Adaptive Management

Framework for Adaptive Management of the Corps of Engineers' Habitat Restoration Programs in the Lower Columbia River and Estuary

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Introduction

In this chapter we provide the background, purpose and need for developing an adaptive management plan for COE habitat restoration projects in the CRE. We offer a framework that will be used to capture information and learning about projects conducted under the present CE program and can be used for future projects conducted by others.

Definition of Adaptive Management in an Ecosystem Restoration Context

Adaptive management (AM) is a process where uncertainties are addressed in a systematic manner. Walters (1997) describes it further as *"a structured process of learning by doing that involves more than simply better ecological monitoring and response to unexpected management impacts. It should begin with a concerted effort to integrate existing interdisciplinary experience and scientific information into dynamic models that attempt to make predictions about impacts of alternative policies."* The goal is to maximize learning and minimize uncertainty and, thereby, risk. The process can be active (i.e., systematic manipulations to address plausible hypotheses) or passive (i.e., initiate a situation based on the best available information and monitor the response). In general, the active approach is potentially more complex and expensive than the passive approach because it may yield no net benefit initially. Conducting experiments on a scale large enough to yield results that are meaningful to a program can take years to design, implement and monitor. Conversely, the passive approach, often called 'learn by doing', may take more time to assess and may be more risky in meeting performance goals.

Adaptive Management in the CRE

There is a clear need for implementing an adaptive management program for habitat restoration projects in the CRE. Documented substantial (~75%) losses of tidal vegetated habitats have resulted in significant reduction of marsh detritus input into the estuary (Thomas 1983). In addition, construction of dikes and levees has severely limited juvenile salmon access to productive tidal wetland feeding and rearing areas (Bottom et al. 2005). Programs to restore marsh macrodetritus production and input and enhance the opportunities for fish to access these habitats are underway in the estuary. In general, the level of interest in and funding for restoration is increasing dramatically. Multiple agencies, including federal, state and local governments, non-profit agencies, and NGOs, conducting ecosystem restoration are driven by a

wide variety of factors ranging from federal legislation through the mission-based goals. Restoration programs sponsored by the US Army Corps of Engineers, Portland District, are specifically driven by compensatory mitigation associated with dredging programs, national Corps guidance to conserve, protect and restore wetlands, as well as the newly published remand draft Biological Opinion on the effects of the Federal Columbia River Power System on salmonids (NOAA 2007). The Corps acts to restore habitats under several legislative acts, and receives funding for restoration through these programs. The Water Resources Development Act (WRDA 2007) authorizes spending for large-scale ecosystem restoration programs developed by the Corps and local sponsors nation-wide. Taking into account all programs, several million dollars is allocated annually for habitat restoration in the CRE. With planned expansion of these programs, this total could rise to tens of millions of dollars annually over the next decade.

Uncertainties in Ecosystem Restoration in the CRE

Funding is contingent on several factors, not the least of which is proving that restoration projects are having a net positive impact on the estuary and its resources. Furthermore, the science of restoration ecology and the practice of tidal ecosystem restoration contain significant uncertainties (Palmer et al. 2006). Lack of information on outcomes hampers the ability to improve project performance because there is no systematic way to reduce uncertainties associated with project planning and implementation. Examples of uncertainties that have surfaced recently in the CRE include:

- accidental flooding of adjacent properties associated with tidal reconnection projects,
- lack of juvenile salmon use of a wetland behind a newly installed regulated tide gate,
- colonization of an excavated site by an invasive non-native plant species,
- disproportionate coverage of invasive non-native plant species on intertidal fill material,
- poor understanding of migration patterns of juvenile salmon in lowland tidal systems tributary to the CRE,
- poor documentation of elevation distributions of major tidal wetland plant species,
- lack of data on accretion (i.e., land building) rates in tidal wetlands,
- no estimates of flood attenuation capacity of restored tidal wetlands,
- actual tidal range relative to land surface elevation between the mouth and the upper end of the estuary, and between the river and the upstream ends of tidal influence on the tributaries,
- lack of data on actual fish passage through “fish-friendly” tide gates,
- effects of pile structures and structure removal on fish,
- ecological role of large wood debris in estuaries, and
- rates and patterns of vegetation assemblage and geomorphological feature development relative to tidal hydrology, levee breach size, culvert size and tide gate operation.

In general we know that tidal wetland systems perform important ecological functions. However, we have little empirical information on the actual:

- relationships between factors controlling the development of these functions at site, reach and river scales,
- rates, patterns and scale of functional development,
- risks of disruption of functional development,
- resilience of these systems to disturbances,
- effect of climate change on restored habitats, and
- cumulative effects of multiple restoration projects on the broader ecosystem and its biological resources.

The actual and general uncertainties jeopardize our ability to effectively plan restoration projects. A recent case in point is that, even though considerable effort has gone into planning, the Corps is both unsure of the eventual outcome as well as actual costs of restoring the Florida Everglades. In this case the projects initial cost estimate ($8B) is estimated to be substantially greater ($10B). The public is ultimately the funding source for restoration, and spending $10B on an uncertain project may be unpalatable to the public.

Cumulative Effects Research Program

The Cumulative Effects Study has focused on reducing key uncertainties in order to help plan the effective and efficient restoration of the CRE ecosystem. We have been employing six basic steps to accomplish this:

1) a scientific approach based on a review of the literature and our own internals discussions on how to learn from restoration projects.
2) research on projects of opportunity to evaluate some of the key uncertainties (i.e., passive adaptive management).
3) existing knowledge about the ecosystem as is available from past work and ongoing research.
4) review of programs in other regions, and spoken with researchers and managers in these systems to help fill out our understanding of approaches taken elsewhere that might be applicable in the CRE.
5) a framework involving field studies, experiments, monitoring and modeling to capture and analyze relevant information, which can be sued to formulate predictions of outcomes associated with alternative restoration plans.
6) A draft adaptive management approach, described herein, to systematically capture and disseminate learning.

Our approach to improving restoration effectiveness in the CRE should be modified and improved as dictated by experience. Restoration of the CRE ecosystem requires a large-scale,

long-term effort to enact significant change. In order to improve the approach, we need to assess outcomes along the way.

Objective and Principles of this AM Plan

Within the CRE, a complex ecosystem and one for which it is hard to find an analog, there needs to be an effective framework for evaluating restoration projects that maximizes information gain and reduces uncertainties. *The objective here is to provide an adaptive management framework to maximize functional performance of restoration projects in the CRE.* In order for an AM program to be effective and long lasting, it must have strong scientific underpinnings, show relevance to cooperating agencies, and be feasible to implement. Thus, the program is guided by the following principles:

- *Science Based* – The program must adhere to scientific principles of data acquisition, analysis and interpretation. Appropriate questions to address should drive what is done. Hypotheses as needed should be developed to help frame the monitoring. The scientific knowledge base should be consistently utilized and improved.
- *Implementable* – The program will be feasible and reasonable to implement.
- *Corps-Centric in Scope* – The program will adhere to the Corps planning process and to the operation and maintenance process as much as possible, and other procedures promulgated as part of the authorities under which the Corps conducts restoration programs.
- *Regional Collaboration* – Although Corps focused, the program will capture and compliment learning from other projects, and work collaboratively to raise the general success of restoration projects in the estuary from agencies and entities. This cooperation can extend to other Northwest ecosystems including Puget Sound, and outer coast estuaries in Oregon and Washington.
- *Minimize Redundancy* – The program will utilize existing organizational processes to avoid additional demands on staff or redundancy. This type of approach is advocated by the Environmental Advisory Board (EAB 2006) of the Corps. Examples of processes in the Columbia River estuary include PNAMP, NED, etc.

Learning from past experience is critical to improving restoration project success. With the exception of a few very large and conspicuous projects (e,g., sediment delivery experiment in the Colorado River), there is no effective mechanism to disseminate the knowledge gained to others under either the active or passive approach. The three most common methods at present are presentations at regional or national meetings, publication of reports, and informal word of mouth. All methods suffer from obvious inabilities to fully reach the relevant audience. Publications in the peer-reviewed literature are constrained by long lag periods, bias of peer reviewers and editors, and page limits. Gray literature, which is that form of reports not published in peer-reviewer technical journals, has traditionally had very limited distribution. Word of mouth dissemination is often the role that a practitioner (e.g., restoration expert) plays in capturing their experience through their career and utilizing it on projects they are directly involved in or their colleagues are involved in. This “institutional” knowledge is highly vulnerable to retirements,

change of employer, or change of career. When the manager or "guru" leaves, a great deal of understanding leaves with them. Finally, there is an overriding problem of practitioners not spending the time to fully explore the knowledge base. A case in point is with seagrass restoration. In 1947, C.E. Addy published guidance on methods to restore eelgrass. Although the methods are amazingly current, many of them were "discovered" by others only over the last decade (M. Fonseca, 2007).

National Guidance on Monitoring and Adaptive Management for Ecosystem Restoration in the Corps of Engineers

The Corps of Engineers, through the efforts of its leadership with guidance from their Environmental Advisory Board (EAB), has issued direct guidance to staff on the role and use of AM in the restoration programs. How this is implemented in programs at the District level is not standardized, and is generally left up to the Districts. For example, within the Jacksonville District, the Everglades ecosystem restoration program has a specific section devoted to monitoring and adaptive management. Their system has evolved over several years and has included extensive collaboration with the South Florida Water Management District and other regional and local entities. To date, AM implementation is "grass roots," often conducted by individual project managers.

In this section, we summarize the national guidance on AM to the Corps. There are a number of documents that specifically address AM within the Corps of Engineers restoration programs. These documents include general as well as some specific guidance to Corps planners and program managers. To date, there is no universally accepted procedure for applying AM on Corps projects. A key impediment has been restrictions on funding level for monitoring. Although Corps project managers have found ways to implement significant pre-project monitoring and assessment, it has been consistently difficult to conduct post-project monitoring with accompanying project adjustments under the present rules by which the Corps operates. The guidance documents summarized here have been issued primarily by the National Research Council (NRC), Corps headquarters, and the EAB. As a rule, the documents recommend the use of the AM process to improve performance of existing and planned projects. The first five summaries that follow are based on Thom et al. (2007b).

Restoring and Protecting Marine Habitat (NRC 1994) -- The National Research Council (NRC) committee considered a coastal engineering strategy to preserve, protect, enhance, restore, and create marine habitats to mitigate or reverse coastal marine habitat loss. They recommended the following points to advance the state of the practice of restoration and guide monitoring and adaptive management: better understanding of ecosystem function; promotion of policy and procedural change; establishment of restoration goals and objectives; cooperation among involved organizations, including integrated and collaborative actions; collaboration of relevant scientific and engineering disciplines; adapting technology and innovation through experimentation; information transfer; incentive-based solutions; and, performance measurement.

Ecosystem Restoration in the Civil Works Program (Department of the Army 1995) -- This circular (No. 1105-2-210; expired 30 June 1997) is specific and profound in terms of guidance to

Corps' staff on ecosystem restoration, monitoring, and adaptive management. It instructs staff to meet natural resource restoration objectives using an ecosystem approach by considering the roles of plant and animal species populations and their habitats in a larger context of community and ecosystem frameworks. Furthermore, adaptive management should be considered for inclusion in restoration projects recognized to have potential for uncertainty in achieving their objectives. The circular states, *"At the heart of adaptive management, and the cornerstone for its success, is a carefully designed monitoring program that begins during construction and continues for a specific period after the project has been completed…Improving the knowledge base regarding a particular restoration approach or ecosystem component is a significant subset of the overall goal of adaptive management."*

Compensating for Wetland Losses under the Clean Water Act (NRC 2001) -- The NRC determined that compensatory mitigation of wetland losses under the current wetland legislation was not being achieved. They reached five conclusions, with recommendations to improve the situation. Conclusion 3 was that performance expectations have been unclear, and that compliance has not been assured. Among the recommendations were that projects need clear goals, implementation must be conducted correctly and documented through implementation monitoring, and functional assessments must be part of the effectiveness-monitoring program. In addition, project management must be adaptive to improve the chances for success.

Adaptive Management for Water Resources Project Planning (NRC 2004) -- This NRC panel, in part, examined ways in which AM might usefully be applied in Corps' project planning and operations. Nine recommendations, paraphrased here for berevity, were developed: 1) post-construction evaluations should be standard practice; 2) stakeholder collaboration is a must; 3) independent experts should periodically consulted for advice; 4) the Administration should strengthen interagency coordination for large restoration programs; and Congress should 5) establish a Corps Center for Adaptive Management; 6) clarify water management objectives for the Corps; 7) increase authority for the Corps to monitor and evaluate projects during post-construction; 8) allocate funding to sustain the program; and, 9) revise cost-sharing formulas to promote adaptive management.

Planning Aquatic Ecosystem Restoration Monitoring Programs (Thom and Wellman 1996) -- This report provides a unified approach to plan, implement, and interpret restoration monitoring programs. The report, written specifically for Corps' planners, helps them identify factors to consider in designing and implementing an efficient, cost-effective monitoring program. Monitoring should be designed to address performance relative to a goal. A conceptual model is used as the basis to select parameters to monitor.

Restoration Authorities of the U.S. Army Corps of engineers: A Discussion Paper (EAB 2005) -- This discussion paper provides an assessment by the EAB of the Corp's mission and authorities for ecosystem restoration. The EAB determined that there has been a shift from single-agency driven programs to multi-agency collaborations. "The Corps is uniquely positioned to play a leadership or key partnership role in large scale ecosystem restoration, protection and sustainable use." The document provides the following recommendations: 1) "The corps should develop and implement an information/education campaign to inform current and perspective partners and

constituents of its authorities and capabilities for ecosystem restoration;(2) elevate ecosystem restoration as a priority activity, and actively pursue opportunities to "market" Corps services to propective partners and constituents"; and, 3) "Review recently signed MOU's for collaborative restoration efforts…and identify/pursue specific tasks and timelines."

Integrating Ecosystem Restoration into Programs of the US Army Corps of Engineers (EAB 2006a) -- The Corps' Environmental Advisory Board is a group of independent experts who provide advice and guidance to the Corps at a national level. This letter report of the EAB to the Chief of Engineers states that the Corps has substantial in-house expertise relevant to ecosystem restoration, and the EAB believes that conceiving, implementing and maintaining a restoration project requires an adaptive management framework. The EAB recognizes that the Corps has institutional and organizational constraints in accomplishing the long-term monitoring and evaluation that are essential to effective adaptive management. Further, the EAb recommends that the Corps undertake an initiative that involve training, learning and outreach to promote ecosystem restoration and adaptive management within the agency, and that a Center for Ecosystem Restoration be established.

Environmental Benefits and Performance Measures: Defining National Ecosystem Restoration and How to Measure its Achievements, a Discussion Paper (EAB 2006b) -- Recently, the EAB has addressed issues concerning ecosystem restoration. This paper summarizes recommended performance measures at project and program scales and recommends that explicit guidance be produced. They provided the following recommendations relevant to monitoring and adaptive management to the Chief of Engineers: 1) "The Corps should encourage the explicit use of conceptual models to guide ecosystem restoration planning and implementation;" 2) "Benefits metrics used in Corps planning should explicitly identify the linkages between hydrogeomorphic change and native communities and ecosystem functions (as identified in the Conceptual Model), and should rely only on inputs that can be confidently predited at the spatial and temporal scales appropriate to the project; 3) "The Corps should develop guidance to the field regarding the development and application of performance measures. This guidance should specifically identify the differences between performance that the Corps' actions directly impact and those expected outcomes which may be influenced by external factors;" and 4) "The Corps should continue to work with other Federal agencies with interests in ecosystem restoration to identify regional goals for restoration and develop common metrics to assess outcomes of ecosystem restoration investments."

Supplemental Actions to the USACE Campaign Plan, Applying Lessons Learned resulting from Hurricanes Katrina and Rita (Strock 24 August 2006) -- This memorandum for Directors from the Chief of Engineers outlines specific actions relative to 12 points for applying lessons learned resulting from Hurricanes Katrina and Rita. These essentially represent 12 steps toward improving how the Corps does their work in an adaptive framework. Point 5, Employ adaptive planning and engineering systems, states "We will generate a culture of planning and design for expected and unexpected changes to provide long-term life-cycle solutions for the public. We will develop the methods to routinely include dynamics/non-linear processes in our planning and

design criteria (like climate change), and we will employ a clear and credible methodology to do so. We will also assess existing infrastructure to meet future relevant needs of the nation."

Status Update: 12 Actions for Change (Waters 6 Draft, December 2006) -- This draft document provides more specific and methods to implement the 12 points for applying lessons learned (Strock 2006), and terms them *12 Actions for Change*. The overriding theme directs the Corps staff to employ an integrated, comprehensive systems-based approach in an open and adaptive framework.

Current Monitoring and Adaptive Management Practices in the CRE

Portland District, Corps of Engineers

This past year we focused our assessment of Portland District-level implementation of AM by developing an understanding of what are the main drivers for restoration, i.e., programs, authorizations, and funding. Understanding the main drivers facilitates efficient targeting of the framework structure and information outputs. In addition, we have had the opportunity to develop preliminary guidance to the Lower Columbia River and Estuary Partnership (EP; Thom et al 2007a) and the Puget Sound Nearshore Ecosystem Restoration Program (PSNERP; Thom et al 2007b). This work has helped us to better understand the drivers, needs, etc., for the three major programs to restore Pacific Northwest estuarine systems.

Responses to a set of questions provided critical information to ensure that the adaptive management program a) utilizes existing data and products rather than re-creating them, in order to reduce the impact of implementation on the organization's resources and to build redundancy into the system to ensure its continuance, and b) produces data and products that support the Corps' existing needs and objectives (e.g., ranging from restoration project design to various reporting requirements). Adaptive management as presently practiced by the Portland District is presented in the topical summaries below, which include both the limitations inherent in implementation and the methods utilized to overcome them:

Data on effectiveness of Corps funded restoration projects are primarily collected by contractors (e.g., PNNL, USGS, CREST). Corps staff most often collects engineering data, such as hydraulics, hydrodynamics, soils, and elevations during pre-construction phases of the project. Modeling design work is also conducted by Corps staff. Environmental information that feeds into the design of projects can be collected by Corps staff or contractors. Funding for post-project monitoring is limited to 1% of the project cost, and therefore is often short term and not intensive. In some cases, projects with multiple stages, often driven by the timing of funding, can be conducted over protracted periods of time. This allows parts of projects to be completed, and monitored for effectiveness while the entire project is still in design and implementation phases. The information that is gained post-phase implementation can be used to refine designs of subsequent of the same project. Portland District employs a team approach to effectively pull together required in-house expertise. The knowledge base of the team members is developed through their experience on similar projects.

Up until the publication of the draft Monitoring Protocols (Roegner et al. 2006), there were no specific standards for metrics to monitor or methods to use. Most restoration projects within the District are focused on restoring conditions for fish (primarily salmonids). Hence, monitoring of fish presence, spatial extent of habitat use, prey availability and consumption is conducted. However, not all projects are monitored, and not all of the above methods are collected if monitoring is conducted. Often hydraulic data of some kind is collected. If the project involves "construction" there generally is "as built" data collected which often include elevations, plant survival (if plantings are done), and perhaps soil/sediment conditions. More extensive monitoring of invasive and non-native plant species (e.g., reed canary grass) may occur under the implementation phase because the project plan calls for control or elimination of these species following construction.

There is not a formal practice regarding posting data or reports on restoration projects. However, Corps staff members routinely send monitoring reports, at a minimum, to all regional fishery managers (WDFW, ODFW, IDF&G, USFWS, NOAA, BPA, Treaty Tribes). Once comments are received they are incorporated if relevant or addressed as to why they were not relevant. The final report is sent to the same groups. Some final reports are posted on the District's web site for pubic access, although posting again is not a formalized procedure or always done.

Data are applied in the review of new restoration projects. There is no formal process for capturing learning from projects. Project reporting systems for various authorities (e.g., Section 536) have a very simple scoring system that essentially is one line in a spreadsheet, and does not provide any detail regarding the background information used to arrive at the score. However, lessons learned are 'brought to the table' by project team members with relevant experience. Staff members endeavor to learn from past projects on their own, apply this learning to new projects, and contribute the knowledge to others on the project team. As mentioned above, where projects are divided into incremental phases, the information on early phases is reviewed to inform later phases. At issue within the District is loss of the knowledge base as people retire, or leave for other reasons. To alleviate some of this problem, senior technical area leads are increasingly being paired with junior staff members for mentoring purposes.

Data from more than one project are not routinely and systematically analyzed together for any purposes of comparing effectiveness of restoration methods or the outcomes of a restoration action implemented in different habitat types. Cross-project comparisons are made on an ad hoc basis during periodic meetings. These meetings can involve a large range of staff capabilities and experience. Although not used routinely, a standardized project management tool exists (the After-Action Report) that could be used to capture learning on projects.

The goal for the COE is to 'deliver' the project to the local project sponsor. The COE develops an agreement in collaboration with a local sponsor who has requested the project. The COE and local sponsor collaborate on a project proposal, which is submitted to COE HQ. Headquarters staff respond with a statement of what the District will do and the final disposition of the project. Once the project is delivered, the COE normally no longer has responsibilities to maintain project functioning unless stipulated in the agreement. Restoration projects are often

given to a local or national resource agency such as the USFWS, and it is up to that agency to maintain the project. If the District retains long-term maintenance responsibility during the Operations and Maintenance (O&M) phase, then no more than 1% of the project cost can be used for monitoring the project.

Congress ultimately funds restoration projects. Designs are developed internally and generally involve a team approach to capture the knowledge base. Designs are based upon a series of relevant analyses that may have an associated level of effort concordant with the size or complexity of the project. The COE has a formal planning process that involves an initial feasibility study phase, followed by general investigation, and design phases. Each of these phases are incrementally funded by Congress. In order to receive funding, the project must have strong justification, and meet the criterion of a net benefit to the nation vs. project costs. Environmental benefits from habitat restoration project can be accounted for in calculating project benefits. The projects are proposed from the level of the District, through the Division to Headquarters. Headquarters prepares a package for consideration by Congress. The District must report back to Congress on how the money allocated for projects were actually spent, and if the project was built.

Funding cycles are driven by the federal budget, which can suffer from delays. Hence, initiation of project and various phases of projects are often stalled waiting for funding allocations. This may make satisfying project goals difficult to achieve on a regular schedule. The funding cycle is probably one of the most difficult issues project managers deal with. Once in house, funds must be expended according to the project plan, with completion of milestones coinciding with amount of funds expended. The spend plan is closely monitored by the District.

Projects that are selected are often done so on an opportunistic basis, rather than a systematic analysis of all potential projects. For example, a local sponsor may approach the District with a project that would obviously provide environmental benefits (e.g., donation of a parcel of undeveloped or minimally-developed land). The District then must decide if it fits within their authorities and meets internal criteria relative to larger programs such as the Anadromous Fish Evaluation Program (AFEP). If the project might address issues identified in the remand draft Biological Opinion (NOAA 2007), it may also be viewed as high priority for funding. Finally, sets of projects such as dike breaches, tide gate replacements, and pile structure removal have known or suspected benefits relative to authorities and regional programs. If a proposed project opportunity aligns with these actions, the District may view it favorably.

During various phases of a project, uncertainties can be addressed. The study phases are designed to refine the project plan. This involves target investigations to reduce uncertainties, and represents a key opportunity to address the critical element of adaptive management; i.e., identifying, acknowledging and reducing uncertainties. Examples cited included efforts to understand the effects of pile structures on fish and habitats and the effects of pile structure removal on improving habitat and migratory pathways for fish.

General investigation studies can be used to address uncertainties. Presently the USACE has one ongoing General Investigation Study involving ecological restoration in the CRE under

Section 306 of WRDA 1990, General Investigation Studies for Environmental Restoration. This study provides an opportunity for research to inform the future directions of restoration project designs, although at present funding levels results can be expected on a timescale of decades.

Corps intensively monitored projects and Corps-funded intensive monitoring of other projects. The USACE is developing the understanding of the Columbia estuary ecosystem necessary for the design and evaluation of projects through intensive monitoring of two of its restoration projects – Julia Butler Hansen and Crims Island – and by funding intensive monitoring of two other restoration projects representing different fish habitat types through the AFEP program under the auspices of this cumulative effects study: Vera Slough and Kandoll Farm. Funding of the former projects was enabled by the multi-year construction schedules, with Crims Island monitoring continued under the cumulative effects study (see Appendix A).

Non-Corps Monitoring and Adaptive Management in the CRE

Estuary Wide Scale

RME Plan

In response to the Biological Opinions (NOAA 2000; 2004; 2007), a Research, Monitoring, and Evaluation Plan (RME Plan) has been developed for the Columbia River Estuary with input from the Action Agencies (Corps of Engineers, Bonneville Power Administration), NOAA Fisheries, the Estuary Partnership, and others and review by the ISRP and others (Johnson et al. 2008). This plan sets forth science-based frameworks for monitoring status and trends in the estuary, conducting action effectiveness research concerning habitat restoration projects, and critical uncertainties research pertaining to endangered salmonids and wetland habitats in the CRE. A comprehensive assessment of existing monitoring projects is made in that plan and therefore will not be reiterated herein (see Johnson et al. 2008).

Reference Sites

The RME Plan (Johnson et al. 2008) recommends establishment of a suite of reference sites representing conditions of natural plant communities along environmental gradients from the mouth of the Columbia to Bonneville Dam and laterally from the main stem river into the floodplain. The project has been taken up by the Bonneville Power Administration, which funded the Lower Columbia River Estuary Partnership to assess potential sites and begin data collection in 2007. The monitoring protocols are congruent with Roegner et al. (2008). Over time, as the number of representative examples increases, this suite of sites will enable analyses of restoration project trajectories to be compared to target conditions using statistical methods described in the RME Plan.

Estuary Partnership Adaptive Management Plan

The Estuary Partnership has a highly developed project prioritization and selection system including a geographical information system (GIS) database, criteria and guidelines for project proposals, a Science Work Group review process, an interagency Project Review Committee, and review roles for contributing funding agencies. The Estuary Partnership's data-gathering and management abilities have benefited from its primary restoration project funding agency requirements: the National Oceanic and Atmospheric Agency (NOAA) Restoration Center requires limited effectiveness-monitoring of structural and functional indicators, and Bonneville Power Administration requires tracking of acreage restored. However, restoration monitoring is rarely if ever funded for longer than one year under existing funding agency requirements, and the submission of any further monitoring data collected by project sponsors not funded by the Estuary Partnership cannot be contractually required. Any data provided by project sponsors are tracked in a comprehensive conservation and management plan tracking database, which has been collected into one volume of 10 case studies. However, a regular cycle for data evaluation and synthesis has not been implemented, and there is no explicit schedule for application of the data to a) the ongoing management of existing projects or b) the prioritization and selection of future projects. Thus, a recent Adaptive Management Plan for the EP's Ecosystem Restoration Program (Thom et al. 2007a) made the following recommendations: 1) standardize project input formats and automate program summarization; 2) implement an annual adaptive management cycle; 3) coordinate with the U.S. Army Corps of Engineers (COE), NOAA Northwest Fisheries Science Center, and Puget Sound restoration program on their adaptive management programs; and 4) enhance the lower Columbia River conceptual model. It is clear that coordination between the Corps of Engineers and the Estuary Partnership will be essential to the capture of both Corps and non-Corps ecosystem restoration projects in estuary-wide syntheses of monitoring data in an adaptive management framework.

Project Scale

Varying Contractual Restoration Project Monitoring Requirements

As described in the Estuary Partnership's Adaptive Management Plan (Thom et al. 2007a), restoration project monitoring metrics and durations differ by project funding source: the Corps, BPA, NOAA, EPA, or others. Typical requirements are sparse (e.g., acreage only for BPA projects) relative to the basic biological and physical information needed to evaluate project trajectories relative to goals. Since the funding contract is the ultimate source of requirements for on-the-ground implementation and monitoring, additional monitoring is rarely conducted. This is a challenge to the collection of comparable monitoring data (i.e., same metric, unit, frequency) to support estuary-wide analysis and synthesis of progress of the multi-agency and non-governmental organization (NGO) ecosystem restoration effort.

CRE Restoration Monitoring Protocols

Restoration monitoring protocols have become available first in a working draft (Roegner et al. 2006) that was vetted by practitioners prior to revision (Roegner et al. 2008). These were first introduced in a meeting of restoration project managers at the Estuary Partnership under the

auspices of the USACE AFEP cumulative effects study on June 23, 2004 (see Diefenderfer et al. 2005, Appendix A for meeting minutes). The purpose was to involve restoration project managers in identifying minimum monitoring indicators and developing appropriate protocols. Further feedback was received at a workshop held in 2007. These protocols are currently in use on projects monitored by CREST and the CLT. However, as previously stated, where contractual requirements on LCREP restoration projects do not include monitoring above the basic requirements of funding agencies, the protocols have not yet come into wide use.

Summary of CRE Monitoring and Adaptive Management

Based on the above review of recent information and publications emanating from the Corps nationally, and an assessment of how restoration planning, monitoring and AM are presently implemented at the District level, these summary points can be made:

1) There is strong and specific guidance from the Head of the Corps as well as the Environmental Advisory Board that mandates the employment of AM principles and frameworks in Corps ecosystem restoration program. This guidance appears to extend beyond restoration to other programs within the Corps.
2) This guidance appears to not have made it down the official chain of command to project managers and planners within the Portland District. We suspect this is the case for most if not all Districts.
3) It appears that the AM process is implicitly applied to Corps project planning and implementation through an ad hoc lessons learned process. Planners understand the need to reduce uncertainties by implementing studies at appropriate times during the standard Corps planning process.
4) Project managers have figured out a method to conduct monitoring to evaluate project performance by staggering project implementation. The monitoring information is then applied to improve later stages of the project.
5) A major impediment to long-term and systematic learning is the requirement for the Corps to pass the completed project to the local sponsor. The Corps can only spend a limited portion of O&M funds on monitoring after passing the project on. Although acceptable in terms of risk for projects that have a long history of implementation (e.g., dredging, filling, jetty construction), restoration projects, which do not have the extensive engineering experience, are much less certain. Thus, these projects can fail, and without an assessment, little can be learned about why they failed.

AM needs for CRE reflect state-of-science & national policy. As is the case in virtually every aquatic ecosystem in the United States, there is a clear need for, but a lack of, focused performance-based monitoring in restoration programs in the CRE. This type of monitoring is

needed in the CRE, but who will fund it, how it will be implemented, and how the knowledge will be rolled up, analyzed, and disseminated from remains unclear. We believe that the lack of monitoring comes not from individuals involved in restoration programs but the constraints embedded within program authorities. Some programs simply do not allow allocation of funds for monitoring. Furthermore, the perception that monitoring is always complicated and expensive may hinder managers within some programs from pushing for monitoring funds. The fact is that there are ways to streamline monitoring efforts, coordinate them, and maximize the learning from them (e.g., Thom and Wellman 1996). The fundamental driver is the reduction of uncertainties in the design and implementation of restoration projects in order to maximize the probability of meeting the projects goals. There are a number of opportunities and methods for doing this, and there are examples in the above sections, of these from ongoing projects within Portland District. The ultimate aim of the AM program is to understand what initial actions efficiently produce optimal and repeatable results.

Recommended Adaptive Management Framework for Portland District Ecosystem Restoration in the CRE

We outline here the major components of the Corps-AM program within the CRE that address the essential elements of adaptive management (Thom 2000). The components involve monitoring and analysis of information, dissemination of information, and feedback to Corps project planning, implementation and operation.

Regional monitoring requires spatially extensive sampling in order to make inferences to broad geographic areas. Consequently, there is usually a trade-off between spatially extensive and locally intensive sampling efforts. Resources that might have been used to intensively characterize specific restoration sites must be reallocated in order to provide greater geographic coverage. Examples of extensive sampling include nested designs where sampling effort varies directly with geographic scale and panel designs where individual sites are rotated in and out of the sampling frame over time. In all cases, effort is redistributed from the site level to more locations across the landscape. The reallocation of effort may also include measuring fewer responses and responses that better summarize or integrate overall effects of habitat restoration. Characterizing the processes of restoration is often sacrificed at these individual restoration sites in lieu of measuring recovery end points at more locations.

Guidance on which recovery end points to measure and when to measure them, nevertheless, must be determined from *intensively studied* reference and treatment areas. Integrated within the fabric of an extensive regional monitoring program must be a few intensively sampled areas where sampling protocols are developed and the trajectories of physical and biological responses to restoration can be mapped. These intensive sites provide a virtual model of the restoration process that can be used to guide the selection of the strategic measurements to be taken at the extensive sites. These intensively monitoring reference sites, in turn, provide the inferential framework to help assess the success of restoration from the cursory observations taken over time at the individual restoration projects. By developing a regional restoration program as a proper

mix of extensive and intensively monitored sites, individual restoration projects may be surveyed with minimal effort while providing maximum opportunities to detect regional benefits.

Intensive Monitoring -- Project Site Scale

With the prime objective of reducing uncertainty in restoration programs, we recommend that intensive monitoring be conducted within "strata" based on a suite of factors that are likely to affect the patterns, rates and trajectories of results. Furthermore, the methods and metrics used for monitoring should provide efficient and effective feedback on these rates and patterns.

A. Gradients in Habitat Types – For example, emergent marsh habitats within the mainstem will have different patterns, rates and trajectories of recovery, as well as actions that initiate recovery, than will tidal forested swamps in the tributaries to the estuary. Further, salt marshes in the very lower reaches of the estuary will differ in recovery as compared with wapato stands in the reaches near Bonneville. The differences are driven by biological factors (e.g., species recruitment patterns), as well as key factors controlling development (e.g., salinity, water level variation, geomorphology, sediment dynamics).

The ecosystem classification scheme under development for the CRE (Leary 2005) is based on these differences, and provides a convenient, science-based, framework for stratifying the CRE ecosystem. At this point in time, the categories within the ecosystem that form the most meaningful strata are **reaches**, **ecosystem complexes**, and **primary cover classe**s. These classes recognize the major gradients in controlling factors, geomorphology and habitat types, and may differ in rates and patterns of recovery. Habitat monitoring and reference site monitoring programs underway within the CRE are focusing effectively on primary cover classes and ecosystem complexes indicating that monitoring and assessment at this level of complexity is feasible and meaningful (Leary 2005; Borde et al. 2007). Furthermore, monitoring of basic and higher order metrics now under investigation through the CE program, indicate that 'signals' of restoration projects are effective in assessing at least near-term restoration action effectiveness. Although the category of **geomorphic catena** has been identified within the CRE classification system as the level of classification that describes connectivity and captures metrics of ecologically important landscapes and their dynamic nature, the full definition of this classification is still in progress for the CRE. Functions and processes associated with these strata may differ such that goals and time frames for restoration projects must be adjusted to be realistic and relevant to each stratum.

B. Differences among Restoration Action Type – The types of restoration actions (e.g., levee breech, tide gate replacement, filling of excavations) vary in focus and degree. For example, levee breeches and tide gate replacements, while focused on restoring natural tidal hydrology, vary in the degree to which hydrology is restored. Filling of an excavated site raises the elevation of the site to former levels, and thereby "restores" the amount of light reaching the site. The rate and pattern of recovery of the sites under these various actions will necessarily be different. Supplementary actions to facilitate recovery such as vegetation plantings will also affect rates and patterns of recovery.

C. Prioritization of Projects for Intensive Monitoring – The factors that should be used to prioritize projects for intensive monitoring include the following with examples:

- *Relevance of a habitat type to the goals of the CRE program.* For example, if the program is focused on restoring salmonid populations to the CRE, then habitats that contribute most effectively to this goal should receive most study. The Corps' restoration program has as its goal net improvement of CRE ecosystem conditions that demonstrably support recovery of salmonid populations;
- *Location of the potential restoration actions.* For example, if emergent tidal marshes in the lower main stem of the River are considered most critical for restoring salmonid populations then these should be a focus. However, because some salmonid species (e.g., Chinook) are believed to utilize the gradient of shallow water habitats throughout the CRE "landscape", all potential salmonid landscape elements can be considered a priority;
- *Degree of loss and existing stress.* Consideration for the amount of loss of the habitats most relevant to the program's goal should be made. For example, levees and development have resulted in overwhelming loss of shallow water habitat in the upper reaches of the CRE near Portland. Because these areas are affected by large losses at the site-scale, general degradation of natural habitat forming processes at the landscape-scale, and continued stress from human use and contamination, these areas have enhanced uncertainties in terms of the effectiveness of restoration actions in the short-term and the sustained effectiveness in the long-term.
- *Degree of uncertainty regarding highest potential restoration actions.* If, for example, breeching levees and enhancing tide gates in levees surrounding lower main stem emergent tidal marshes have the greatest implementation potential, then the uncertainties (e.g., How large should a breech be made? How much water needs to be introduced through a tide gate?) associated with these actions in terms of rates and processes of recovery of structure, processes and functions should be highest priority for resolving. This addresses the issue of understanding the probability of an action working, which is based on the results from similar actions in similar conditions in the estuary, in other ecosystems, and the level of disturbance of the site and the landscape within which the site resides (Johnson et al. 2003).

In the CRE, restoration actions primarily target hydrological reconnection projects. Other project actions, such as adjusting elevation through dredging or filling, represent fewer but potentially viable opportunities. Finally, removal of obstructions to migration (e.g., pile structures), obstructions to light (e.g., docks and piers), enhancement of habitat quality on dredged material islands (e.g., removal of invasive plant species, enhancing channels), and abatement of contaminant input, represent potentially important restoration actions.

In Table __, we provide a breakdown of these prioritization factors by CRE reach. The information in the Table indicates that _____ restoration projects with the highest priority for intensive monitoring for the Corps CE program based on our present understanding, and the need for information. We recommend that three projects be assessed within each reach based on the prioritization for each project type and habitat type within each reach…

Comment [RT1]: We need to make sure this it accurate

Comment [RT2]: MORE when table is done

Comment [RT3]: Fix this after table

D. Metrics and Methods for Intensive Monitoring. The rates and patterns of recovery of restored systems can be measured in terms of habitat structure (e.g., vegetative community composition; species cover), processes (e.g., sediment retention), and function (e.g., juvenile salmonid rearing capacity). How a restoration action, within a certain location and involving certain habitats type, works can be judged by quantifying the effect of the action on controlling factors (e.g., wetted area, period of inundation, correspondence with natural tidal hydrodynamics, water temperatures and salinities).

It is difficult to be highly prescriptive in recommending metrics and protocols for effectiveness monitoring at intensively monitored sites. Each project may require an approach tailored to the specific aspects of the project. For example, if there if development of a tidal marsh is dependent on accretion of sediment, and there is considerable uncertainty on the sediment source, level of connection between the source and sink required to introduce sediment, and the rate at which sediment will build elevation, then accretion and sediment supply may be important factors to measure to understand these relationship to improve plans for future projects.

Removal of piling structures has been proposed as one methods to restore access by fish to feeding and rearing habitat, reduce potential fish predation (by eliminating roosting sites for predatory birds), and reduce contaminants associated with creosote wood. However, for pile structure removal projects, it is presently unclear if and how removal will benefit salmonids. Studies presently underway by the Corps are addressing this key question (=uncertainty) at several project sites by measuring salmonid behavior, changes in physical processes (e.g., circulation), and potential release of contaminants from piling extractions (D. Putman, Portland District COE, personal communication).

That said, there are a suite of monitoring metrics and methods that can address a majority of critical information gaps in the CRE. Through the CE program, Roegner et al. (2006) developed a monitoring protocols manual to allow practitioners and sponsors to quantify, in a standard way, the effectiveness of their restoration projects in the CRE. The intent of the manual is to provide simple, basic yet scientifically valid methods for measuring effectiveness, and reporting the results to others. The results from multiple projects from a variety of practitioners and sponsors can then be combined to improve the overall understanding of the effect of various restoration actions by improving project planning, implementation and maintenance.

The CE program has also been evaluating what are termed “higher order” metrics for their ability to assess restoration effectiveness. Although still in development there is a suite of these metrics that appear to assist in detecting broader ecosystem consequences of restoring individual projects. In Table __ we provide a list of basic and higher order metrics we recommend for intensively monitored restoration projects. The justification and main benefit and use of the information is indicated. We also recommend the duration of time and frequency for monitoring for each metric.

Because restoration success must be judged in context with natural variation in the system, habitat monitoring and reference site as characterization programs now underway by the EP

provide a vital set of information (Leary 2005; Borde et al. 2007). By comparing both the natural variation seen at the habitat monitoring sites as well as the reference site characteristics, restored sites can be effectively judged.

The end product for this effort is a set of case studies with lessons learned. In addition, they will provide key relationships between metrics that can be used to verify and assess performance of restoration projects estuary-wide. Further, the intensely monitored sites provide a wealth of information that can be used in many ways to improve project success and inform sponsors regarding effectiveness of their projects in meeting goals both for the project and broader goals for the estuary.

Extensive Monitoring -- Program and Estuary Scales

The purpose of the extensive sampling is to be able to infer whether the CRE ecosystem is benefiting from habitat restoration projects. In other words, are restoration projects collectively resulting in a net improvement in the ecosystem? Net ecosystem improvement (NEI) is defined as "following development, there is an increase in the size and natural functions of an ecosystem or the natural components of the ecosystem" (Thom et al. 2005). The general equation for NEI is:

$$NEI = \Delta function \times area \times probability.$$

The probability terms refers to the chances that the site will reach its functional goal and that function will be sustained (Thom et al. 2005). The NEI can be calculated for each project site. Thus to calculate cumulative NEI (= CNEI) for an entire ecosystem like the CRE, the NEI from all resorted sites are summed.

Because dealing with a large and complex ecosystem makes broad scale questions such as this difficult if not impossible to resolve, in order to make an inference with confidence the "signal" must be strong. That is, the ecosystem must show clear evidence that it is moving from its existing state to another, improved, state (cf. Johnson et al. 2003). The challenge is to select the sampling design and set of metrics that will most efficiently provide convincing evidence on which to base the inference. Adequate evidence requires widespread objective and comparable data sets, evaluation of data against conditions at natural, minimally disturbed sites, incorporation of scientific understanding of the ecology and dynamics of the system, and collective thinking among knowledgeable people regarding the results and direction for improving progress.

What is the ecosystem state now? Johnson et al. (2003) proposed that the system state can be defined according to level of disturbance of three major controlling factors; bathymetry, tidal exchange, and salinity. Using published data they provided the characterization to broad estuarine subareas, which we have summarized in Table 3.1. These factors 'explain' a large amount of the alteration of the ecosystem state from historical (i.e., pre-dams, tidal wetland diking, navigation channel development) to present conditions. They also can be the focus of restoration efforts estuary wide. For example, tidal exchange broadly refers to the water level and dynamics in the floodplain. Water control structures and levees have significantly altered the

flooding of habitat in the floodplain, access of fish and other aquatic species to rearing and feeding habitat, and the exchange of materials (e.g., sediments, organic matter, salt water) between floodplain habitats and the broader ecosystem. Efforts that move the level of disturbance from a high to a moderate in any of these factors should have ramifications on the ecological conditions within a subarea. Furthermore, improvement in several subareas should have a cumulative effect resulting in NEI of the estuary.

Table 0.1. Table derived from Johnson et al. (2003) of the levels of disturbance of three controlling factors within subareas of the Columbia River estuary. Levels of disturbance: H = high, M = moderate, L = low.

Subarea	Tidal exchange disturbance	Bathymetry disturbance	Salinity disturbance
Entrance	L	H	L
Mixing zone	L	L	M
Youngs Bay	H	M	M
Baker Bay	H	H	M
Grays Bay	H	M	L
Cathlamet Bay	M	M	L
Upper estuary	H	H	L
Tidal freshwater middle reach	H	H	L
Tidal freshwater upper reach	H	H	L

To address the estuary-wide question of NEI, we recommend the following approach that utilizes four basic components:

1) *Assessment of indicator metrics at sites spread estuary-wide.* We recommend that a maximum of three indicator metrics be monitored at restored sites throughout the estuary. The three metrics we recommend are water level, geomorphology and sedimentation rate. Water level coupled with geomorphology addresses the tidal exchange disturbance factor because once water level and geomorphology are known, the area that receives water at a site can be calculated. Further, coupled with the information now being collected on elevation distribution of tidal wetland plant species, vegetation composition can be predicted based on wetted area and geomorphology. Wetted area is also measure of size, which is a component of the NEI definition. Water level is collected by automated sampler, which also contains a water temperature sensor. Water temperature is important in that juvenile salmon in particular may be sensitive to temperature above about 19oC or some revised threshold.

Comment [RT4]: Subgroup: how to address monitoring this for determining wetted area..or do we do something else?

Understanding whether restored sites with potential fish access are too warm to support fish, is an important input to evaluating NEI. Sedimentation rate measures a process that appears to be generally important in tidal systems that have subsided because of lack of sediment input and farming practices. The rate of development of vegetation appears to be directly dependent on the rate of sedimentation and trapping and processing of organic matter. Further data on sedimentation rate and vegetation development is being developed at sites monitored within the CE program. Finally, the CE research is clearly showing that tidal wetland communities at restored sites process nutrients, export marsh macrodetritus, and likely carry out other important natural processes that are important to the broader ecosystem.

Sampling design for the extensive aspect of the AM program is under development. However, we feel that a panel-type design where a selected few sites are monitored every year, and others are sampled on a rotational basis based on a randomization process. At present we are unsure about the total number, location and availability of sites for monitoring. Further, we understand that not all types of tidal reconnection projects would be available throughout the estuary to carry out a complete random rotational panel design. Thus the sampling design will require refinement to take into consideration the practicalities of selecting restoration projects for the extensive assessment portion of this plan.

2) *Meta-analysis of site evaluation cards (SEC) developed for individual project monitoring of basic metrics.* The purpose of the SEC is to succinctly summarize the performance of restored sites relative to key metrics. An example of an SEC is provided in Figure 3.1. The SEC reports short-term performance of restored sites, from which data can be easily summarized and extracted, and is often the basic set of information needed to report back to project sponsors and supporting programs. The concept is to use the SEC to report information in support of the cumulative effects analysis, including direct input into the calculation of the NEI and CNEI.

The SEC is an important aspect of adaptive management, which, in turn, has implications to management of restoration programs. Monitoring is limited to one percent of the operation and maintenance costs of COE projects at present, so reporting has to be efficient and provide maximum information about the performance of the project. The SEC forces planners and practitioners to utilize metrics that provide the most effective and efficient measure of project performance. There are numerous national (e.g., NOAA, EPA, COE) and regional guidance documents on what metrics are most relevant and useful. The protocols manual for the CRE has taken these guidance documents into consideration in development of the recommended list of basic metrics (Roegner et al. 2008). We recommend that the CRE protocol manual be consulted first when selecting metrics and methods for monitoring restored sites.

In order to derive broader conclusions regarding adaptive restoration, the project information can be grouped into relevant strata (see above) such as project type and location in the system. By doing this, replication is built over time within the various strata, which facilitates development of a base from which inferences can be made.

Restoration Site Evaluation Card

Site Name:_____

Location:_____

Vision:_____

Goal:_____

Objectives:

Physical change predicted - _____

Physical change realized - _____

Habitat change predicted - _____

Habitat change realized - _____

Function change predicted - _____

Function change realized - _____

Pre-Survey:

Condition of physical metrics -

Condition of habitat metrics -

Condition of functional metrics -

Post-survey and assessment (1-year):

Condition of physical metrics -

Condition of habitat metrics -

Condition of functional metrics -

Actions -

Post-survey and assessment (5-year):

Condition of physical metrics -

Condition of habitat metrics -

Condition of functional metrics -

Actions -

Final assessment:

Was the project successful in meeting its goals

If not, what should be done to fix the project?

Figure 0.1. Example Site Evaluation Card.

Critical to the meta-analysis is clearly identifying the linkage between the metrics used to assess performance at individual sites to the metrics used for extensive sampling and the higher order metrics (Table 3.2). Because of the connections articulated earlier in versions of

conceptual models for the CRE (e.g., Thom et al. 2004) between controlling factors, structure, process and function, we believe that this is possible and are pursuing this linkage under the CE program.

Table 0.2. Core and higher order restoration site monitoring metrics, with recommendations for frequency and duration. Basic metrics are from Roegner et al. (2008). Higher order metrics are from Johnson et al. (2007).

Metric	Level	Justification	Duration	Frequency

3) *Incorporation of science base, habitat monitoring and reference site data bases.* The scope and implications of the results of the meta-analysis, intensive and extensive monitoring will be evaluated against the most up to date scientific findings from the CRE and from other relevant ecosystems, information from highly relevant programs within the CRE, and input from regional program managers, planners, practitioners and scientists. We recommend that this evaluation be conducted annually at a meeting specifically designed to a) infer the ecosystem effects of multiple restoration projects, b) develop a set of recommendations on how to improve individual project performance, and c) enhance the rate of restoration of the broader CRE ecosystem.

In preparation for the meeting, an AM core team will develop a draft analysis of results from of the meta-analysis, intensive and extensive monitoring, as well as advancements in science of restoration from other systems, and the cumulative effects of restoration projects on ecosystems. They will calculate the NEI's for each project and the CNEI for the

ecosystem. They will organize the data into strata as outlines above and provide a summary of differences in results that may be affected by differences among the strata. The team will provide a draft set of findings and recommendations for review and discussion at the annual meeting. The major questions addressed by the core team would be: Are projects meeting performance expectations? If not, what needs to be changed? What are key lessons learned that can be implemented in existing and future projects? Are there any critical needs (e.g., planning, research, experiments, implementation, monitoring) to improve performance? How does the new information affect prioritization of restoration projects? What if any changes are needed in the AM framework?

Following discussions and input at the annual meeting, the AM team will finalize the analysis and recommendations into a report. We envision this report to be succinct and easily interpretable and implementable by a broad range of interested parties including regional program managers, planners, practitioners and scientists. Because this is a Corps-based program, results will necessarily be oriented toward addressing Corps needs (see below).

4) *Analysis of cumulative effects.* Broader ecosystem and cumulative effects questions to be answered are: Are projects resulting in NEI? If not, what needs to be changed? Are collective projects resulting in CNEI? If not, what needs to be changed? Does the analysis of NEI and CNEI need to be changed?

Answers to these questions also derive from the meta-analysis but also other information from GIS-based modeling, hydrodynamic modeling, time-series trajectories in restored sites, and new scientific information. Under the CE program we continue to explore and test how to best utilize and incorporate this information. The NEI and CNEI equations provide the fundamental organizing relationships, and are used to synthesize the information from multiple lines of evidence.

Dissemination of Information

Information developed under the AM program must be effectively disseminated to be useful to the widest and most relevant audience. How best to disseminate the work, however, should be determined by managers, regulators, planners, scientists and practitioners, and well as representatives of the interested public. Some of the following represent potential avenues for dissemination that have been effective both in the CRE and in other regions:

- Regular CRE research and restoration conferences (CERRC) to facilitate inter-agency sharing.
- Committee on estuary RME (cf. RME Plan) to facilitate inter-agency partnerships, commitments, co-decision-making, prioritization systems, etc.
- Web site devoted to the cumulative of all restoration programs in the system with links to other programs.
- An annual report summarizing the work of the AM program.

Integration of Information in Corps Portland District Planning Processes.

Because this AM framework is begin developed for the Corps, one of the principles of the framework is that it be "Corps-centric in scope – The program will adhere to the Corps planning process and to the operation and maintenance process as much as possible, and other procedures promulgated as part of the authorities under which the Corps conducts restoration programs." That said, the recent guidance emanating from Corps HQ and their Environmental Advisory Board summarized above appears to go well beyond existing Corps procedures. This guidance provides high level thinking relevant to a rapidly emerging major mission of the Corps nationally.

Within the Corps present project planning process, the Corps should continue to conduct studies with the appropriate phases that reduce uncertainties in potential restoration projects. As opposed to other project phases, planning and construction phases generally offer more opportunity for studies to improve project plans and to evaluate construction progress. For example, studies initiated in FY07 to investigate the potential benefits and effects of removal of piling structures are essentially investigating key uncertainties. Presently, it is not known what if any the benefits will be to salmon, and what issues in terms of contaminant release may be encountered. By evaluating existing structures and, in collaboration with the EP, the results of a piling removal project, a set of information will be established that forms the basis of planning and implementing an expanded program of piling stricture removal as a benefit to the ecosystem and salmon.

In this way, the Corps is following the directives from the Environmental Advisory Board and Chief of Engineers to incorporate restoration monitoring elements of adaptive management, by using other authorities such as monitoring associated with project construction phases and a general investigation study. Opportunities to conduct construction projects in a phased manner should be explored to reduce uncertainties. Uncertainties can be evaluated in early construction phases and adjustments can be made in later phases to improve performance. For example, the Julia Butler Hansen tide gate replacement project is being carried out in phases where a few tide gates are replaced and the results monitored to evaluate performance. The lesson learned then can be applied to future tide gate replacements.

Collecting and disseminating the lessons learned should involve a more systematic process. Although the team approach now used by Portland District is an effective method for brining together the collective expertise on a project, this expertise is lost when an individual retires or leaves the District. Mentoring by senior staff of junior staff, and direct involvement of junior staff on project teams would help alleviate some this loss. Effective documentation of lessons learned in a present computer based system or a modification of a system would be another way to capture learning.

At present, learning about restoration takes place by hands on experience, talking with others, reading published material, and attending workshops and conferences. The Corps has taken leadership of the National Conference on Ecosystem Restoration, which has focused much of their meetings on Corps-related issues. Attendance by senior and junior staff at these types of conferences would improve learning opportunities outside the auspices of the District. Further, making presentations about projects that are conducted within the District would help both

District staff formalize their approach and learning s because they would have to effectively and efficiently convey their experience. Making presentations often results in making connections with others who have similar problems, ideas, and solutions. Sharing information should be a principle and high priority responsibility.

Finally, collaboratively working with other agencies within the District, and expanding collaborations with other districts and agencies, will improve information flow. Where it makes sense, the District should strive to interact with entities like the EP, The Nature Conservancy, Columbia Land Trust, etc., is collaboratively exchanging information and working on problems. Where systems, such as restoration prioritization frameworks, exist, develop collaborations so that the Corps and others can use one system for the same purpose. These regional collaborations go a long way toward another principle of this AM program, to minimize redundancy.

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