

Columbia Estuary Ecosystem Restoration Program

2012 ACTION PLAN

FINAL

Prepared by the Bonneville Power Administration and U.S. Army Corps of Engineers, Portland District



**US Army Corps
of Engineers®**

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Preface

The 2012 Action Plan was produced by the Bonneville Power Administration (BPA) and U.S. Army Corps of Engineers, Portland District (Corps). A BPA/Corps committee developed a first draft, which was reviewed by staff from Columbia Land Trust, Columbia River Estuary Study Taskforce, Lower Columbia Estuary Partnership, Lower Columbia Fish Recovery Board, National Marine Fisheries Service, Northwest Power and Conservation Council. Based on extensive, in-depth review comments, the draft report was revised to produce the final 2012 Action Plan. The BPA/Corps take full responsibility for the report's content.

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Executive Summary

The 2012 Action Plan for the Columbia Estuary Ecosystem Restoration Program (CEERP) was developed by the Bonneville Power Administration (BPA) and U.S. Army Corps of Engineers, Portland District (Corps) to document their plans for habitat restoration projects and research, monitoring, and evaluation in the lower Columbia River and estuary (LCRE) during 2012. The overall goal of the CEERP is to understand, conserve, and restore ecosystems in the LCRE. The Action Plan is one of three inter-related, annual CEERP deliverables; the others are the Synthesis Memorandum and the Strategy Report.

The Action Plan outlines restoration and research, monitoring, and evaluation (RME) actions based on the strategy developed in the Strategy Report. Monitoring and research results are evaluated in the subsequent Synthesis Memorandum, which in turn is used adaptively to update the next Strategy Report and Action Plan. In other words, the Synthesis Memorandum establishes the knowledge base for restoration ecology and engineering at site, landscape, and estuary-wide scales; the Strategy Report applies this knowledge base to provide strategic, programmatic guidance for restoration implementation and RME; and the Action Plan uses CEERP strategies to prioritize and select specific implementation and RME projects under the CEERP. The CEERP deliverables are intended to guide or inform, as appropriate, the Actions Agencies, National Marine Fisheries Service, Northwest Power and Conservation Council, restoration project sponsors, researchers, and various interested parties. The CEERP will use as appropriate information from projects funded outside CEERP for other purposes, such as studies regarding predation, toxics, dredging, hydrosystem operations, and tributary habitat improvements, and other topics.

The 12-month period for the CEERP deliverables is a calendar year (CY) and starts with CY 2012. The 2012 Synthesis Memorandum, a comprehensive compilation of science to date concerning juvenile salmon ecology and ecosystem restoration in the LCRE, is currently under development and scheduled for regional release in June 2012. Rather than wait for one-half year, the BPA and the Corps (BPA/Corps) initiated the 2012 Strategy Report and 2012 Action Plan to jump-start the CEERP process. The 2012 Strategy Report, however, contains a synthesis and evaluation “brief” to support strategies for restoration and RME actions during CY 2012. The 2012 Synthesis Memorandum will feed the 2013 Strategy Report and 2013 Action Plan. Within the CEERP’s adaptive management process, the CEERP deliverables will be updated annually for applicability, transparency, and accountability.

The Action Plan applies the CEERP’s ecosystem-based strategy to prioritize and select specific implementation and RME projects. The Action Plan was prepared by the BPA/Corps with review by and collaboration with regional restoration sponsors, researchers, and other stakeholders involved in the CEERP, including the Columbia Land Trust, Columbia River Estuary Study Taskforce, Lower Columbia Fish Recovery Board, Lower Columbia Estuary Partnership, National Marine Fisheries Service (NMFS), Northwest Power and Conservation Council (Council), Oregon Department of Fish and Wildlife, Pacific Northwest National Laboratory, U.S. Fish and Wildlife Service, U.S. Geological Survey, Washington Department of Fish and Wildlife, and others. The BPA/Corps intend to provide the Action Plan for review by NMFS, the Council, the Independent Scientific Review Panel (ISRP), and other parties. The 2012 Action Plan, along with the recently released 2012 Strategy Report and the forthcoming 2012 Synthesis Memorandum, address ISRP and Council conditions for BPA-funded projects designed to support a programmatic approach to LCRE habitat restoration and RME within an adaptive management process. The BPA/Corps and other CEERP stakeholders will use the Action Plan for implementation

organization and for tracking progress, thereby helping increase the program's certainty in attaining its goals and objectives.

This CEERP 2012 Action Plan is based on the BPA/Corps' fundamental strategy for estuary habitat actions and RME—apply an ecosystem-based approach to restoring, enhancing, or creating ecosystem structures, processes, and functions in the estuary, and perform RME to assess the effectiveness of these actions, while building basic understanding of LCRE ecosystems. The Action Plan details the approach for developing and prioritizing projects, including several key decision points, such as survival benefit unit (SBU) results. Briefly, CEERP decision-making involves an iterative process which, for Biological Opinion-related work, focuses on cost per SBU, total SBUs and project likelihood (relative to social and technical complexity). Project sponsors are required to develop project goal maps such that preliminary SBUs are assigned. Projects proposed to the BPA and Corps will get funding based on total SBUs, cost per SBU, project likelihood, as well as other factors as applicable. As a project moves through successive phases, the estimate of cost per SBU will become more robust, thereby reducing decision uncertainty. This iterative process will continue until the project is ready for construction, at which point the ERTG will assign SBUs, the last decision point for the BPA/Corps.

The CEERP has four key management questions that affect program decision-making and are addressed through RME: 1) What are the limiting factors or threats, i.e., stressors and controlling factors, in the estuary preventing the achievement of desired habitat or fish performance? 2) Which actions are most effective at addressing the limiting factors preventing achievement of habitat, fish, or wildlife performance objectives? 3) Are the estuary habitat actions achieving the expected biological and environmental benefits? 4) What adjustments should be made, if any, to improve the ability of the SBU crediting method to predict benefits to ESA-listed fish from ecosystem protection and restoration in the LCRE? The RME results are used to adaptively inform the CEERP decision-making.

The BPA/Corps plan to implement restoration projects throughout the LCRE during calendar year 2012. The projects were developed in collaboration with restoration project sponsors as described in the 2012 Strategy Report. Project status ranges from initial concept to design, with many projects in the feasibility phase. Some of the projects are land acquisitions. This restoration effort will be closely coordinated with associated ongoing CEERP RME. Seven RME projects are queued for CY 2012, including one status and trends monitoring project, one critical uncertainties research project, and five action effectiveness monitoring and research projects. Furthermore, finalization of the estuary habitat classification system is especially important to the CEERP because it will help support RME modifications to existing study designs as identified by the ISRP and others. Also, the LCRE ecosystem classification system will inform project development and prioritization.

In closing, the CEERP 2012 Action Plan reflects the integrated strategy for restoration and RME, as described in the 2012 Strategy Report. To be successful, data and coordination are focus areas for CEERP managers with the BPA/Corps. Development on a publically available, geospatial relational database for the LCRE will commence in 2012. Periodic coordination meetings of various kinds of CEERP-related activities are scheduled. The 2012 schedule for final versions of CEERP deliverables is 2012 Synthesis Memorandum (June), 2013 Strategy Report (September), and 2013 Action Plan (November).

Acronyms and Abbreviations

AEMR	action effectiveness monitoring and research
AER	action effectiveness research
AFEP	Anadromous Fish Evaluation Program
AM	adaptive management
BiOp	Biological Opinion
BPA	Bonneville Power Administration
BPA/Corps	Bonneville Power Administration and the U.S. Army Corps of Engineers
CE	cumulative effects
CEERP	Columbia Estuary Ecosystem Restoration Program
CLT	Columbia Land Trust
Corps	U.S. Army Corps of Engineers
COTR	contracting officer's technical representative
Council	Northwest Power and Conservation Council
CREEC	Columbia River Estuary Ecosystem Classification
CREST	Columbia River Estuary Study Taskforce
CSR	Columbia Stock Ranch
CUR	critical uncertainties research
CY	calendar year
EOS	Estuary/Ocean Subgroup
EP	Estuary Partnership (Lower Columbia Estuary Partnership)
ERTG	Expert Regional Technical Group
ESA	Endangered Species Act
ESU	evolutionarily significant unit
FCRPS	Federal Columbia River Power System
FY	fiscal year
ICM	implementation and compliance monitoring
ISRP	Independent Scientific Review Panel
JBH	Julia Butler Hansen (National Wildlife Refuge)
LCRE	lower Columbia River and estuary
LOE	levels of evidence
NA	not applicable
MOA	Memorandum of Agreement
MS	multi-scale
NOBPA/CORPS	National Oceanic and Atmospheric Administration
NPCC	Northwest Power and Conservation Council
NMFS	National Marine Fisheries Service

NWFSC	Northwest Fisheries Science Center
NWR	National Wildlife Refuge
PNAMP	Pacific Northwest Aquatic Monitoring Partnership
ODFW	Oregon Department of Fish and Wildlife
OHSU	Oregon Health Sciences University
OSU	Oregon State University
PDT	
PNNL	Pacific Northwest National Laboratory
PSU	Portland State University
RME (or RM&E)	research, monitoring, and evaluation
RPA	Reasonable and Prudent Alternative
SBU	survival benefit unit
S&E	synthesis and evaluation
SM	Synthesis Memorandum
SRWG	Studies Review Work Group
STM	status and trends monitoring
SWG	Science Work Group
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UW	University of Washington
WDFW	Washington Department of Fish and Wildlife

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1.0 Introduction

The purpose of the Columbia Estuary Ecosystem Restoration Program (CEERP)¹ 2012 Action Plan is to document the process and resulting plans to implement the CEERP strategy for ecosystem restoration and research, monitoring, and evaluation (RME) in the lower Columbia River and estuary (LCRE) during calendar year (CY) 2012. The Bonneville Power Administration (BPA) and the U.S. Army Corps of Engineers, Portland District (Corps) jointly instituted the CEERP to implement federal ecosystem restoration actions and RME in the LCRE in response to various requirements, mandates, and authorities (see the 2012 Strategy Report [BPA/Corps 2012]). The BPA and the Corps (BPA/Corps) conduct the CEERP using an adaptive management process that includes an Action Plan containing the annual blueprint for ecosystem restoration and RME actions in tidally influenced areas of the LCRE floodplain (Figure 1).



Figure 1. Map of Lower Columbia River and Estuary Study Area

The annual action plans also serve the implementation plans for the Biological Opinion (BiOp) on operation of the Federal Columbia River Power System (FCRPS) required by the U.S. District Court (U.S. District Court 2011). In addition to the FCRPS BiOp, the CEERP addresses recovery plans for Endangered Species Act-listed salmon and steelhead species (Lower Columbia Fish Recovery Board 2010; NMFS 2011), the Washington Memorandum of Agreement on Estuary Habitat Actions (Washington-Action Agencies 2009), and various federal Water Resources Development Acts, Sections 206, 536, and 1135.

The CEERP is an integral part of BPA's implementation of the estuary provisions of the Northwest Power and Conservation Council's (Council's) 2009 Fish and Wildlife Program (Council 2009). The CEERP specifically addresses the Council's estuary strategies for habitat reconnections, long-term

¹ CEERP is a name recently established for the BPA/Corps estuary restoration effort that started with the 2000 FCRPS BiOp. Broadly speaking, the goal of the CEERP is to understand, conserve, and restore ecosystems in the LCRE. CEERP restoration actions are also intended to provide survival benefit units (SBUs) for salmonids established in the 2008 FCRPS BiOp, i.e., 45 units for ocean-type and 30 units for stream-type salmon, by 2018 (NMFS 2008). The ecosystem-based strategy prioritizes restoring habitat, increasing access to areas that have been cut off from the main stem system; restoring habitat capacity and the quality of existing habitats for juvenile salmonids; and controlling predators (Simenstad and Cordell 2000; Johnson et al. 2003). The intent is to implement projects that provide the most SBUs at the least cost to rate payers.

effectiveness monitoring, estimation of juvenile salmon survival rates, impacts from estuary stressors, and partnerships. The Lower Columbia Subbasin Plan (Council 2005), part of the Council’s Fish and Wildlife Program, was a building block for the CEERP because of its comprehensive assessment of identifying limiting factors and environmental conditions for a suite of focal species in the LCRE and a wide range of potential management actions. Furthermore, the Council’s RME/Artificial Production Categorical Review Recommendation Report – Recommendation 3 to monitor and evaluate the effectiveness of habitat actions in the estuary (ISRP 2010) is being fulfilled by the CEERP, as this Action Plan demonstrates.

The Action Plan was prepared by the BPA/Corps in collaboration with regional restoration sponsors, researchers, and other stakeholders participating and collaborating in the CEERP. The BPA/Corps intend to provide the Action Plan for review by the National Marine Fisheries Service (NMFS), the Council, the Independent Scientific Review Panel (ISRP), and other interested parties. The BPA/Corps intend that the 2012 Action Plan, along with the CEERP 2012 Strategy Report, address the ISRP and Council recommendations for BPA-funded projects designed to support a programmatic approach to LCRE habitat restoration and RME within an adaptive management process. The BPA/Corps and other CEERP stakeholders will use the Action Plan for implementation organization and for tracking progress, thereby helping increase the program’s certainty in attaining its goals and objectives.

1.1 Goal, Objectives, Hypotheses, and Management Questions

The BPA/Corps have formulated a goal, objectives, hypotheses, and management questions for the CEERP (Table 1). (See the 2012 Strategy Report [BPA/Corps 2012] for a more detailed explanation of these fundamental program elements.) The overall goal of the CEERP is to understand, conserve, and restore ecosystems in the LCRE. Restoration projects are implemented to meet the survival benefit unit (SBU) goals and RME is performed to reduce uncertainty and assess effectiveness, while answering the management questions (see details in Sections 2.0 and 3.0).

Table 1. CEERP Objectives and Management Questions (after Johnson et al. 2008, 2011a). Indicators are listed in Section 4.3 of the Strategy Report (BPA/Corps 2012).

Category	Description
Specific Objectives	<p>Understand what effect primary stressors have on ecosystem controlling factors; e.g., flow regulation, passage barriers.</p> <p>Conserve and restore factors that control ecosystem structures/processes; e.g., hydrodynamics.</p> <p>Increase quantity and quality of ecosystem structures; e.g., estuarine habitat for juvenile salmonids.</p> <p>Maintain and enhance LCRE food webs to benefit salmonid performance.</p> <p>Improve salmonid performance in terms of life-history diversity, foraging success, growth, and survival/fitness.</p>
Management Questions	<p>Q1: What are the limiting factors or threats, i.e., stressors and controlling factors, in the estuary preventing the achievement of desired habitat or fish performance?</p> <p>Q2: Which actions are most effective at addressing the limiting factors preventing achievement of habitat, fish, or wildlife performance objectives?</p> <p>Q3: Are the estuary habitat actions achieving the expected biological and environmental benefits?</p> <p>Q4: What adjustments should be made, if any, to improve the ability of the SBU crediting method to predict benefits to ESA-listed fish from ecosystem protection and restoration in the LCRE?</p>

1.2 Adaptive Management Process

The CEERP is implemented using an adaptive management process entailing five phases (Figure 2)—decisions, actions, monitoring/research, synthesis and evaluation, and strategy (Thom 2000). The process feeds back on itself so that decisions and actions are based on input from previous RME and strategy phases (see Figure 3 for a hypothetical example of this process). Teams of key staff perform specific functions and assume certain responsibilities to produce desired outcomes (Tables 2 and 3). The CEERP adaptive management process is described in detail by Thom et al. (2011). The Action Plan is the deliverable from the Decide Phase in the CEERP adaptive management process.

The 12-month period for the CEERP deliverables is a calendar year (CY) and starts with CY 2012. The 2012 Synthesis Memorandum, a comprehensive compilation of science to date concerning juvenile salmon ecology and ecosystem restoration in the LCRE, is currently under development and scheduled for regional release in June 2012. Rather than wait for one-half year, the BPA/Corps initiated the 2012 Strategy Report and 2012 Action Plan to jump-start the CEERP process. The 2012 Strategy Report, however, contains a detailed outline for the 2012 Synthesis Memorandum and a chapter with a synthesis and evaluation brief to support strategies for restoration and RME actions during CY 2012. The 2012 Synthesis Memorandum will feed the 2013 Strategy Report and 2013 Action Plan. The CEERP deliverables will be updated annually for transparency and accountability.



Figure 2. CEERP Adaptive Management Process. Brown and blue boxes signify adaptive management phases and deliverables, respectively.

1.3 Contents

The sections of the Action Plan that follow are based on the BPA/Corps' fundamental strategy for estuary habitat actions and RME—apply an ecosystem-based approach to restore, enhance, or create ecosystem structures, processes, and functions in the estuary, and perform RME to assess the effectiveness of these actions, while building our understanding of ecosystems in the LCRE (BPA/Corps 2012). The 2012 Action Plan provides plans for restoration (Section 2.0) and RME (Section 3.0). We explain how CEERP project decisions are made using the integrated strategy for restoration and RME

described in the 2012 Strategy Report. Here we list and describe projects and explain the rationale for the planned restoration and RME efforts. We also present plans for supporting activities, such as data management and dissemination (Section 4.0), and the 2012 schedule of CEERP activities (Section 5.0). Note that abbreviated terms used in tables are defined in the list included in the front of this report.

Table 2. CEERP Adaptive Management Phases, Teams, and Deliverables (from Thom et al. 2011; abbreviated terms used in tables are defined in the list in the front matter of this report)

Phase	Responsible Parties	Function	Deliverable(s)
Strategize	BPA/CORPS, Council, SRWG, SWG, EOS	Provide strategic priorities on project types that will provide the most benefit	Strategy Report
Decide	BPA/CORPS (final decisions); Council, ISRP, SWG, SRWG, ERTG (inputs)	Select projects and identify RME for a given implementation year	Action Plan, Feasibility Studies
Act (Implementation)	BPA/CORPS; Sponsors	Implement restoration projects	Design Memoranda, As-built drawings
Monitor and Research	BPA/CORPS; Researchers	Study “on the ground” implementation	Site Evaluations, Technical Reports
Synthesize and Evaluate	BPA/CORPS, NMFS, Council, ERTG	Synthesis RME findings and make recommendations to inform following years’ strategy	Synthesis Memorandum

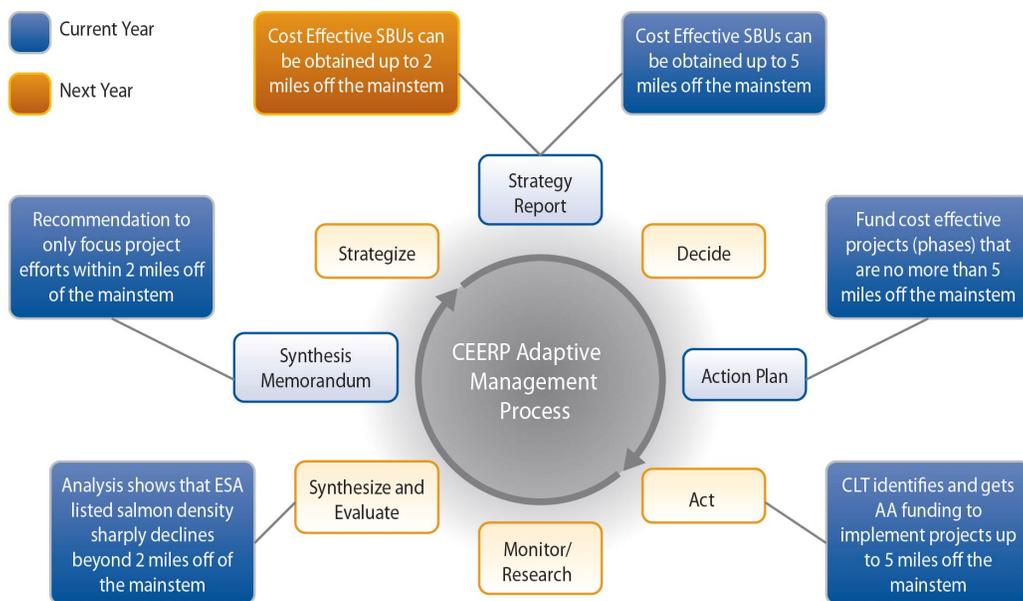


Figure 3. *Hypothetical* Example of the CEERP Adaptive Management Process

Table 3. CEERP Roles and Responsibilities

Entity	CEERP Role and Responsibility
BPA/Corps	<p>BPA/Corps fund habitat actions in the CEERP Action Plan.</p> <p>Corps implements habitat actions under authorities in Water Resources Development Act Sections 536, 1135, 206.</p> <p>Corps implements RME through the Congressionally funded Columbia River Fish Mitigation Project and its Anadromous Fish Evaluation Program (AFEP) in response in part to the 2008/2010 FCRPS BiOp.</p> <p>BPA implements habitat restoration and RME through the Council's Fish and Wildlife Program in response in part to the 2008/2010 FCRPS BiOp.</p> <p>Corps funds the CEERP Synthesis Memorandum and both BPA/CORPS rely upon these findings to inform adaptive management of the CEERP Strategy.</p> <p>The BPA/CORPS ensure that ERTG scoring criteria are consistent with BPA/CORPS policies.</p>
National Marine Fisheries Service	<p>Reviews the annual CEERP Strategy Reports, Action Plans, and Synthesis Memoranda.</p> <p>Considers CEERP documents and findings to inform Endangered Species Act (ESA) consultations on the FCRPS BiOp.</p> <p>Is responsible for overseeing implementation of the Estuary Module of the Columbia Recovery Plans and, therefore, coordinates with the BPA/CORPS' CEERP.</p> <p>Participates in the SRWG, SWG, EOS, and ERTG Steering Committee.</p> <p>Reviews for ESA compliance for actions implemented under the CEERP Action Plan.</p> <p>Ensures that ERTG scoring criteria are consistent with NMFS policies.</p>
Northwest Power and Conservation Council	<p>Develops the Columbia River Basin Fish and Wildlife Program. Makes funding recommendations pertaining to BPA funded projects in the estuary consistent with the Northwest Power Act.</p> <p>Oversees and coordinates ISRP review of BPA/CORPS projects.</p>
Independent Scientific Review Panel	<p>Reviews RME and restoration project scopes and methodologies for scientific rigor, consistent with the Northwest Power Act</p> <p>http://www.nwcouncil.org/fw/isrp/background.htm</p>
Expert Regional Technical Group	<p>Reviews, scores, and provides comments on restoration projects queued by the BPA/CORPS.</p> <p>Assigns survival benefits units for ocean- and stream-type juvenile salmon from LCRE habitat restoration actions implemented by the BPA/CORPS, as called for in the 2008 FCRPS BiOp.</p> <p>Provides technical input on restoration topics queued by the BPA/CORPS.</p>
Science Work Group (EP)	<p>Provides advice and support to the EP Board of Directors and staff on scientific and technical issues.</p> <p>Oversees and coordinates technically oriented aspects of the EP's habitat restoration program, long-term monitoring strategy, and data management efforts.</p> <p>Helps ensure the EP is working collaboratively and supporting regional needs.</p> <p>Provides a forum for the exchange of scientific information about the LCRE.</p> <p>Reviews proposed restoration and RME projects.</p>
Studies Review Work Group (AFEP)	<p>Reviews the RME projects funded by the Corps for the CEERP.</p> <p>Participates in the annual AFEP review, which includes CEERP RME projects.</p> <p>Coordinates with other review groups through the Corps.</p>
Estuary/Ocean Subgroup for Federal RME	<p>As tasked by the BPA/CORPS and NMFS, develops RME plans and guidance for the LCRE.</p> <p>The EOS functions under the auspices of the federal BiOp-related RME planning process to implement federal RME in the estuary.</p>
Sponsors	<p>Develop, design, propose, and implement restoration projects. Example sponsors include the</p>

Entity	CEERP Role and Responsibility
	Columbia Land Trust, Columbia River Estuary Study Taskforce, Cowlitz Tribe, Estuary Partnership, Oregon Department of Fish and Wildlife, and Washington Department of Fish and Wildlife.
Researchers	Perform RME. Examples include NMFS, Oregon Department of Fish and Wildlife, Pacific Northwest National Laboratory, U.S. Fish and Wildlife Service, and U.S. Geological Survey.

2.0 Restoration Plan

This section contains the restoration component of the 2012 Action Plan to implement the strategy formulated in the 2012 Strategy Report (BPA/Corps 2012). Within the CEERP, the BPA/Corps implement integrated restoration and RME projects (Figure 4). After providing background on CEERP strategy and objectives below, we present the project prioritization and selection (decision-making) process and list and describe the projects to be implemented in 2012. Projects for out-years 2013–2018 currently are being developed, but it is too early and sensitive in the project development cycle to present the prospective projects here. We anticipate, though, using a process in the out-years similar to that used for 2012 to identify and prioritize restoration projects.

The BPA/Corps' strategy for LCRE habitat restoration makes use of existing programs, processes, technical groups, and plans to avoid redundancy and increase efficiency. The main existing programs, with their associated processes and technical groups, are the Corps' Anadromous Fish Evaluation Program (AFEP) and the Council's Fish and Wildlife Program. Important existing plans include the Council's Columbia River Basin Fish and Wildlife Program, which provides programmatic goals and objectives (Council 2009); the Council's Lower Columbia Subbasin Plan, which characterizes limiting factors, threats to the environment, and proposed solutions (Council 2005); and, the NMFS BiOp on FCRPS Operations, which provides restoration mandates, performance goals, and RME actions (NMFS 2008). Furthermore, the Expert Regional Technical Group (ERTG) provided guidance for CEERP projects: bigger area is better than smaller area; close to the main stem is better than farther away; restoring remnant channels is better than excavating new ones; natural processes are preferred over engineered processes; a holistic perspective from a landscape scale is better than a narrow, site-specific perspective. In general, the BPA/Corps' approach to LCRE restoration for 2012 and beyond is to expedite project development using an aggressive, systematic, collaborative approach that is informed by the best available science from the collective RME effort to date.

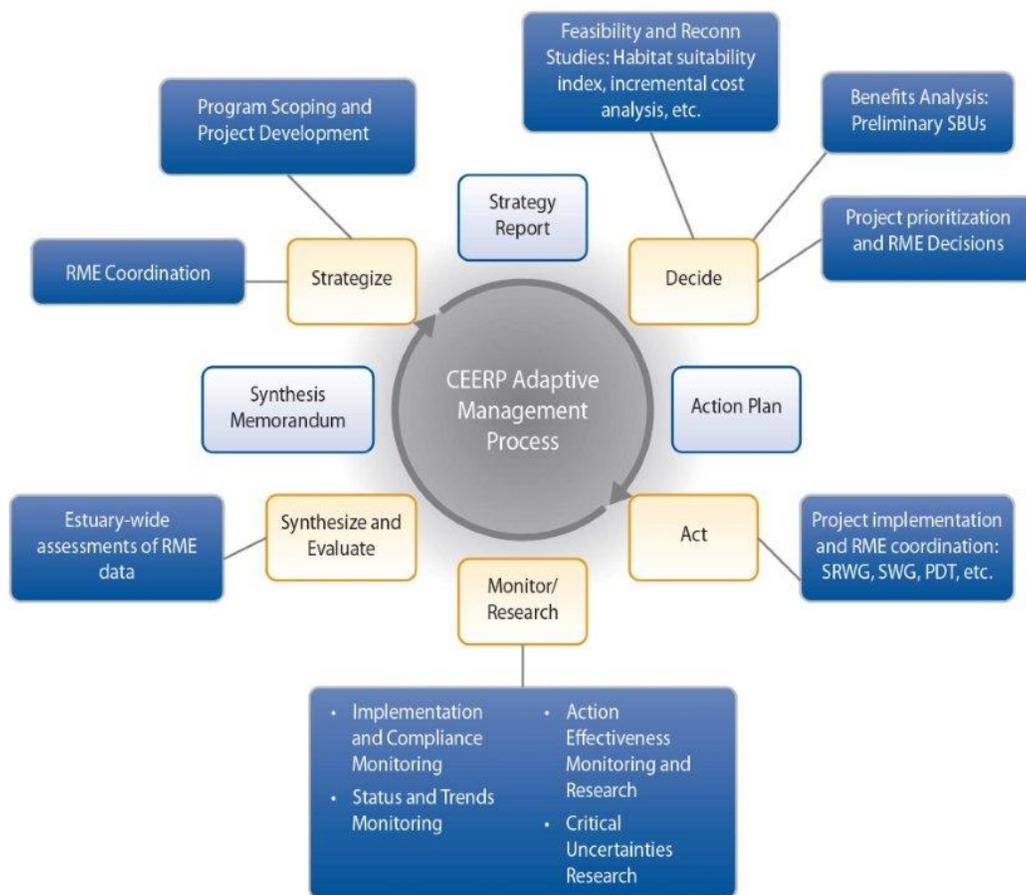


Figure 4. CEERP's Integrated Restoration Project Planning and RME¹

During 2012, the BPA/Corps will work with local parties and agencies to aggressively pursue and implement habitat protection and restoration projects in the LCRE floodplain as part of the CEERP. As the CEERP matures, projects will be implemented even more efficiently and strategically than in the past. The overall goal for 2012 is to make noticeable progress towards BiOp goals for ocean- and stream-type fish. The BPA/Corps' emphasis in 2012 will be on projects that will deliver high numbers of SBUs and/or low cost per SBU, while concurrently meeting our cost-share partners' goals and objectives for their respective restoration projects. The 2012 restoration-related activities (italicized below) responding the CEERP's objectives (Table 2) are as follows:

1. Understand what effect primary stressors have on ecosystem controlling factors, e.g., flow regulation, passage barriers—*Inventory and map passage barriers, including dikes/levees, tide gates, and culverts.*
2. Conserve and restore factors that control ecosystem structures/processes, e.g., hydrodynamics, water quality—*Reconnect flows between floodplain habitats and the main stem.*

¹ The difference between action effectiveness monitoring and action effectiveness research is that monitoring concerns extensive sampling of a few core indicators across many restoration projects, whereas research concerns intensive sampling of core and higher-order indicators at a few selected projects.

3. Increase the quantity and quality of ecosystem structures, e.g., estuarine habitat for juvenile salmonids—*List all potential restoration opportunities; investigate technical and practical feasibility; prioritize; develop site-specific restoration plans; quantify habitats and acreages; index habitat connectivity estuary-wide.*
4. Maintain and enhance LCRE food webs to benefit salmonid performance—*Restore shallow water wetland habitats in the LCRE.*
5. Improve salmonid performance in terms of life-history diversity, foraging success, growth, and survival—*Index early life history on a landscape scale; assign SBUs for restoration actions to date.*

2.1 Decision-Making Process

In the project development process, CEERP stakeholders actively pursue potential opportunistic and strategic sites. In many cases, local parties, landowners, and communities are an integral part of the project development process, because it is often their properties that are being considered for conservation and restoration and without their willing participation and cooperation the projects cannot be implemented. Once a project is initiated and developed in the Strategy Phase of the adaptive management process, it enters the Decide Phase (Figure 2) where decisions are made about implementing the project.

CEERP decision-making (Figure 5) involves an iterative process which, for BiOp-related work, focuses on technical review, cost per SBU and total SBUs, and project likelihood. All BPA-funded restoration projects go through the Estuary Partnership's Science Work Group (EP's SWG) review process for habitat restoration projects involving a ranking step using specific criteria (available at www.lcrep.org/sites/) and the "Tier 2" prioritization (Evans et al. 2006). Corps-funded projects are reviewed and scrutinized during the Corps' standard feasibility study process (e.g., Section 536). (Technical review is explained further in the next paragraph.) For both BPA- and Corps-funded work, project sponsors are required to develop project templates that include maps showing the acreage/mile goals for each project restoration activity. This allows the BPA/Corps to assign a preliminary SBU for internal planning and decision-making purposes. Project likelihood is determined using a questionnaire that ascertains the project's social and technical complexity. Project funding decisions by the BPA/Corps are based on total SBUs, cost per SBU, project likelihood, as well as other factors, as applicable. Projects are often funded in stages (e.g., initial design, final design, and construction). If a project meets the BPA/Corps' goals based on these criteria at various decision-points in the process, the BPA/Corps will fund the next stage of the project. If sponsors identify key project information that would materially change the preliminary SBU estimate or cost estimate, the BPA/Corps will recalculate cost per SBU before making any decisions on funding the next project stage. As the project moves through successive stages, the estimate of cost per SBU will become more robust, thereby reducing decision uncertainty. This iterative process will continue until the project is ready for construction, at which point the ERTG assigns SBUs, which are reviewed by the BPA/Corps and are usually the final decision point for the BPA/Corps.

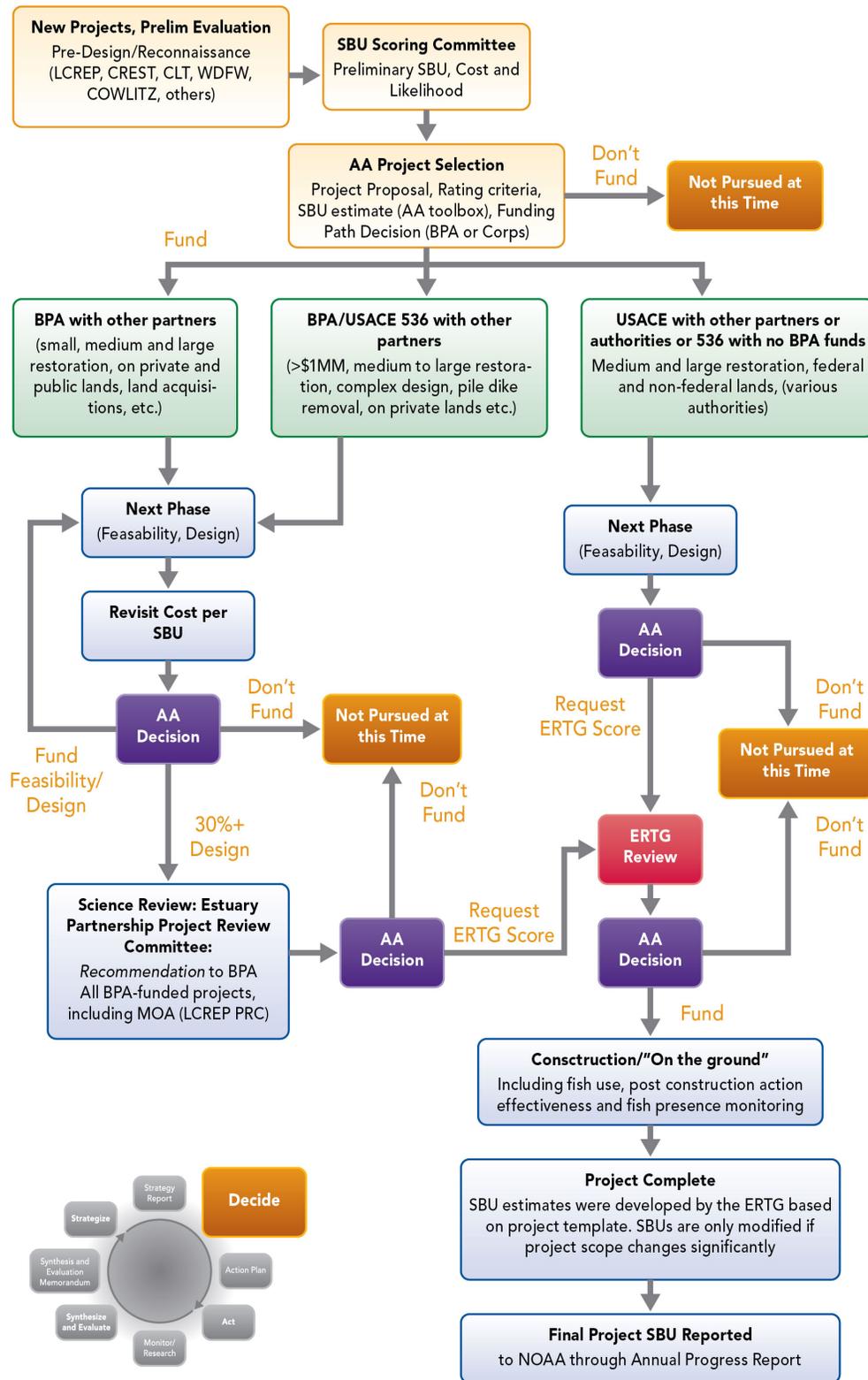


Figure 5. Decision-Making Process for CEERP Restoration Projects. This diagram depicts the process for an individual, on-the-ground restoration project. The ISRP reviews the BPA-funded restoration program projects, not individual restoration projects.

Three important review elements contribute information to CEERP stakeholders and decision-makers: the ISRP, EP's SWG, and ERTG. As part of the Council's periodic categorical reviews, the ISRP reviews the three Council Fish and Wildlife Program projects funded by BPA and conducted by the Columbia Land Trust (CLT), Columbia River Estuary Study Taskforce (CREST), and EP that serve as umbrella projects to implement numerous individual restoration projects. It is the intent of the BPA/Corps that the ISRP review the three BPA-funded umbrella projects. This review is important because it will address how well each umbrella project meets the goals and objectives of the Council's Fish and Wildlife Program for the LCRE; integrates with the overall LCRE restoration effort; implements a landscape-ecosystem-based strategy; institutes a robust project development and selection process; and uses a scientifically sound approach. That is, the ISRP reviews the programmatic framework for the umbrella projects, but not individual restoration projects. This approach involves ISRP and Council agreement. The SWG reviews and comments on individual projects using ecosystem-based project review criteria (available at www.lcrep.org/sites/) and a prioritization process (Evans et al. 2006) for individual restoration projects arising from the CLT, CREST, and EP projects in the Council's Fish and Wildlife Program. The ERTG, on the other hand, reviews and scores individual projects (ERTG 2010a) and assigns SBUs (ERTG 2010b, 2011) as requested by the BPA/Corps whether the project is part of the Council's Fish and Wildlife Program or the Corps' restoration authorities (Figure 5). BPA or the Corps, as the appropriate funding agency, uses the review comments to inform its final decision to fund a given project.

2.2 Current Projects (CY 2012)

Sixteen restoration projects are planned for implementation during CY 2012 (Figure 6; Table 4). These projects have been developed by the BPA/Corps in collaboration with restoration project sponsors, including Clark County, CLT, CREST, EP, and the Washington Department of Fish and Wildlife (WDFW). Project status ranges from initial concept to design, with six projects in the feasibility stage. Three of the projects are land acquisitions.

The project stages in Table 4 represent the work that is currently scheduled for funding in FY 2012 in the estuary by the BPA/Corps. As described above for the Decide Phase of adaptive management (Section 2.1), projects funded by BPA are selected by a combination of cost per SBU, total SBUs (higher is better), and by social and technical complexity (lower is better). Projects funded by the Corps are selected based on the Corps' economic analysis as well as considerations of the cost-share partner. At this time the BPA/CORPSs are focusing on a cost/benefit model for restoration projects because it provides clear direction on the types of projects that the BPA/Corps prefer and will help ensure that budgets are used in the most cost effective manner possible. Table 5 shows the cost per SBU of the 2012 portfolio before and after the BPA/Corps change to focus on cost/benefit. The result is a significant increase in projected SBUs for just 20% more funding for after the change in focus than would have been before the focus on cost per SBU (Table 5).



Figure 6. Master Map of the Inventory of Planned CEERP Projects with Project Activities Starting in 2012 with Planned On-the-Ground Implementation in 2012, 2013, and 2014

Table 4. Master Inventory of Planned CEERP Projects with Project Activities Starting in 2012 with Planned On-the-Ground Implementation in 2012, 2013, and 2014, Including All-In^(a) SBUs.^(b) ID numbers are from the Mingle Database. (Caveat: This list is subject to change as new information becomes available.)

ID	Name	Lead Sponsor	Category	2012 Stage	Projected		
					Implementation Year	All-In Ocean SBUs	All-In Stream SBUs
748	Grays Bay - Kandoll Farm Restoration Phase 2	CLT	Restoration	Design	2012	0.68	0.18
336	Wallacut River - Acquisition Phase	CLT	Land Acquisition	Complete	2012	0.58	0.21
300	Otter Point	CREST	Restoration	Implementation	2012	0.22	0.01
279	Liberty Lane	CREST	Restoration	Implementation	2012	0.02	0.01
273	Lewis River - Mud Lake - Acquisition Phase	Clark County	Land Acquisition	Implementation	2012	0.37	0.15
269	Knappton Cove Acquisition	CLT	Land Acquisition	Implementation	2012	0.30	0.30
247	Gnat Creek	CREST	Restoration	Implementation	2012	0.25	0.08
232	Dibblee Point	CREST	Restoration	Implementation	2012	0.10	0.04
223	Col. Stock Ranch (CSR) - Acquisition Phase	CLT	Land Acquisition	Complete	2012	4.96	1.61

ID	Name	Lead Sponsor	Category	2012 Stage	Projected		
					Implementation Year	All-In Ocean SBUs	All-In Stream SBUs
222	Grays Bay - Crooked Creek Parcel 2 - Restoration Phase	CLT	Restoration	Implementation	2012	0.15	0.05
210	Colewart Creek (Nutel Landing)	CREST	Restoration	Implementation	2012	0.04	0.02
207	Chinook River WDFW - Acquisition Phase	WDFW	Land Acquisition	Design	2012	0.77	0.33
191	Abernathy Creek Tidal Restoration	WDFW	Restoration	Design	2012	0.01	0.00
324	Skamakowa Creek - Dead Slough Restoration - Phase 2	Wahkiakum Cons. District	Restoration	Implementation	2013	0.08	0.05
320	Sauvie Island, North Unit Phase 1	CREST	Restoration	Design	2013	0.75	0.25
314	Sandy River Dam Breach	COE	Restoration	Design	2013	0.26	0.09
310	Ridgefield NWR: Ridgeport Dairy Unit - Post Office Lake	COE	Restoration	Design	2013	0.25	0.08
266	Karlson Island Restoration	CREST	Restoration	Feasibility	2013	0.55	0.19
224	CSR - Full Restoration Phase	COE	Restoration	Feasibility	2013	4.96	1.61
208	Chinook River WDFW - Restoration Phase	WDFW	Restoration	Design	2013	0.77	0.33

ID	Name	Lead Sponsor	Category	2012 Stage	Projected		
					Implementation Year	All-In Ocean SBUs	All-In Stream SBUs
236	Elochoman Slough Thomas Property - Parcel 1 - Restoration	WDFW	Restoration	Design	2014	0.49	0.20
<p>(a) All-In” refers to total projected SBUs for the completed project restoration</p> <p>(b) SBUs in this column cannot be summed for a total SBU value because the list is not mutually exclusive. For example, the CSR acquisition is a 2012 effort, while the restoration is a 2013 effort. They both have the same “all-in” total projected SBUs, so they are not additive.</p>							

Table 5. Cost per SBU Before and After Focus on Cost/Benefit for the 2012 Restoration Project Portfolio.

Portfolio of Projects Funded (in part) in FY 2012	Projected				
	All-In ^(a) Cost ^(b)	All-In Ocean SBUs	All-In Stream SBUs	All-In Ocean Cost/SBUs	All-In Stream Cost/SBUs
Before Change in Focus	\$16,725,000	3.75	1.58	\$4,463,571	\$10,555,380
After Change in Focus	\$19,921,000	6.76	2.37	\$2,945,804	\$8,395,213

(a) “All-In” cost refers to **total** cost of the project (acquisition, pre-design, feasibility, design and construction, which can be spread across **multiple years**) and “All-In” SBUs refers to **total** projected SBUs for the completed project restoration.

(b) These cost estimates are preliminary and will change over time as the project progresses and we get more information.

3.0 RME Plan

CEERP's strategy for RME is to monitor compliance and implementation of CEERP restoration actions; monitor status and trends of LCRE ecosystems hypothesized to support juvenile salmonids; research, monitor, and evaluate juvenile salmonid performance in the LCRE relative to environmental, physical, or biological performance objectives; research, monitor, and evaluate LCRE migration and habitat conditions that may be limiting achievement of biological performance objectives; determine the effectiveness of restoration actions; and assess and investigate critical uncertainties related to the scientific relationships between habitat conditions, including restored sites, and the survival and condition of fish residing in and/or migrating through the LCRE.

Between 2004 and 2007, the BPA/Corps worked with NMFS to develop a comprehensive plan for estuary RME (Johnson et al. 2008). Elements of the plan were incorporated as Reasonable and Prudent Alternatives (RPAs) 58 through 61 in the FCRPS BiOp (NMFS 2008). Today, estuary RME is conducted according to the CEERP's adaptive management process (Figures 2 and 4) and is designed to provide relevant and time-critical research and monitoring information to the BPA/Corps and other CEERP stakeholders. A collaborative, adaptively managed process is used to conduct CEERP RME (Figures 7 and 8).

The BPA/Corps fund RME projects to deliver data and information to support program objectives, test hypotheses, and inform management questions explained in the 2012 CEERP Strategy (Section 2.1) and listed above in Table 1. Knowledge gained through RME efforts will be used to guide strategy development, management, and on-the-ground actions in the estuary. CEERP RME has specific objectives for status and trends monitoring, action effectiveness monitoring and research, critical uncertainties research, synthesis and evaluation, and implementation and compliance monitoring (Johnson et al. 2008).

The RME Plan for the 2012 Action Plan describes RME activities in detail by RME category. This action plan also lists and describes the RME projects planned for CY 2012. This section closes with a description of plans for CEERP RME in out-years 2013–2018.

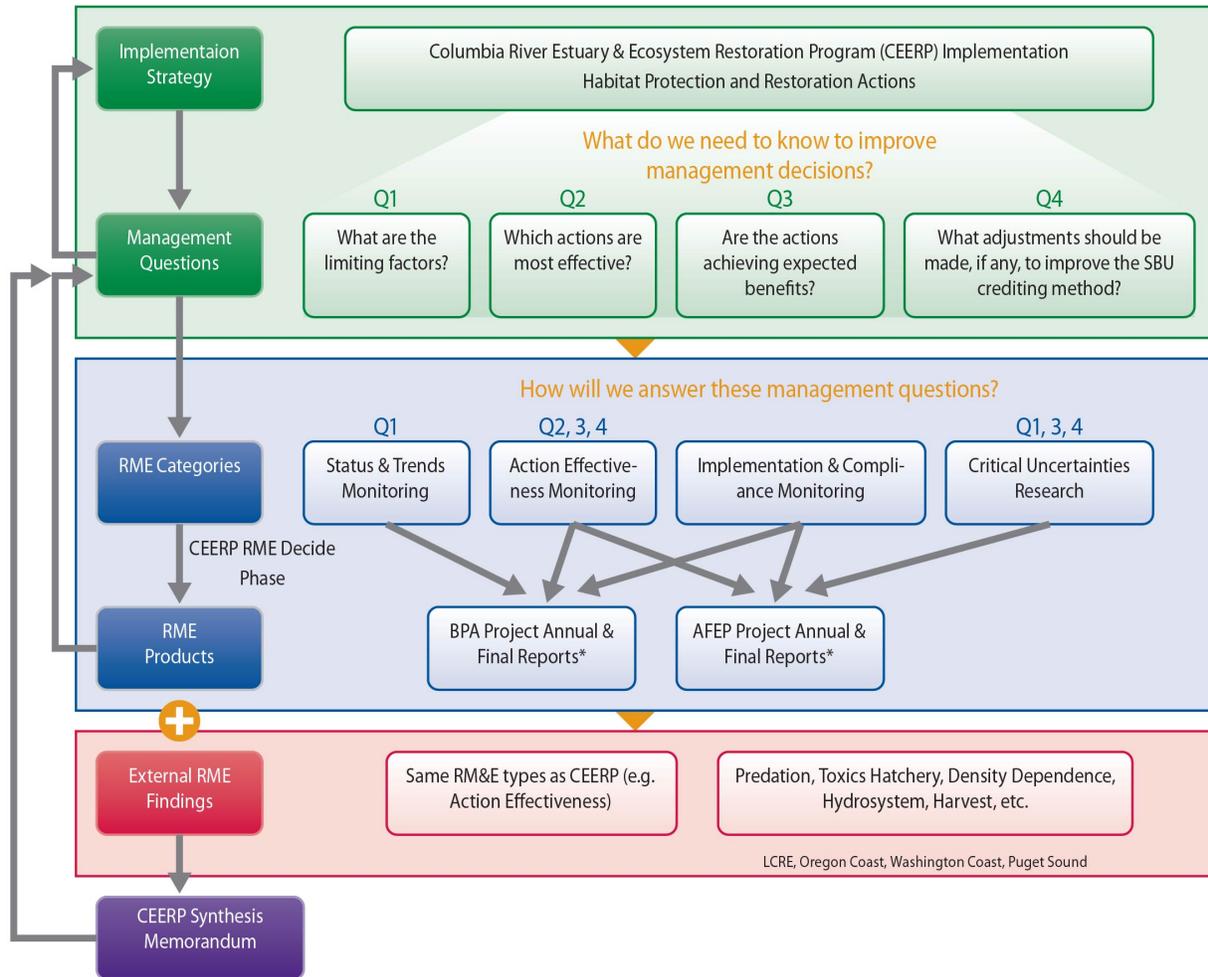


Figure 7. CEERP RME Process. See Figure 8 for further detail on the CEERP RME Decide Phase and Section 2.1, Program Goals, Objectives, and Management Questions.

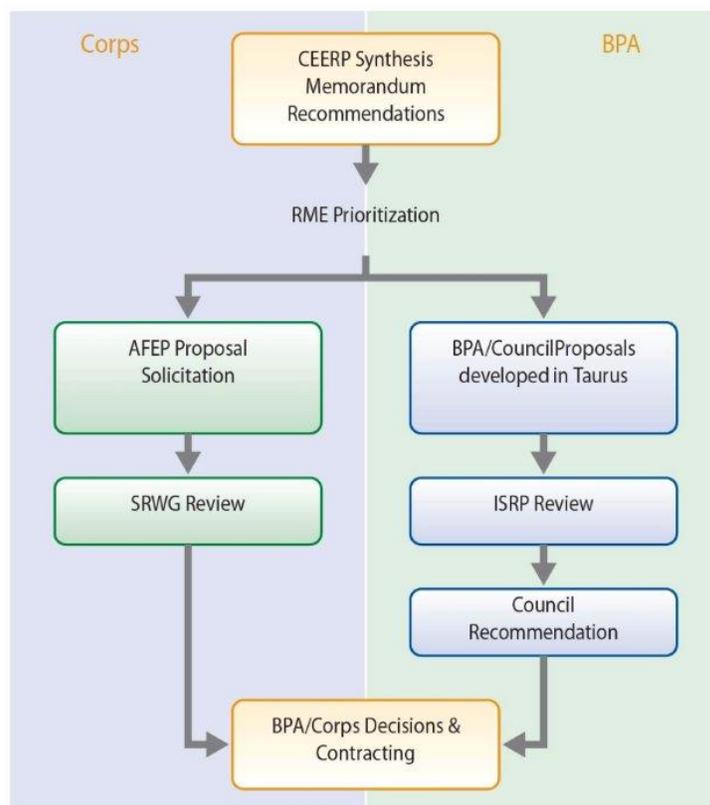


Figure 8. CEERP RME Decision Process. The Corps' Anadromous Fish Evaluation Program process is annual and the BPA's implementation of the Council's Fish and Wildlife Program is on a 3- to 5-year review cycle.

3.1 RME Categories

The following sections describe estuary RME implementation by category. In brief, the relevance of various RME categories to the CEERP is as follows:

- Implementation and Compliance Monitoring (ICM) – Determines whether restoration projects were implemented as planned; e.g., were restoration designs followed as proposed to the BPA/Corps?
- Status and Trends Monitoring (STM) – Provides ecological context for CEERP decision-making; e.g., are LCRE ecosystems degrading irrespective of CEERP restoration?
- Action Effectiveness Monitoring and Research (AEMR) – Determines the success of the CEERP restoration projects at site-, landscape-, and estuary-wide scales; e.g., what are the most effective restoration actions?
- Critical Uncertainties Research (CUR) – Resolves uncertainties in the CEERP knowledge base; e.g., what are the effects of aquatic invasive species on food webs supporting juvenile salmon?

- Synthesis and Evaluation (SE) – Assesses progress for the CEERP as whole to inform adaptive management of the CEERP Strategy; e.g., are habitat restoration activities in the LCRE having a cumulative beneficial effect on salmon?

3.1.1 Implementation and Compliance Monitoring

The overall objective of ICM is to determine whether projects are being implemented as planned and to whether objectives, such as the amount of estuary habitat being conserved and restored annually, are being met. ICM includes two sub-objectives:

1. Determine whether restoration projects were implemented as planned and reported; i.e., whether specified project criteria were met (“Implementation Monitoring”). For BPA, implementation monitoring will be completed by the contracting officer’s technical representative (COTR) and project sponsors. BPA will also report project performance metrics in the Pisces project tracking database. The Corps requires as-built drawings from the construction contractors and conducts “inspection of completed projects.”
2. Report on the total amount (acreage/miles) of estuary habitat conserved and restored annually by habitat type, and the number of accrued SBUs annually.

The monitored indicators for ICM are Pisces Habitat Restoration Action Metrics (e.g., acres restored, SBUs) and similar CEERP tracking metrics. Sampling design is not applicable. The products provide implementation guidance, validated action performance metrics, and summary data reported in the annual Action Plan. The project leads are the BPA/Corps, project sponsors, COTRs, and third-party contractors. Timelines include annual reporting. A compliance monitoring project may be initiated by BPA after completion of results and lessons learned from Pilot Project 2010-075-00 expected during FY 2013. Coordination of efforts occurs within the CEERP adaptive management process. Implementation and compliance monitoring results inform the BPA/Corps, sponsors, Council, ERTG, and Estuary/Ocean Subgroup within the CEERP adaptive management process.

3.1.2 Status and Trends Monitoring

STM is intended to reveal whether the LCRE ecosystems are improving, staying the same, or degrading. STM involves monitored indicators that are ecologically significant to listed salmonids in the estuary. For example, food web characteristics are an important element of STM. To support programmatic recommendations from the Council and ISRP, and address BPA/Corps’ recommendations (Action Agencies 2010), the STM project’s (BPA project 2003-007-00 [Lower Columbia River Estuary Ecosystem Monitoring](#)) spatial and temporal design is being revised using the LCRE habitat classification system as a basis (Simenstad et al. 2011).

STM data help determine whether the condition of the ecosystem is improving, staying the same, or degrading relative to baseline conditions identified for the 2008 FCRPS BiOp (NMFS 2008) and Estuary Module (NMFS 2011). This information also serves as reference data for comparison with the results of action effectiveness studies and provides a baseline to help determine whether actions are achieving expected benefits and evaluating potential fish use of habitat actions scored by the ERTG. The monitored indicators, which could be revised in response to the sampling design review, include water surface elevation, sediment accretion rate, water temperature, dissolved oxygen, channel cross-sectional area,

bathymetry/topography, vegetation percent cover, fish species composition, size, etc. The protocols are based on Roegner et al. (2009). BPA project 2003-007-00 protocols also include “[Lower Columbia River Habitat Status and Trends Protocols](#)” and “[Coastal Margin Observation and Prediction \(CMOP\) Protocol](#).” The sampling design is a rotational split panel; a revised design will include a Generalized Random Tessellated Sample master sample of the estuary habitat classification and full temporal distribution for all species of main stem and freshwater tidal habitat zones.

The products of the 2012 STM will include data delivered in annual progress reports and technical reports. Specifically, STM reports will be delivered by researchers to the BPA/Corps in January of each calendar year. These reports will be synthesized and evaluated with other RME data in the annual CEERP Synthesis Memorandum. The STM sampling redesign will start in December 2011 with implementation planned for the 2012/2013 field season. As part of STM and the sampling design, the Columbia River Estuary Ecosystem Classification (CREEC) will be finalized by early 2012. The project leads are the BPA/Corps, in coordination with the EP and others. Coordination of efforts will occur within the CEERP adaptive management process; STM sample design will be coordinated through the EP SWG and will be submitted to the ISRP for review. CEERP STM responds to actions outlined in RPAs 58 (Fish Performance) and 59 (Migration Characteristics and Estuary/Ocean Conditions) of the 2008 FCRPS BiOp (NMFS 2008).

3.1.3 Action Effectiveness Monitoring and Research

The overall purpose of AEMR is to quantify and demonstrate how restoration actions affect controlling factors, ecosystem structures, and processes at site and landscape scales and, hence, ecosystem function as expressed by salmon fitness and survival. It is intended to inform decisions regarding the next generation of habitat projects. Results of monitoring of treatments (the restoration actions) and their effects are translated into implications regarding juvenile salmonid performance. Site-scale action effectiveness is evaluated relative to reference and control sites. Because such implications are important for CEERP adaptive management, a network of reference sites is established (Borde et al. 2009) and is used in AEMR to evaluate whether and how restoration actions are having desired ecosystem effects.

The BPA/Corps, which both conduct CEERP action effectiveness work, have drafted a programmatic approach to site-scale AEMR (see the appendix in the 2012 Strategy Report; BPA/Corps 2012). This coordinated, programmatic approach to AEMR demonstrates collaboration among the BPA/Corps, stakeholders, and research. It will be completed 2012 and be informed by Tetra Tech (2010), Johnson et al. (2011c), and other AEMR assessments. The programmatic approach to CEERP AEMR will help the BPA/Corps’ plan, prioritize, and conduct their respective AEMR activities. The BPA/Corps intend that the ISRP reviews the programmatic approach to AEMR when the ISRP reviews the CEERP documents in summer 2012.

Monitored indicators and protocols for AEMR build on those for STM (Johnson et al. 2008). In addition, AEMR includes area-time inundation, wetted-channel edge length, floodplain wetted area, flux rates for nutrients, chlorophyll, dissolved organic matter, plant biomass, total organic carbon, macro-invertebrates, residence time, diet, growth rate, fitness, prey availability, and genetic stock. Protocols for core monitored indicators are provided by Roegner et al. (2009). For BPA Project 2003-007-00, the protocol is defined and implemented within the Pacific Northwest Aquatic Monitoring Partnership (PNAMP) and is called “Lower Columbia River Estuary Habitat Action Effectiveness.”

Applicable sampling designs for AEMR are before-after-reference-impact design, before-after-control-impact sampling design, or accident design (see Roegner et al. 2009). AEMR sites are chosen based on priorities identified in the CEERP adaptive management process. For example, if a new restoration technology is being applied but the outcome of the activity is uncertain, the action and the site will likely be considered for AEMR. Additional work during 2012 is intended to provide further statistical analysis of sample size per treatment type required to determine the significance of the effect.

AEMR products for 2012 include the site-scale AEMR strategy and the AEMR data delivered in annual technical reports, which are synthesized and evaluated (see below) with other RME data in the annual Synthesis Memorandum. The project leads for AEMR are 1) BPA Policy and Planning, Corps, Bureau of Reclamation, the National Oceanic and Atmospheric Administration's (NOBPA/CORPS's) Northwest Fisheries Science Center (NWFSC); and 2) BPA/Corps in cooperation with Pacific Northwest National Laboratory (PNNL). The timeline calls for a site-scale AEMR strategy by 2012; annual project/contract reporting in May; and FCRPS comprehensive analyses in 2013 and 2016. Coordination of project efforts occurs within the CEERP adaptive management process, which incorporates the EP's SWG, the Corps' AFEP Science Review Work Group (SRWG), and the federal Estuary/Ocean RME Subgroup. Check-ins are part of the CEERP annual adaptive management process. CEERP AEMR responds to actions outlined in BiOp RPA 60, Action Effectiveness.

3.1.4 Critical Uncertainties Research

CEERP RME involves investigation of critical uncertainties in the LCRE state of the science, especially those dealing with critical uncertainties underlying the management questions (Section 1.1). (For a list of critical uncertainties, see the 2012 Strategy Report, Section 3.3 [BPA/Corps 2012]). Specific uncertainties pertain to the ecological importance of the Columbia River estuary to salmonids, causal mechanisms affecting survival, early life history in tidal freshwater, effects of hatchery fish on wild fish in the estuary, factors affecting wetting and drying of floodplain habitats, and food web dynamics. Many of the monitored indicators for CUR are ecosystem processes and linkages between these and ecosystem structures and salmonid performance. Results from CUR will reduce risk during management decision-making for the CEERP because there will be less uncertainty and stronger science in the knowledge base supporting the program.

Monitored indicators, protocols, and sampling design are research-specific depending on the CUR objective. Current indicators (e.g., AFEP project EST-P-10-01) include genetic stock identification, fish species composition and density, salmon trophic relationships (e.g., prey availability and stomach content), salmon performance (e.g., consumption, growth rate, and residency in local habitats). Products include CUR data delivered in annual technical reports, which are synthesized and evaluated with other RME data into the annual Synthesis Memorandum. The project leads are the BPA/Corps in coordination with NMFS. Timelines entail annual reporting and BiOp Comprehensive Analyses in 2013 and 2016. Coordination of projects occurs within the CEERP adaptive management process and through the AFEP SRWG because CUR is conducted by the Corps. CEERP CUR responds to actions outlined in BiOp RPA 61, Critical Uncertainties.

3.1.5 Synthesis¹ and Evaluation²

Available information from monitoring and research funded by the BPA/Corps, such as data summaries, data reports, technical reports, and scientific articles, are used in CEERP SE. A central method for the evaluation is an estuary-wide meta-analysis of AEMR data. In addition, the levels-of-evidence approach to evaluating the cumulative effects of multiple restoration projects (Diefenderfer et al. 2011) is applied to address overall progress toward the CEERP management questions, critical uncertainties, and hypotheses. The cumulative effects analysis assesses whether there has been an overall net improvement in the ecosystem and the resources it supports, and results in recommended adjustments to the program.

External RME efforts (Figure 7) will inform the CEERP and be considered in the synthesis and evaluation phase. These efforts will include relevant RME findings from other regions, such as the Puget Sound. Topics outside of BPA/Corps' authorities under CEERP, but nonetheless important to consider for context during CEERP implementation, are toxics, predation, harvest, and hatchery effects.

CEERP RME results would be rolled up in the annual Synthesis Memorandum (see the 2012 Strategy Report [BPA/Corps 2012]). This memorandum evaluates the results of the AEMR, CUR, and STM in the context of other sources of information, such as project development and construction. The memorandum summarizes results of analysis intended to address key management questions and hypotheses developed based on program uncertainties. Along with the estuary-wide analysis, the memorandum includes recommendations for addressing CEERP objectives as well as the critical uncertainties. The outcome is a determination of whether strategies and related actions should continue to be implemented or whether alternative actions or treatments should be applied.

The project leads are the BPA/Corps. Related work includes an AFEP Project called "Synthesis and Evaluation" (EST-P-12-01), and peer- and external-review of project reports and presentations by staff from the BPA/Corps, the Council, sponsors, and research organizations. Timelines entail annual reporting and FCRPS comprehensive analyses in 2013 and 2016. Overall coordination is conducted within the CEERP adaptive management process; specifically, synthesis and evaluation are coordinated through the Corps AFEP's SRWG, the EP SWG, and the Federal Estuary/Ocean RME Subgroup. (See Section 4.1 for more information about the database development and analysis effort.)

3.2 2012 RME Projects

As stated in the CEERP 2012 Strategy Report (BPA/Corps 2012), the CEERP's general RME strategies are to monitor compliance and implementation of CEERP restoration actions; monitor status and trends of LCRE ecosystems hypothesized to support juvenile salmonids; research, monitor, and evaluate juvenile salmonid performance in the LCRE relative to environmental, physical, or biological performance objectives; research, monitor, and evaluate LCRE migration and habitat conditions that may be limiting achievement of biological performance objectives; determine the effectiveness of restoration actions; and assess and investigate critical uncertainties related to the scientific relationships between

¹ Synthesis is the compilation and summarization of results from multiple monitoring and research studies, including STM, AEMR, and CUR.

² Evaluation is the analysis of data and information from multiple studies and restoration projects at landscape and estuary-wide scales.

habitat conditions, including restored sites, and the survival and condition of fish residing in and/or migrating through the LCRE. The BPA/Corps are funding seven RME projects during CY 2012 to contribute toward meeting these needs (Table 6).

CEERP RME projects for 2012 include one STM project (Ecosystem Monitoring), one CUR project (Contributions to Salmon Recovery), and five AEMR projects (Cumulative Effects, Multi-Scale AEMR, Salmon Benefits, Synthesis and Evaluation, and Synthesis Memorandum). The sampling sites for the projects are located throughout the LCRE (Figure 9). The RME projects have direct application to the CEERP management questions outlined in Section 1.1 (Table 7). This information illustrates the relationship of RME and outcomes to CEERP decision-making and program goals. The emphasis on synthesis is responsive to Council/ISRP concerns.

Finalization of the estuary habitat classification system (within Project [2003-007-00](#)) is important to the CEERP for two main uses: 1) Help support RME modifications to existing study designs as identified by the ISRP and FCRPS Estuary RME workgroup recommendation report (Action Agencies 2010). The intent is to improve the representativeness of spatial sampling of the LCRE. Accordingly, ecosystem monitoring programs may be redesigned based on the estuary classification system. 2) Inform restoration project development, and prioritization, and ERTG review.

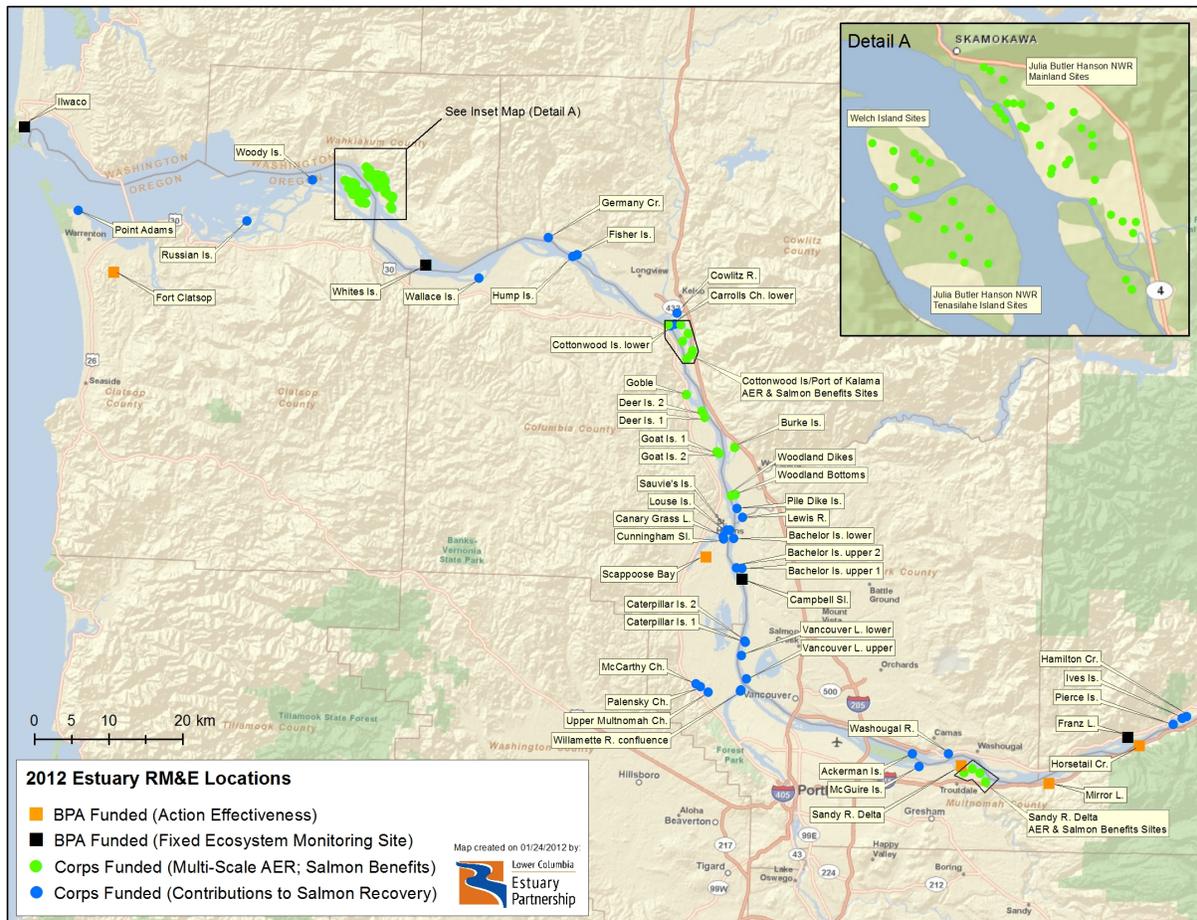


Figure 9. Map of FY 2012 RME Projects Sampling Sites

Table 6. 2012 CEERP RME Projects. (Caveat: This list is subject to change.)

Project	Type	RPA	Project No.	Lead Entity/ Collaborators	Status/Description	Deliverables/Products
Ecosystem Monitoring	STM, AEMR	58,59, 60	BPA 2003-007-00	EP/PNNL,USGS, NMFS, CREST, CT	Ongoing; ecological data at sentinel sites and rotational panel design; 2012 baseline and post-const. AEMR ^(a)	Trends in ecological conditions in LCRE wetlands; final Columbia River Estuary Ecosystem Classification System; AEMR data
Ocean Survival of Salmonids	STM	58, 59		NOAA NWFSC	Newly implemented scope to monitor status and trends of ecol. factors in mainstem	Trends in ecological conditions in LCRE mainstem food and fish;
CREST Estuary Hab Restoration for Action effectiveness	AEMR	60	BPA 2010-004-00	CREST	Ongoing action to monitor the effectiveness of restoration actions in LCRE	AEMR data
Contributions to Salmon Recovery	CUR	61	AFEP EST-P-09-01	NMFS/UW,OSU, OHSU	Ongoing; synoptic determination of genetic stocks; fish/habitat assoc.	LCRE's contribution to salmon genetic and life-history diversity and implications for habitat restoration
Cumulative Effects	AEMR	60,61	AFEP EST-P-02-04	PNNL/NMFS,UW, CREST,PSU	Closeout 2012; CE methods being transferred regionally	AER protocols; CE methodology (levels of evidence [LOE]); AM framework; wetted area methodology; ecological relationships; LOE of early stage CEERP due in 2012
Multi-scale AEMR	AEMR	60	AFEP EST-P-11-01	PNNL/ODFW,UW, NMFS,USFWS	Ongoing; site-, landscape-, and estuary-scale data collection and analyses; in 2012 includes EST-P-05-07 (JBH)	Project-specific AER data, landscape-scale estimates of juvenile salmon density, associations between juvenile salmon density and habitat features, residence times, migration pathways, and estuary-wide analyses of action effectiveness
Salmon Benefits	AEMR	58,59, 60	EST-P-10-01	PNNL/UW	Ongoing, FY 2012 last year; developing methods	Methods to index early life-history diversity, habitat connectivity, and survival benefits of restoration
Synthesis and Evaluation	SE	all	EST-P-12-01	PNNL	New project FY 2012; planned 3-year effort	Regional coordination; geospatial relational database for CEERP restoration and RME data
2012 Synthesis Memorandum	SE	all	NA	NMFS and PNNL	New project FY 2012	Draft 2012 Synthesis Memorandum due spring 2012

(a) Initial studies to develop a suite of AEMR reference sites and project-level AEMR were conducted under the LCREP Habitat Restoration project [2003-011-00](#). However, for future management all BPA-funded RME has been transferred to project [2003-007-00](#).

Table 7. RME Project Applications to Management Questions. See Table 1 for the full text of the management questions.

Project/Reference or Status	Q1 Limiting Factors	Q2 Effectiveness	Q3 Performance	Q4 SBUs and Survival
Ecosystem Monitoring (2003-007-00)	Wetland vegetation, prey availability; water quality; toxic contaminants in fish; genetic stock identifications	Site-scale action effectiveness monitoring at various sites	Report ecosystem and fish status in representative (reference) habitats across the estuary	Information to ERTG to help inform SBU process
Contributions to Salmon Recovery (ongoing)	Genetic stock identified by habitat type, habitat usage, factors affecting salmon population viability	Identification and prioritization of the type, location and characteristics of estuarine habitat restoration and protection actions that would optimally benefit juvenile salmon of specific ESUs and life-history types	Illustrations of associations and connectivity among different salmon ESU and life-history types at landscape and site scales	Ibid
Cumulative Effects (Johnson et al. 2011a)	Hydrology, wetland vegetation, invasive species, water temperature, etc.	Site-scale action effectiveness research at Kandoll, Vera, and with USGS at Crims; effectiveness monitoring protocols; method to evaluate cumulative effects of restoration actions	Adaptive management process	Ibid
Multi-Scale AEMR (Johnson et al. 2011b)	Feeding ecology and bioenergetics modeling of juvenile salmon; overwintering residence time; genetic stock identified	Site-, landscape-, and estuary-wide action effectiveness evaluations based on ecosystem structures and functions for juvenile salmon	Landscape-scale estimates of juvenile salmon density	Ibid
Salmon Benefits (Diefenderfer et al. 2010)	NA	Methods to index habitat connectivity, early life-history diversity, and benefits of restoration to juvenile salmonids	Method to index benefits of restoration to juvenile salmonids	Ibid
Synthesis and Evaluation (planned start February 2012)	Publicly accessible geospatial database for STM and other data on limiting factors	Publicly -accessible geospatial database for AEMR and other data on action effectiveness	Publicly accessible geospatial database for salmonid performance data	Ibid
2012 Synthesis Memorandum (started January 2012)	Comprehensive assessment of the literature on LCRE limiting factors	Detailed examination of action effectiveness results	Synthesis and evaluation of the literature regarding salmon performance in the LCRE	Recommendations for research on the relationship between SBUs and survival benefits

3.3 Out-Year (2013–2018) RME Projects

The CEERP has three projects tentatively scheduled through 2018: Ecosystem Monitoring, Contributions to Salmon Recovery, and Multi-Scale AEMR (Table 8). (All projects are reviewed and funded on an annual basis and, hence, are subject to change or cancellation.) The four projects ending in the next few years will produce important data and products that the BPA/Corps will synthesize and evaluate and use to inform strategy in the CEERP adaptive management process. Prioritization of RME work will be necessary due to budget constraints.

Table 8. RME Project Inventory – Out-Year Plans (CY 2013–2018). (This list is subject to change.)

Project Name	2013	2014	2015	2016	2017	2018	Comment
Ecosystem Monitoring	STM, AEMR	STM, AEMR	STM, AEMR	STM, AEMR	STM, AEMR	STM, AEMR	Synthesis of status and trends of LCRE ecosystems
CREST Estuary Habitat Restoration for Action effectiveness	AEMR	AEMR	AEMR	AEMR	AEMR	AEMR	Coordinated with other AEMR projects
Ocean Survival of Salmonids	STM	STM	STM	STM	STM	STM	Ongoing with sampling in lower estuary
Contributions to Salmon Recovery	CUR	CUR	CUR	CUR	CUR	CUR	Culminates with recommendations for actions for salmon recovery; MOA project to end in 2018
Cumulative Effects							Project to be completed in 2012; application is expected to be conducted under MS AEMR
Multi-Scale (MS) AEMR	AEMR	AEMR	AEMR	AEMR; CE evaluation	AEMR	AEMR	MOA project to end in 2018; continue to emphasize AEMR
Salmon Benefits	Final report for 2012 project						Project to be completed in 2013
Synthesis and Evaluation (S&E)	Database development; CEERP documents	Database development; CEERP documents	Final report for 2013 project				Project to be completed in 2015; new project to be considered for annual CEERP documents
2012 Synthesis Memorandum (SM)							Project to be completed in 2012; after this, the SM will be prepared under the S&E project

4.0 Data, Coordination, and Schedule

This final section concerns three critical elements of the CEERP Action Plan: data, coordination, and schedule.

4.1 Data Management and Dissemination

Data management and dissemination are receiving increased attention because of the need to efficiently and effectively apply data in decision-making across the Columbia River basin. Data repository specifications for regional RME are being managed by PNAMP in the www.monitoringmethods.org tool and tracked in BPA's Pisces contracting tool and the BPA Fish and Wildlife Program's Taurus reporting system at www.cbfish.org. Standardized methods for STM and AEMR have been developed to facilitate comparison of results over time for selected parameters and are documented at www.monitoringmethods.org (Johnson et al. 2008; Roegner et al. 2009). Work is underway through the EP SWG and the new Corps Synthesis and Evaluation project to coordinate data sharing and dissemination.

A database is being developed by the Corps under the Synthesis and Evaluation project (EST-P-12-01) that will include a central, web-accessible repository for LCRE data and a publicly accessible website with links to a networked system of databases. The ultimate goal of this project is a web-based, geospatial database system to be implemented within CEERP's existing adaptive management framework and used by CEERP stakeholders estuary-wide. The overall objectives of this 2012–2014 project are as follows:

- Coordinate with CEERP funding agencies and regional stakeholders to ensure the database system will meet management's needs for ecosystem restoration throughout the floodplain study area of the LCRE.
- Develop and populate a web-based, publicly accessible geospatial database management and analysis system to support CEERP action planning, RME, synthesis and evaluation, strategy development, reporting, public communication, regional and basin review processes, information dissemination, and decision-making.
- Apply data and information within the CEERP adaptive management process.

Data are currently being disseminated through several avenues. Results or preliminary findings are reported for CEERP RME actions in the FCRPS BiOp annual progress reports. In addition, an annual Columbia River Estuary Conference (www.cerc.labworks.org) is convened to evaluate the CEERP RME effort, to exchange information, and to update managers regarding the status of RME efforts, as appropriate. The annual CEERP Synthesis Memorandum includes data summaries and provides adaptive management recommendations at the program level for consideration by the BPA/Corps, restoration sponsors, and other related entities. The BPA/Corps and their partners are working to schedule meetings and workshops between decision-makers and RME researchers in a manner that will facilitate basin-wide adaptive management. This step is part of the CEERP adaptive management process.

CEERP data management and dissemination are a priority for BPA/Corps. In coordination with existing data repositories managers, CEERP provides guidance and stewardship to implement data

management and analysis through development of data-exchange templates and regional data repositories for fish and habitat data. The intent is improved efficiency in data management and reformatting through use of data-exchange templates and management of regional data repositories. Many monitored indicators will be included; e.g., Roegner et al. (2009) metrics and indicators. Two specific deliverables/products are anticipated: data-exchange templates for specific protocols and a regional estuarine database. The leads will be project/contract sponsors with PNAMP's and BPA/Corps' support to manage monitoring methods and the Corps for the CEERP database. Data coordination will occur in various ways, using the following:

- monitoring protocols (www.monitoringmethods.org)
- PNAMP's STM Databank for the Integrated Status and Effectiveness Monitoring Program (<http://webapps.nwfsc.noBPA/Corps.gov/>)
- Columbia Habitat Monitoring Program (CHAMP; www.champmonitoring.org/)
- Salmonid Population Summary databank (<http://webapps.nwfsc.noBPA/Corps.gov/>, PTAGIS Information System www.ptagis.org/)
- NOBPA/CORPS data repositories to coordinate genetics information (<http://www.nwfsc.noBPA/Corps.gov/research/divisions/cbd/standardization.cfm>)
- collaboration with PNNL for new database development (EST-P-12-01)
- EP's project tracking database (<http://maps.lcrep.org/>).

4.2 Coordination

CEERP coordination involves using existing processes. CEERP RME is funded by BPA through the Council's Fish and Wildlife Program and by the Corps through the AFEP. Both programs have well-defined coordination and review processes. For example, the annual AFEP review and coordination cycle involves identifying research priorities based on management needs, developing and reviewing preliminary research proposals, finalizing the research scopes of work, and disseminating results in reports and the annual AFEP review conference. The Estuary/Ocean Subgroup for federal RME coordinates overall estuary RME planning and implementation. In addition, the EP has its SWG, where CEERP activities are communicated and discussed and restoration projects are reviewed technically. The EP also convenes an annual coordination meeting of the BPA/Corps, NMFS, and other entities charged with research and monitoring in the estuary. Furthermore, the BPA/Corps coordinate CEERP RME with other basin-wide RME groups, other federal monitoring programs, interested parties, and state and local monitoring efforts. Finally, the BPA/Corps have cross-agency coordination meetings to ensure consistent estuary RME and CEERP implementation. Periodic calls, meetings, and events to coordinate, plan, and exchange information relevant to the CEERP include the following, organized by periodicity (points of contact are in parentheses):

Weekly or Bi-Weekly

- BPA/Corps Coordination Committee (Zelinsky/Ebberts)
- ERTG Steering Committee (Johnson)
- BPA/CORPS/WDFW for the Washington MOA (Foster, Ebberts, and Vigg)

Monthly

- ERTG with region or Steering Committee (Johnson)
- BPA/CORPS/Restoration Project Sponsors (Zelinsky, Ebberts, Corbett, McEwen, M Russell, Vigg, Cowlitz Tribe)
- EP SWG (Corbett)

Quarterly

- AFEP RME coordination (Studebaker)

Semi-Annually

- EP/BPA/CORPS/RME Researchers (Corbett, Studebaker, Scranton, etc.)

Annually

- Columbia River Estuary Conference (Corbett)
- AFEP SRWG (special estuary focus; Studebaker)
- AFEP Annual Review (Studebaker)

As Needed

- Estuary/Ocean Subgroup for Federal RME (Johnson)
- ISRP (Merrill)
- BPA/CORPS Policy Executives (Bodi and Brice).

4.3 Schedule

Under the CEERP, project-specific restoration and RME actions take place continuously, day-to-day, nearly 365 days per year. Different projects typically have different schedules and no single annual cycle of events will fit all projects. Therefore, CEERP participants meet regularly and move projects through the project-development process. This will ensure that the adaptive management process that includes checkpoints, deliverables, and work products is fixed in time that program stakeholders can access the process for guidance and decision-making (see Section 2.1 for details about the project prioritization process). Another scheduling factor for the CEERP timeline is that it needs to meet the BPA/Corps' reporting requirements for the 2013 and 2016 comprehensive analyses for BiOp reporting (NMFS 2008).

During 2012, the schedule for the main CEERP deliverables is as follows:

- June 2012 – 2012 Synthesis Memorandum
- July 2012 – draft 2013 Strategy Report and draft 2013 Action Plan
- September 2012 – 2013 Strategy Report
- November 2012 – 2013 Action Plan.

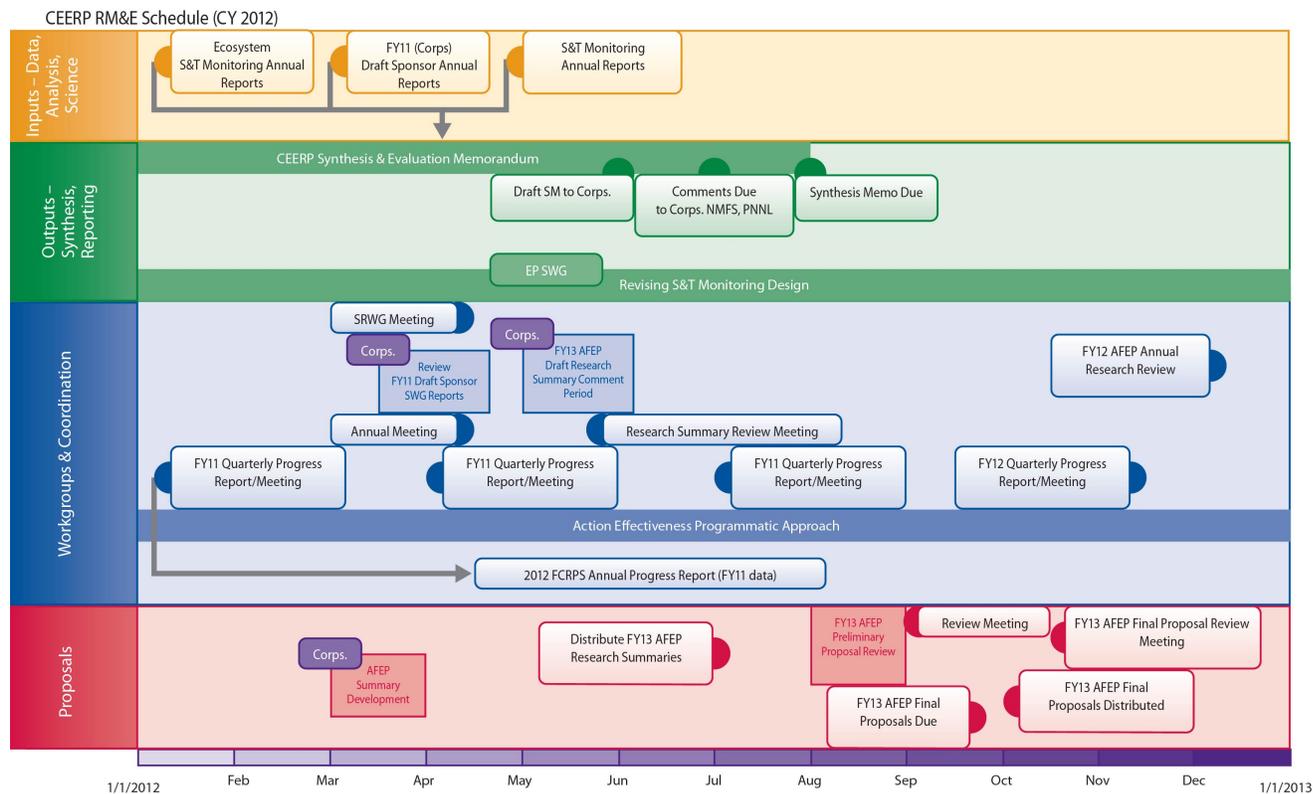


Figure 10. Gantt Chart of Key CEERP Activities

4.4 Summary

The CEERP 2012 Action Plan is based on the BPA/Corps’ fundamental strategy for estuary habitat actions and RME. That is, apply an ecosystem-based approach to restore, enhance, or create ecosystem structures, processes, and functions in the estuary, and perform RME to assess the effectiveness of these actions, while building basic understanding of LCRE ecosystems. This strategy builds on and is consistent with the Council’s Fish and Wildlife Program. The Action Plan details the approach the BPA/Corps use to develop and prioritize projects. The BPA/Corps plan to implement 16 CEERP restoration projects throughout the LCRE during CY 2012. The restoration effort will be closely coordinated with ongoing CEERP RME. Seven RME projects are queued for CY 2012, including one STM, one CUR, and five AEMR projects. CEERP uses an integrated strategy for restoration and RME, as described in the 2012 Strategy Report. Data and coordination are focus areas for CEERP managers. Periodic coordination meetings of various kinds of CEERP-related activities are scheduled. The 2012 schedule for the main CEERP deliverables is as follows: 2012 Synthesis Memorandum (June); 2013 Strategy Report (September); and 2013 Action Plan (November).

5.0 References

- Action Agencies/NOBPA/CORPS/NPCC RM&E Workgroup. 2010. *Recommendations for Implementing Research, Monitoring and Evaluation for the 2008 NOBPA/CORPS Fisheries FCRPS BiOp*. Bonneville Power Administration, Portland, Oregon.
- Borde AB, HL Diefenderfer, SA Zimmerman, NK Sather, and RM Thom. 2009. *Lower Columbia River and Estuary Restoration Reference Site Study 2008 Report*. PNWD-4133, Battelle–Pacific Northwest Division, Richland, Washington.
- BPA/Corps. 2012. *Columbia Estuary Ecosystem Restoration Program: 2012 Strategy Report*. Final report, Bonneville Power Administration and U.S. Army Corps of Engineers, Portland, Oregon.
- Council (Northwest Power and Conservation Council). 2005. “Lower Columbia Subbasin Plan.” In *Columbia River Basin Fish and Wildlife Program*. Portland, Oregon.
- Council (Northwest Power and Conservation Council). 2009. *Columbia River Basin Fish and Wildlife Program*. Council Document 2009-09, Portland, Oregon. Available at <http://www.nwcouncil.org/library/2009/2009-09/>.
- Diefenderfer HL, GE Johnson, NK Sather, JR Skalski, EM Dawley, AM Coleman, KG Ostrand, KC Hanson, DL Woodruff, EE Donley, Y Ke, KE Buenau, and AJ Bryson. 2011. *Evaluation of Life History Diversity, Habitat Connectivity, and Survival Benefits Associated with Habitat Restoration Actions in the Lower Columbia River and Estuary, Annual Report 2010*. PNWL-20295, prepared for the U.S. Army Corps of Engineers, Portland District, Portland, Oregon, by the Pacific Northwest National Laboratory, U.S. Fish and Wildlife Service, and University of Washington, Richland, Washington.
- Endangered Species Act of 1973. 7 USC § 136; 16 USC § 1531 et seq.
- ERTG (Expert Regional Technical Group). 2010a. *ERTG Scoring Criteria*. Document # ERTG 2010-02, Available from the Bonneville Power Administration or the U.S. Army Corps of Engineers, Portland District, Portland, Oregon.
- ERTG (Expert Regional Technical Group). 2010b. *History and Development of a Method To Assign Survival Benefit Units Scoring Criteria*. Document # ERTG 2010-03, Available from the Bonneville Power Administration or the U.S. Army Corps of Engineers, Portland District, Portland, Oregon.
- ERTG (Expert Regional Technical Group). 2011. *Feedback on Inputs to the Calculator to Assign Survival Benefit Units*. Document # ERTG 2011-01, Available from the Bonneville Power Administration or the U.S. Army Corps of Engineers, Portland District, Portland, Oregon.
- Evans NR, RM Thom, GD Williams, J Vavrinec, KL Sobocinski, LM Miller, AB Borde, VI Cullinan, JA Ward, CW May, and C Allen. 2006. *Lower Columbia River Restoration Prioritization Framework*. Prepared for the Lower Columbia River Estuary Partnership by Battelle-Pacific Northwest Division, Richland, Washington.
- ISRP (Independent Scientific Review Panel). 2010. *Final RME and Artificial Production Categorical*

Review Report. Document ISRP 2010-44, submitted to the Northwest Power and Planning Council, Portland, Oregon.

Johnson GE, RM Thom, AH Whiting, GB Sutherland, T Berquam, BD Ebberts, NM Ricci, JA Southard, and JD Wilcox. 2003. *An Ecosystem-Based Approach to Habitat Restoration Projects with Emphasis on Salmonids in the Columbia River Estuary.* PNNL-14412, final report submitted to the Bonneville Power Administration, Portland, Oregon, November 2003, by Pacific Northwest National Laboratory, Richland, Washington.

Johnson GE, HL Diefenderfer, BD Ebberts, C Tortorici, T Yerxa, J Leary, and J Skalski. 2008. *Research Monitoring and Evaluation for the Federal Columbia River Estuary Program.* PNNL-17300, final report for the Bonneville Power Administration, Portland, Oregon, by Pacific Northwest National Laboratory, Richland, Washington.

Johnson GE, HL Diefenderfer, RM Thom, GC Roegner, BD Ebberts, JR Skalski, AB Borde, EM Dawley, AM Coleman, DX Woodruff, SX Breithaupt, AX Cameron, CX Corbett, EX Donley, DA Jay, Y Ke, KX Leffler, CX McNeil, CX Studebaker, and JX Tagestad. 2011a. *Evaluation of Cumulative Ecosystem Response to Restoration Projects in the Lower Columbia River and Estuary.* PNNL-20296, prepared for the U.S. Army Corps of Engineers, Portland District, Portland, Oregon, by Pacific Northwest National Laboratory, Richland, Washington.

Johnson GE, NK Sather, AJ Storch, DJ Teel, JR Skalski, EM Dawley, AJ Bryson, GR Ploskey, C Mallette, TA Jones, AB Borde, SA Zimmerman, ES Van Dyke, DR Kuligowski, and KL Sobocinski. 2011b. *Ecology of Juvenile Salmon in Shallow Tidal Freshwater Habitats of the Lower Columbia River, 2007–2010.* PNNL-20083, Pacific Northwest National Laboratory, Richland, Washington.

Johnson GE, JR Skalski, and J Tagestad. 2011c. “Statistical and Other Considerations for Restoration Action-Effectiveness Monitoring and Research,” pp. F.1-F.23, in: *Evaluation of Cumulative Ecosystem Response to Restoration Projects in the Lower Columbia River and Estuary*, Johnson et al. PNNL-20296, prepared for the U.S. Army Corps of Engineers, Portland District, Portland, Oregon, by Pacific Northwest National Laboratory, Richland, Washington.

Lower Columbia Fish Recovery Board. 2010. *2010 Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan.* Revision of the 2006 interim recovery plan for the Washington portion of the lower Columbia River recovery domain. Available at www.lcrfb.org.

National Marine Fisheries Service (NMFS). 2008. *Biological Opinion – Consultation on Remand for Operation of the Federal Columbia River Power System, 11 Bureau of Reclamation Projects in the Columbia Basin and ESA Section 10(a)(1)(A) Permit for Juvenile Fish Transportation Program.* NMFS (National Oceanic and Atmospheric Administration Fisheries) – Northwest Region, Seattle, Washington.

National Marine Fisheries Service (NMFS). 2011. *Columbia River Estuary ESA Recovery Plan Module for Salmon & Steelhead.* NMFS (National Oceanic and Atmospheric Administration Fisheries) – Northwest Region, Seattle, Washington.

Northwest Power Act of 1980. Public Law 96-501.

Roegner GC, HL Diefenderfer, AB Borde, RM Thom, EM Dawley, AH Whiting, SA Zimmerman, and GE Johnson. 2009. *Protocols for Monitoring Habitat Restoration Projects in the Lower Columbia River and Estuary*. NOBPA/CORPS Technical Memorandum NMFS-NWFSC-97, prepared for the U.S. Army Corps of Engineers, Portland District, by NOBPA/CORPS Fisheries and Pacific Northwest National Laboratory. Seattle, Washington.

Simenstad CA and JR Cordell. 2000. "Ecological Assessment Criteria for Restoring Anadromous Salmonid Habitat in Pacific Northwest Estuaries." *Ecological Engineering* 15:283–302.

Simenstad CA, JL Burke, JE O'Connor, C Cannon, DW Heatwole, MF Ramirez, IR Waite, D Counihan, and KL Jones. 2011. *Columbia Estuary Ecosystem Classification – Concept and Application*. U.S. Geological Survey Open File Report 2011-1228.

Tetra Tech. 2010. *An Inventory and Assessment of Action Effectiveness and Status Monitoring Projects Targeting Chinook and Steelhead Tributary Habitat in the Columbia River Basin*. Report submitted to the Bonneville Power Administration, Portland, Oregon.

Thom RM. 2000. "Adaptive management of coastal ecosystem restoration projects." *Ecological Engineering* 15(3–4):365–372.

Thom RM, GE Johnson, BD Ebberts, CL Studebaker, HL Diefenderfer, and C Corbett. 2011. "Adaptive Management of Ecosystem Restoration in the Lower Columbia River and Estuary." Pp. 3.1–3.23, in: *Evaluation of Cumulative Ecosystem Response to Restoration Projects in the Lower Columbia River and Estuary*, Johnson et al., PNNL-20296, prepared for the U.S. Army Corps of Engineers, Portland District, Portland, Oregon, by Pacific Northwest National Laboratory, Richland, Washington.

U.S. District Court. 2011. Opinion and Order, National Wildlife Federation et al. v National Marine Fisheries Service *et al.* Case 3:01-cv-00640-RE Document 1855 Filed 08/02/11. (Available at <http://www.salmonrecovery.gov/>.)

Washington-Action Agencies. 2009. *Estuary Habitat MOA*. Memorandum of Agreement on Columbia River Estuary Habitat Actions Between the State of Washington, the Bonneville Power Administration, The U.S. Army Corps of Engineers, and the U.S. Bureau of Reclamation. Available at www.salmonrecovery.gov/.