understanding of how the estuary responds to various restoration efforts, the ISRP concluded that more information is needed on how restoration activities affect use and survival of salmon in the lower Columbia River estuary. The Cumulative Effects study could then be more useful for planning further work and implementation of estuary restoration in support of salmon recovery and the BiOp. As it stands, there is excessive reliance on inference via food web effects with assumptions that improved access to wetland-derived food (e.g., via increased habitat opportunity and vegetation response to rewatering) will lead to increased salmon survival. This is still an unproven tenet. In addition, results showed that food webs in recovered habitat can be dominated by non-native species (e.g., reed canary grass, killifish) – the implications of these hybrid food webs are not clear (ISAB 2011-1). Further discussion of these long-term, possibly chronic, problems is merited.

The 2010 Cumulative Effects study draft annual report does not fully summarize how the four objectives were met. The levels of evidence paper (Diefenderfer et al. 2011) provides a broad overview of the approach (in their words “introduce(s) a framework”) but naturally lacks details. This limitation in the draft final annual report can be seen by using one of the estuary components, the fish as an example. For monitoring protocols (Objective 1) and methodologies (Objective 2), the fish sampling and data analysis protocols are not clearly summarized, including the critical rationale of their choice of gears and designs over other such possible protocols and methodologies. The literature or *ad hoc* studies from this project supporting those decisions should be identified. One must assume that the most appropriate gears, sampling designs, and analytical approaches were used to compare reconnected vs. unconnected areas without having the supporting information to evaluate their scientific appropriateness. This process should be documented to fully address Objectives 1 and 2, in the final report, not only for fish but for all estuary components and the overall integrated approach across taxa and the estuary landscape.

General questions that the ISRP had about the project are as follows.

- Will these restoration activities significantly increase the production and life history diversities of salmonids, either within the Grays River system or the Columbia?
- With the huge number of releases of salmonids by hatcheries, usually large-sized juveniles, and their restricted seasonal migrations and utilization of tidal areas compared to pre-dam years, is availability of off-channel wetland habitat limiting rearing capacity for wild salmon?
- Will restoration actions be large enough to enable comparison of before/after differences in production and life history changes or "quicker recovery" of wild salmonids?

In this regard, recommendations described in report section 4.5.1 should include basin-by-basin assessment of available and available-and-utilized off-channel habitats in the estuary to estimate (model) possible limitations of these habitats to recovery.

With respect to this assessment, the ISRP identified several important questions, as follows:

- What is the percentage increase in habitat type represented by the restoration?
- Approximately what fraction of salmon populations use the habitats and for how long?
- What is the change in growth (bioenergetics approach needed) associated with rearing in restored versus unrestored areas?
- To what extent might export of organic matter and invertebrates to downstream areas contribute to growth of salmon that might not enter the newly restored habitat?

The ISRP also concluded, as found in reviews of earlier years of the program, that there is heavy emphasis in the draft report on suggestions for administrative processes to improve coordination and cooperation for restoration in the estuary (planning for a plan). This makes some parts of the report, especially the important discussions on management considerations (Chapter 4), difficult to assess and not amenable to scientific review. Improvement of administrative processes will likely require a more comprehensive landscape approach (ISAB 2011-4). More involvement of stakeholders, especially local governments such as County and town planners, and those outside the conservation-oriented agencies, is necessary. Development of indicators to monitor improvement in administrative processes may be a worthwhile approach to this complex issue.

The ISRP concludes that the Cumulative Effects study is a preliminary attempt to systematically select, develop, design, and test, in a limited way, an approach to effectively evaluate cumulative ecosystem response to habitat restoration projects. The outcomes of Objectives 3 and 4 will only be as effective as the success in addressing Objectives 1 and 2, that is, optimal on-the-ground protocols and methodologies. In addition, the protocols should have been more comprehensive, for example, by relating observations back to the population level to the extent possible. The final report should synthesize and support in reasonable detail all of the results at achieving the four objectives above. This document should allow readers to follow how effectively the objectives have been addressed and how their use has been scientifically justified.

D. Comments on Chapters

Chapter 2. Ecology and Hydrology of Restoring Wetlands in the Lower Columbia River and Estuary

Generally section 2.2 is a good synthesis of field work to date. The ISRP agrees that Hydrology and Water Quality, Topography and Bathymetry, Landscape, Vegetation, Habitat Availability, Fish, and Productivity and Material Flux are six key indicators (actually eight as they are broken out in Table S.1). They appear to have chosen these indicators based on their literature review in the first year of the study. The literature review was designed to search out methods for cumulative effects of restoration but presumably also sought out sampling methods for biota. Efforts to sample fish in Sitka spruce swamps with trap nets and seines failed to successfully capture fish and produce acceptable results for this reference site. This was the rationale for trying electrofishing. While this effort may be a bit too little, too late, only one year of data and not concurrent with other years, the ISRP concludes that it was a good decision to attempt to collect fish data from potentially important sites that are difficult to sample and fill in the gaps.

The reporting of fish results in Chapter 2 was limited. The proponents have made contributions to the primary literature on indicators for fish use (Appendix A). The paper by Roegner et al. (2010) covers most of the relevant results (residency, feeding, etc.) for juvenile salmon. Unfortunately, for many locations and years, the numbers of fish collected were so small that it is difficult to make any significant conclusions regarding preferences in habitat usage or food habits. It is not clear to the ISRP whether this was because of sampling difficulty or because fish numbers were likely low.

An important finding was that relative abundance of unclipped fry and fingerlings versus clipped hatchery fish appeared to be somewhat high (based on text), suggesting that the smaller natural origin salmonids may be utilizing the restoration sites. Unfortunately, the figures did not highlight CPUE of clipped versus unclipped fish by life stage (see Fig. 2.39; all salmon lumped together), so the reader cannot see the results that might support the text.

The report should have expanded on the salmon diet analysis as a key tool to evaluate restoration effectiveness. The reported information (half page) shows only that coho ate a variety of organisms from the wetland. Ideally, the investigators should have estimated stomach fullness and caloric content of prey, and then used a bioenergetics approach to evaluate growth potential in restored versus unrestored sites. Hatchery and natural salmon should be analyzed separately. An example of this approach was published by Cordell et al. (2011).

Missing from this draft report is a direct link to salmon stocks, especially as relevant to the BiOp. The proponents state that a program to directly measure contributions of juveniles that used wetlands to returns of adults salmon is "neither practicable nor possible" (page 2.2). The ISRP considers this to be an overly pessimistic view. For example, are transfer experiments such as those conducted by Solazzi et al. (1991) totally out of the question? Table 2.2 shows indicators on hatchery/wild origin and use of electronic tags, mark/recapture, and even SARs, although little information on these was provided in the text. How are these to be included in future research?

The Cumulative Effects study has three paired restored and reference sites, but little information is provided on selection or appropriateness, or how they compared. Restoration comparisons with reference sites (the BARR approach) is a reasonable approach given that the proponents were unable to arrange a temporal sequence for a BACI study. However the reference site from Crims Island is a problem – it is a created site and may not reflect natural conditions. Some discussion of the age and other attributes of the latter site would be useful.

For evaluating cumulative effects of restoration actions, the ISRP expected to see comparisons of habitat restoration with habitat availability in the estuary zone, as well as estimates of the fraction of the hatchery and/or natural salmon population that used the sites and residence times at the sites. This type of approach, even if crude estimates, would provide some indication of how much effort is needed to make a difference. For example, in the Duwamish River estuary, Washington, residence time and cumulative number of hatchery versus natural Chinook salmon that utilized five off-channel restoration sites was calculated and compared with estimates of total Chinook salmon abundance (Ruggerone and Jeanes 2004; Cordell et al. 2011). In total, less than 1% of hatchery and less than 1% of natural Chinook salmon populations used the five restoration sites and residence time was brief (average ~1.5 tide cycles). Thus, restoration planners had information suggesting that they needed many more restoration sites and much bigger sites before there would likely be a measurable effect of restoration actions on the Chinook population. The ISRP review asked the key question: how much restoration is needed in the estuary to make a difference to salmon?

There seems to be a problem with the data on shrub and tree vegetation sampling at the Kandoll Farm reference site (KR) as the areal change between 2005 and 2009 was exactly the same for the two types (16242 m^2 to 21248 m^2).

As found in other estuary restoration projects, invasive plants such as reed canary grass move into the restored area. Conversely, other invasives such as Himalayan blackberry are eliminated when inundation is restored after culvert installation. These major changes in ecosystem structure are not discussed, notably the implications of change in *quality* of macrodetritus as well as links to invertebrates. For example a monoculture of reed canary grass was found to support fewer insect taxa relative to a more diverse marsh in Washington (Hansen and Castelle, 1999) and purple loosestrife detritus entered the detrital food web at a different time relative to native marsh plants such as sedges (Grout et al 1997).

One key question the ISRP wanted the proponents to address was the potential contribution of marsh macrodetritus from the restoration back into the estuarine food web. The draft annual report produced estimates of exported organic matter. However, to provide an analysis of cumulative effects, the ISRP expected this export to be placed in perspective. According to their estimates the Kandoll Farm, Vera Slough, and Crims Island restoration sites would have contributed 264 MT biomass per growing season (page 2.96), with the caveat that the Vera Slough site data were very weak. The exported dry weight seems impressive, but how does this compare with organic matter in the estuary zone? What is the percent increase in organic matter within the estuary zone provided by the restoration activity? It would have been useful to put this gain in biomass, which presumably ends up as macrodetritus, in perspective by comparing it with the loss data given in Sherwood et al. (1990). This is but one example of the need to put findings in perspective throughout the entire report.

Some figures in Chapter 2 were incomplete or missing labels. For example, Fig. 2.42 did not match the caption. The caption stated that 2005-2009 values were shown (pre- and post-restoration) but only 2006 and 2007 values were presented. Fig. 2.36 needs labels to identify the three bars. Fig. 2.43 needs labels to identify the three plots in each row. Careful examination of figures and figure captions for completeness is needed throughout the report.

Chapter 3. Adaptive Management of Ecosystem Restoration in the Lower Columbia River and Estuary

The 2010 ISRP review of the project stated that further information on how the adaptive management framework would be tailored to meet the needs of restoration projects would be beneficial (ISRP 2010-6). This chapter addresses that need by describing an adaptive management process that formalizes procedures to integrate existing program documents and activities by making specific recommendations including adaptive management phases, responsible parties, deliverables, schedules, and implementation tasks. The authors repeatedly state that the process could be modified to serve the needs of individual restoration programs. In general, the balance between prescribing detailed processes and identifying flexibility is effectively presented. However, because sampling of fishes in some habitats was a problem in this study, further explanation is needed on whether adaptive management will address this and other methodological issues as a means to reduce uncertainty in the findings.

The authors cite published work that identifies conditions necessary for adaptive management to be warranted and identify necessary steps for success including clear identification of management objectives, decisions, and uncertainties, and a commitment by stakeholders to implement adaptive management.

The chapter includes detailed suggestions for groups to be responsible for the phases in the adaptive management process. The details include suggested outlines for plans, synthesis memoranda, and reports as well as tentative schedules for integration of adaptive management phases, products, meetings, and activities.

This chapter provides carefully crafted suggestions for adaptive management phases, roles, and responsibilities for specified groups, and resulting work products. The authors clearly state that for adaptive management to be successful requires cooperation among the primary funding agencies, stakeholders, and monitoring/research agencies.

Chapter 4. Management Considerations

Chapter 4 summarizes project deliverables and products, restoration lessons learned by the authors, critical uncertainties, and recommendations for future Cumulative Effects research and development and outreach. All of the critical uncertainties listed by the authors are related to information gaps in the estuarine ecology of juvenile salmonids relative to ecosystem restoration and habitat function. The ISRP advises that it is very important to address these critical uncertainties. Furthermore, these uncertainties need to be specifically addressed with respect to listed species and life-history types (ocean-type vs. stream type). Given the current gaps in information, future Cumulative Effects research and development recommended by the authors might fail to achieve the goals of CEERP.

E. Comments on Appendices

Appendix A. Temporal Land Cover Analysis for Net Ecosystem Improvement

Appendix A provides a comparison of methods used to map wetland vegetation and track changes in forest cover during the Cumulative Effects study. These are important methods for the study since the resulting measurements ultimately describe gain or loss in detritus flux, which is a key component of the “cumulative net ecosystem improvement” index (CNEI).

The primary goal was to develop the method for periodic land cover analysis at the reach and watershed scales to support the CNEI index. Remote sensing using satellite data (C-CAP 30-m resolution) was not found to provide appropriate land change analysis at a small scale/site scale, and high level aerial photography (1-m resolution) was used for the restoration sites. However, satellite data showed losses of forest cover in the contributing watersheds of the estuary totalling 190.2 km^2 during the first 6 years of BiOp implementation, 2001–2006, which also brackets the first 3 years of this study. At the whole estuary and watershed scale sources of detritus were being lost on the flanks of the estuary while wetland gains were occurring on the floodplain. On the other hand, sediment input from the watersheds may have increased which in turn raises elevation and encourages wetland vegetation expansion.

The results highlighted the complex issues in estimating detritus contributions from the forested watersheds draining into the estuary and in comparing the magnitude of those contributions to wetland productivity. Closer collaboration with forest managers and researchers is recommended. The ISRP agrees with the proponents that further development and testing of remote sensing is needed to advance reliable cost-effective methods for forest and vegetation mapping in the Columbia River estuary.

Appendix B. The Columbia River Tidal-Fluvial Regime: Water-Level Variations, Inundation, and Vegetation Patterns

Appendix B contains detailed analyses of water-surface elevation and vegetation data to identify biophysical zones in the lower Columbia River between the ocean and Bonneville Dam. Results indicated four biophysical zones: (1) a lower estuary zone (rkm 0-21), affected by tides and salinity, (2) an energy minimum zone (rkm 21-87, to constriction in river at Beaver), affected by tides and river flow, but not salinity, (3) a tidal river zone (rkm 87-229), where river flows dominate over tidal effects, and (4) a landslide-controlled zone (rkm 229-235; final 6 km below Bonneville Dam), containing distinctive vegetation and steeper bed slope than elsewhere in the tidal river zone. The authors note that time series data from only 16 of 35 of the wetland tide gauges have been analyzed and that "preliminary analysis of the remaining 20 shallow-water tide gauge time-series data will be completed in next few months." The authors concluded that their classification system explained a higher proportion of variance in plant cover than five previously published and unpublished classification systems. Detailed results for the other classification systems were not presented, although the authors stated that these findings were further explored by Borde et al. (in preparation), which was not provided to the ISRP. There was no attempt by the authors to relate these biophysical zones to utilization by salmonids. Furthermore, there was no explanation as to how this classification scheme will be used to evaluate the cumulative effects of habitat restoration in the Columbia River estuary.

Appendix C. On realized habitat utilization for salmonids in a restored wetland habitat

Generally Appendix C is well written and informative with instructive figures and tables, especially for quantifying physical habitat availability of channel, edge, and marsh areas at different tidal stages. It also provides information on the duration during the year of presence of juvenile salmonids and "realized" habitat use. The full breach here has apparently "greatly enhanced" habitat availability. This appendix refers only to the Kandoll Farm site and not to the other restored sites

However, this is an appendix and does not include other necessary information in order to stand alone. Some of the needed information is in the text preceding this appendix or apparently in Roegner et al. (2009). Integration of this appendix with sections of Chapter 2 would provide a more complete and comprehensive report.

More information is needed on sampling. For example, details are needed for the trap netting effectiveness—where were they located? Do they extend across the entire channel width? What about fish that remain in the channel at low tide in pools? It would be useful to test effectiveness with tagged fish released above the traps.

Another issue is comparison with a reference site (KR). Is Seal Slough (Fig. 2.4.1) really a good reference for Kandoll Farm? The Kandoll Farm site on the Grays River is close (8 km) to the mainstem Columbia, so juveniles either from upstream in the Grays or "out-of-basin" fish from the Columbia may be utilizing this site. How did they determine that "out-of-basin" fish moved into Kandoll Farm to rear? If this information is contained in another report, it should be adequately summarized and cited in this report.

Times of hatchery release from Grays River hatcheries for all species should be shown along with seasonal fluctuation in catches. In general, there is a need to differentiate hatchery and wild fish and to identify and report the origin of hatchery fish and hatchery/wild ratios.

Catch per unit effort is shown here on the basis of % total annual catches by species, which tell us nothing about abundance or comparisons to reference sites. Some measure of abundance based on flooded areas of marsh surface and edge would be more informative and could be used for comparisons with reference sites. Numbers and sizes are given however in section 2.3.6.4 for Kandoll Farm.

Appendix D. Electrofishing in swamp habitats in the vicinity of Grays Bay during Spring 2010

As the authors indicate the data are limited and only apply to low tide conditions. The small numbers of salmonids collected do not allow many conclusions to be made. A much more extensive effort would need to be implemented over a wider range of tidal levels and seasons as the authors recommend. Also comparisons of electrofishing data collected in 2010 to trap net data from 2006 and 2007 are weak, at best. More detail on the design and deployment of the trap net, as well as comparisons to other studies, would be beneficial to understanding sampling problems in swamp habitats.

However, this preliminary study provides enough information to include electrofishing methods as a potential sampling technique in the program. The methods for electrofishing were only generally described, and we assume that the complete details will be in the USFWS technical/annual report. In general the methods appear adequate with equal effort and tide levels, but without seeing a copy of the USFWS report titled "*Fish Assemblage Structure of Tidal Forested Wetlands in the Columbia River Estuary,*" which presumably is in draft status, it is difficult for the ISRP to determine if the details are well-documented.

Appendix E. Material and nutrient flux from restoring wetlands in the tidal freshwater of the Lower Columbia River and Estuary

Appendix E provides a preliminary application of hydrodynamic modeling to estimate detritus export from the Kandoll Farm restoration area as well as nutrient flux. Overall, the modeling showed that a substantial proportion of the particulate matter from decaying vegetation, that was mobilized, left the Kandoll Farm site. Of this mobilized material, approximately 52% reached the estuary and 48% remained in the floodplain and river. This kind of modeling shows promise for understanding the seasonal dynamics of detritus flux in relation to tides and river flows and could be applied to help forecast effects of changes in the hydrosystem such as seasonal spills. The recommendation section could be improved by suggestions on how to tie these lower trophic level dynamics to invertebrates important to salmonids. This is a very complex area of investigation, but as noted in our summary comments, inferences at the basal trophic levels are difficult to translate to salmon production and diversity with our current knowledge.

Appendix F. Statistical and Other Considerations for Restoration Action-Effectiveness Monitoring and Research

The stated purpose for the appendix is to present program- and project-level considerations for action effectiveness monitoring and research (AEMR). Objectives are listed below with associated review comments.

- Establish a methodology to specify statistical relationships between intensive action-effectiveness research and extensive action-effectiveness monitoring, including a method to indicate how much AEMR sampling is enough.

Comment: The framework for determining the number of intensive sites appears sound. Selection of measures that are highly correlated and use of ratio, regression, or nonlinear model estimators is supported by cited research. The authors appropriately state that this is just one possible quantitative framework that can be used to determine how much sampling is enough in the estuary.

- Provide a statistical approach for quantitative meta-analysis of AEMR data.

Comment: The authors discuss use of the expository weight-of-evidence argument in testing hypotheses of concern but caution that no common standard of evidence exists for everyone. Meta-analysis is proposed as one approach to combine diverse data sources to provide an overall assessment of a hypothesis. A reasonable discussion of weighting of evidence is provided.

- Offer approaches to prioritize AEMR and critical uncertainties research.

Comment: The authors provide a brief description of approaches to prioritizing AEMR, identify gaps in information, and provide questions to aid in prioritization. The brief coverage does not provide sufficient content to effectively guide prioritization.

- Summarize considerations in selecting the appropriate remote-sensing data for monitoring vegetation.

Comment: A table providing a succinct comparison of airborne and satellite platforms for remote sensing to characterize vegetation leads to the conclusion that the satellite platform is preferred.

- Develop or revise templates for project descriptions, action-effectiveness monitoring and research plans, and site evaluation cards.

Comment: Templates are presented for project-specific AEMR plans and for site evaluation cards. The templates are provided to promote standardization and efficiency. The authors state that some templates are not part of the regular reporting by practitioners and that the utility and value depend on the ability and ease with which some templates can be accurately completed by a wide range of restoration personnel. As a consequence the authors state it may be necessary to engage professionally trained teams to ensure the necessary information is accurately and properly collected. It is not clear from the material provided how these teams would be constituted and funded.

Appendix G. Meta-Analysis of Action Effectiveness at Three Restoration Projects in the Lower Columbia River and Estuary

The stated objective was to perform a qualitative meta-analysis of the collective effectiveness of restoration actions at three sites. As such, this appendix presents a limited case study designed to demonstrate the potential for a meta-analysis of action effectiveness in the estuary. The authors state, "The strength of meta-analysis is its ability to *statistically* synthesize results from many studies having a common research question." However, a statistical meta-analysis of the Columbia Estuary Ecosystem Restoration Program (CEERP) effectiveness data was not demonstrated due to limitations in the current state of the data meta-analysis presented. The stated intent is to perform a statistical meta-analysis in the near future to synthesize monitoring results from a suite of common metrics reported in site evaluation cards (SEC) from 15 to 30 sites.

The insights gained from this limited case study should be useful in conducting future quantitative meta-analyses. The authors express appropriate caution about future comprehensive and quantitative meta-analyses by stating limitations due to variability in level of monitoring effort, lack of pre-restoration sampling, varied levels of effort in sampling common indicators, and the need for long-term assessment to fully evaluate condition of the sites. A brief outline of possible next steps for implementing a quantitative meta-analysis concludes this appendix.

It is not clear from the material presented in Appendix G when, or if, a statistically rigorous quantitative meta-analysis can be successfully conducted for CEERP. Publication of the results of future analyses is strongly encouraged.

Appendix H. Detailed Outline for the FY 2012 CEERP Action Plan

The CEERP Action Plan is a proposed effort to help coordinate the various RME programs related to restoration in the estuary. According to the list there are 12 programs underway, but this apparently only includes BPA and USACE and related initiatives. It would be helpful to include the efforts of other agencies such as EPA which also are active in the estuary, as the ISRP learned at the Columbia River Estuary Science-Policy Exchange in Astoria, Oregon, in September 2009 (www.nwcouncil.org/fw/program/2009spe/Default.asp). Additional agencies might have complementary data or related goals.

Appendix I. Photo Points

The photo point methodology worked at some sites to track changes in vegetation, but fluctuations in water levels caused problems. The proponents concluded that photo points are a core indicator. Photos are extremely useful in interpretation of vegetation change. But the time series of photos could have been enhanced with brief text telling the reader what the restoration action accomplished, as indicated in the time series of photos. This may be obvious to the project members but not to the ISRP. Because of fluctuating water levels the photos need to be carefully planned for inclusion as a core indicator.

Appendix J. Plant List

This a comprehensive vegetation inventory that should be useful for monitoring purposes. It would be useful to list the identification manuals used.

F. References

Borde, A.B., H.L. Diefenderfer, S.A. Zimmerman, R.M. Thom, and V.I. Cullinan. In Preparation. Wetland vegetation community distribution and inundation patterns in thee tidally influenced Columbia River, USA. *River Research and Applications.*

Cordell, J. R. J, D. Toft, A. Gray, G. T. Ruggerone, and M. Cooksey 2011. Functions of restored wetlands for juvenile salmon in an industrialized estuary*. Ecological Engineering.* 37:343-353.

Diefenderfer, H.L, R.M. Thom, G.E. Johnson, J.R. Skalski, K.A. Vogt, B.D. Ebberts, G.C. Roegner, and E.M. Dawley. 2011. A levels-of-evidence approach for assessing cumulative ecosystem response to estuary and river restoration programs. *Ecological Restoration.* 29:111-132.

Gray. A., C.A. Simenstad, D.L. Bottom and T.J. Cornwell. 2002. Contrasting functional performance of juvenile **salmon** habitat in recovering wetlands of the **Salmon River** estuary, **Oregon**, USA. *Restoration Ecology.* Vol. 10 No. 3, pp. 514–526.

Grout, J., Levings, C.D. and J.S. Richardson. 1997. Decomposition rates of purple loosestrife (*Lythrum salicaria*) and Lyngbyei's sedge (*Carex lyngbyei*) in the Fraser River estuary. *Estuaries*. 20:96-102.

Hansen, J.D., and A.J. Castelle. 1999. Insect diversity in soils of tidal and non-tidal wetlands of Spencer Island, Washington. *Journal of the Kansas Entomological Society.* Vol. 72, No. 3 (Jul., 1999), pp. 262-272 (article consists of 11 pages).

ISAB (Independent Scientific Advisory Board). 2011-1. Columbia River Basin Food Webs: Developing a Broader Scientific Foundation for Fish and Wildlife Restoration. Northwest Power and Conservation Council. Portland, Oregon. www.nwcouncil.org/library/isab/2011-1/

ISAB. 2011-4. Using a Comprehensive Landscape Approach for More Effective Conservation and Restoration. Northwest Power and Conservation Council. Portland, Oregon. www.nwcouncil.org/library/report.asp?d=640

ISRP. 2010-6. Preliminary Review of Six 2010 Estuary Proposals submitted for the U.S. Army Corps of Engineers' Anadromous Fish Evaluation Program. Northwest Power and Conservation Council. Portland, Oregon. www.nwcouncil.org/library/report.asp?d=625

ISRP. 2010-34. Review of seven 2011 Anadromous Fish Evaluation Program proposals for the Columbia River Estuary. Northwest Power and Conservation Council. Portland, Oregon. www.nwcouncil.org/library/report.asp?d=10

Roegner, G.C., H.L. Diefenderfer, A.B. Borde, R.M. Thom, E.M. Dawley, A.H. Whiting, S.A. Zimmerman, and G.E. Johnson. 2009. Protocols for monitoring habitat restoration projects in the Lower Columbia River and Estuary. U.S. Department of Commerce, National Oceanic and Atmospheric Administration. Technical Memorandum NMFS-NWFSC_97, Northwest Fisheries Science Center, Seattle, Washington.

Ruggerone, G.T., and E. Jeanes. 2004. Salmon utilization of restored off-channel habitats in the Duwamish Estuary, 2003. Prepared for Environmental Resource Section, U.S. Army Corps of Engineers, Seattle District. Prepared by Natural Resources Consultants, Inc. and R2 Consultants, Inc. Seattle, WA.

Sherwood, C. R. , D. A. Jay, R. B. Harvey, P. Hamilton, and C. A. Simenstad. 1990. Historical Changes in the Columbia River Estuary. *Progress in Oceanography.* 25:299-352.

Solazzi, M. F., T.E. Nickelson, and S. L. Johnson. 1991. Survival, contribution, and return of hatchery coho salmon (*Oncorhynchus kisutch*) released into freshwater, estuarine, and marine environments. *Canadian Journal of Fisheries and Aquatic Sciences.* 48: 2493-253.