Part 2. Channel Improvement AEM Plan

2-1 Introduction

The preceding discussion addressed the development and composition of a strategic AEM Plan and the process for managing complex ecosystems. The remainder of the report addresses the specific design and implementation of an AEM Plan and Process in support of the CRCIP. Provisions for implementation are primarily based on information contained in the CRCIP, Final Supplemental Integrated Feasibility Report (FSIFR) and Environmental Impact Statement (EIS) (January 2003), and the NMFS BO (May 2002, February 2005). These primary sources were augmented by additional data and information obtained through electronic searches concerning the LCR ecosystem.

History of AEM in the Lower Columbia River

In August 2000, the NMFS withdrew their 1999 BO of "No Jeopardy" concerning the expected impacts of the Channel Improvement Project on listed salmonids. This withdrawal resulted in part from the availability of new information regarding the anticipated effects of the Project on bathymetry, flows, estuarine habitat, and suspension of chemical contaminants. The USACOE and NMFS consulted to resolve the issues of concern. A new BA was prepared by the USACOE following a series of technical reviews, expert panel workshops, ad hoc meetings, and a survey - activities facilitated by the Sustainable Ecosystems Institute during 2001. The new BA (USACOE 2001), submitted in January 2002, specified compliance measures to minimize the incidental take of listed species, monitoring to ensure minimal impacts of dredging and deepening on listed fish and their habitats, and adaptive management to respond to impacts observed during monitoring.

In May 2002, NMFS and the United States Fish and Wildlife Service (USFWS) concluded "no jeopardy" as the result of the Federal Endangered Species Act (ESA) consultations in relation to the recommended plan. The NMFS reiterated their conclusion of no jeopardy in a more recent BO (February 2005). The USEPA, as a cooperating agency, also supported the recommended Plan developed by the USACOE.

On June 23, 2003, the Oregon Department of Environmental Quality (ODEQ) and the Washington Department of Ecology (WDOE) issued Section 401 Water Quality Certification that outlined conditions (findings) associated with permitting the proposed channel modifications. Amendments to both certifications were issued on June 23, 2005. The certifications expire in June of 2008 and the Corps will have to re-apply for certification.

On January 9, 2004, a record of decision (ROD) was released that approved the Columbia River Navigation Improvement Project. Importantly, the ROD included provisions for MA, EEA, and adaptive management.

Study Area

The recommended Plan described in the 1999 FSIFR and EIS indicated that dredging would be limited to selected areas from Columbia River mile (CRM) 3, near the mouth of the river, to CRM 106.5, near the I-5 Bridge in Portland. The revised study area includes the bank-to-bank run of the Columbia River from Bonneville Dam to the river mouth and extending in a fan shape 12 miles into the Pacific Ocean. The study area divides the run of the river into three reach types: riverine (Bonneville Dam to CRM 40), estuarine (~CRM 40 to CRM 3), and river mouth (CRM 3 to outer boundary of the Deep Water Site). The study area also includes sites for upland disposal or dredged materials, ecosystem restoration, and wildlife mitigation.

Time Scales

The proposed Channel Improvement AEM Process will focus on short- and mid-term management actions and system responses. As indicated in the ROD, the MA will include two years of measurements prior to construction, two years during construction, and a third year following the end of construction. The periods of pre-construction and construction correspond to the near- (0–5 years) and mid-term (5–10 years) timeframes identified in the BO (NMFS 2005, 2002). Emphasis will be on near-term physical impacts of channel improvement.

Mid-term management actions may include the use of monitoring and research results to establish mid-term trends in the physical aspects of the systems and potentially other resources of concern, depending on the results of the near-term system responses to channel improvements.

The long-term actions include years 10 and beyond. At this scale, trend analysis could be used to assess ecosystem impacts of channel improvement. However, longer-term time scales appear more relevant to other AEM Processes being developed in the Columbia River Basin. The Channel Improvement AEM may contribute to some aspects of longer-term AEM planning, but the focus emphasizes the detection and characterization of potential impacts of channel improvement on depth, temperature, and salinity in the near-term.

Time scales also refer to the frequency of sample collection or obtaining measurements in the monitoring program that supports the AEM Process. Time scales for measurement should be determined by considering: (1) the scales of natural variability inherent to the measurement, (2) the scales that characterize the management actions, and (3) the frequency of measurement permitted by available resources. Similarly, the number and location of measurements is influenced by the same three scale considerations in the spatial domain (Gardner et al. 2001). The success of the monitoring program in usefully informing the decision-making process will be proportional to the congruency among these three scales in time (and space).

Scope

The primary purpose or scope of the proposed AEM Plan and implementation process are to manage the Channel Improvement Project in an adaptive manner to avoid or minimize physical-chemical impacts in relation to channel deepening in the LCR and estuary. Although the Channel Improvement AEM Plan is purposefully limited in scope to managing the selected physical-chemical performance measures, one underlying reason for this proposed AEM Process is to ensure compliance with the BO in relation to recovery and sustainability of valued salmonids that utilize the estuary. Table 2.1 lists the salmonid evolutionary significant units (ESU) that are important subjects of more comprehensive management and assessment. Achieving these management goals will realistically require the participation of additional stakeholders and the integration of the Channel Improvement AEM Process with other adaptive management programs underway or planned for the LCR and estuary.

Table 2.1 Federal Register notices for final rules that list species, designate critical habitat, or apply protective regulations to ESU considered in this consultation.

Species ESU	Listing Status	Critical Habitat	Protective Regulations
Chinook salmon (Oncorhynchus tshawytscha)			
LCR	T 3/24/99, 64 FR 14308; P 6/28/05, 70 FR 37160	9/2/05, 70 FR 52630	6/28/05, 70 FR 37160
Upper Columbia River spring-run	E 3/27/99, 64 FR 14308; P 6/28/05, 70 FR 37160	9/2/05, 70 FR 52630	ESA Section 9 applies
Snake River spring/summer-run	T 4/22/92, 57 FR 14653; P 6/28/05, 70 FR 37160	10/25/99, 64 FR 57399	6/28/05, 70 FR 37160
Snake River fall-run	T 6/3/92, 57 FR 23458; P 6/28/05, 70 FR 37160	12/28/93, 58 FR 68543	6/28/05, 70 FR 37160
Chum salmon (O. keta)			
Columbia River	T 3/25/99, 64 FR 14508; P 6/28/05, 70 FR 37160	9/2/05, 70 FR 52630	6/28/05, 70 FR 37160
Coho salmon (O. kisutch)			
LCR	P 6/28/05, 70 FR 37160	Not applicable	6/28/05, 70 FR 37160
Sockeye salmon (O. nerka)			
Snake River	E 11/20/91, 56 FR 58619; P 6/28/05, 70 FR 37160	12/28/93, 58 FR 68543	ESA Section 9 applies
Steelhead (O. mykiss)			
LCR	T 3/19/98, 63 FR 13347; D 6/28/05, 70 FR 37160	9/2/05, 70 FR 52630	7/10/00, 65 FR 42422
Middle Columbia River	T 3/25/99, 64 FR 14517; D 6/28/05, 70 FR 37160	9/2/05, 70 FR 52630	7/10/00, 65 FR 42422
Upper Columbia River	E 8/18/97, 62 FR 43937; D 6/28/05, 70 FR 37160	9/2/05, 70 FR 52630	ESA Section 9 applies
Snake River Basin	T 8/18/97, 62 FR 43937; D 6/28/05, 70 FR 37160	9/2/05, 70 FR 52630	7/10/00, 65 FR 42422

Listing status: "T" means listed as threatened under the ESA, "E" means listed as endangered, "P" means proposed for listing, proposed for designation as critical habitat, or proposed as protective regulations, and "D" means that the final listing determination is deferred until December 28, 2005. The designation of critical habitat for LCR Chinook salmon, UWR spring-run Chinook salmon, UCR spring-run Chinook salmon, LCR steelhead, UWR steelhead, MCR steelhead, UCR steelhead and SRB steelhead is not effective until January 2, 2006.

2-2 Control Theory Model

AEM parallels earlier applications of engineering control theory to the management of ecological systems. Figure 2.1 illustrates an AEM model for the Channel Improvement Project as a problem in control theory. Key components of the control theoretic model include the controller, the controlled system, and a desired system configuration. These components correspond to the manager(s), the managed ecosystem, and the management goals, respectively. Importantly, the control theory model can serve as a template for designing a corresponding AEM Process for the Channel Improvement Project.

In its basic form, the control model includes relevant input information important in determining the state (or condition) of the managed system. The decision-makers implement selected management actions with the objective of changing the current state of the managed system to match the desired conditions. In the Channel Improvement AEM model, the decision-makers are the members and consultants of the AMT. The specification of desired conditions might focus on ensuring that impacts do not exceed those projected for the Project. Specification of desired conditions might: (1) derive from consideration of historical accounts of the lower river and estuary; (2) reflect current conditions consistent with management objectives; or (3) be based on diverse management objectives, such as sustaining salmonid ESU, minimizing risks posed by dredging, or restoring critical habitats and ecosystems

In the control model, the decision-makers have information that describes selected aspects of system structure and function. These inputs can be used to characterize the current condition of the managed system. The inputs of initial primary concern include bathymetry, salinity, temperature, turbidity, and contaminants.

Outputs (or outcomes) that describe system response to management actions are used to compare the effects of management actions in relation to management goals and objectives (i.e., desired conditions). Outputs can include selected performance indicators (i.e., measures to be achieved) or risk endpoints (i.e., impacts to be avoided or minimized). The proposed Channel Improvement AEM focuses initially on possible Project effects on channel bathymetry (accretion/erosion), salinity, temperature, and turbidity as system outputs of interest. Note that in this case the set of primary system outputs is identical to the set of inputs. In a real sense, the control model uses management actions to translate values of inputs to resulting values of outputs, which are then compared to the desired values or decision criteria.

Consistent with the conceptual model (Appendix A), future additional outputs of interest might also include the growth, survival, and ocean entry of juvenile salmonids. Measures of habitat, productivity, and food web dynamics are also of eventual concern, as are possible Project impacts on crab, sturgeon, and smelt. Clearly, the outputs should be selected to provide comprehensive, quantitative measures of system state, including both the current state and desired conditions.

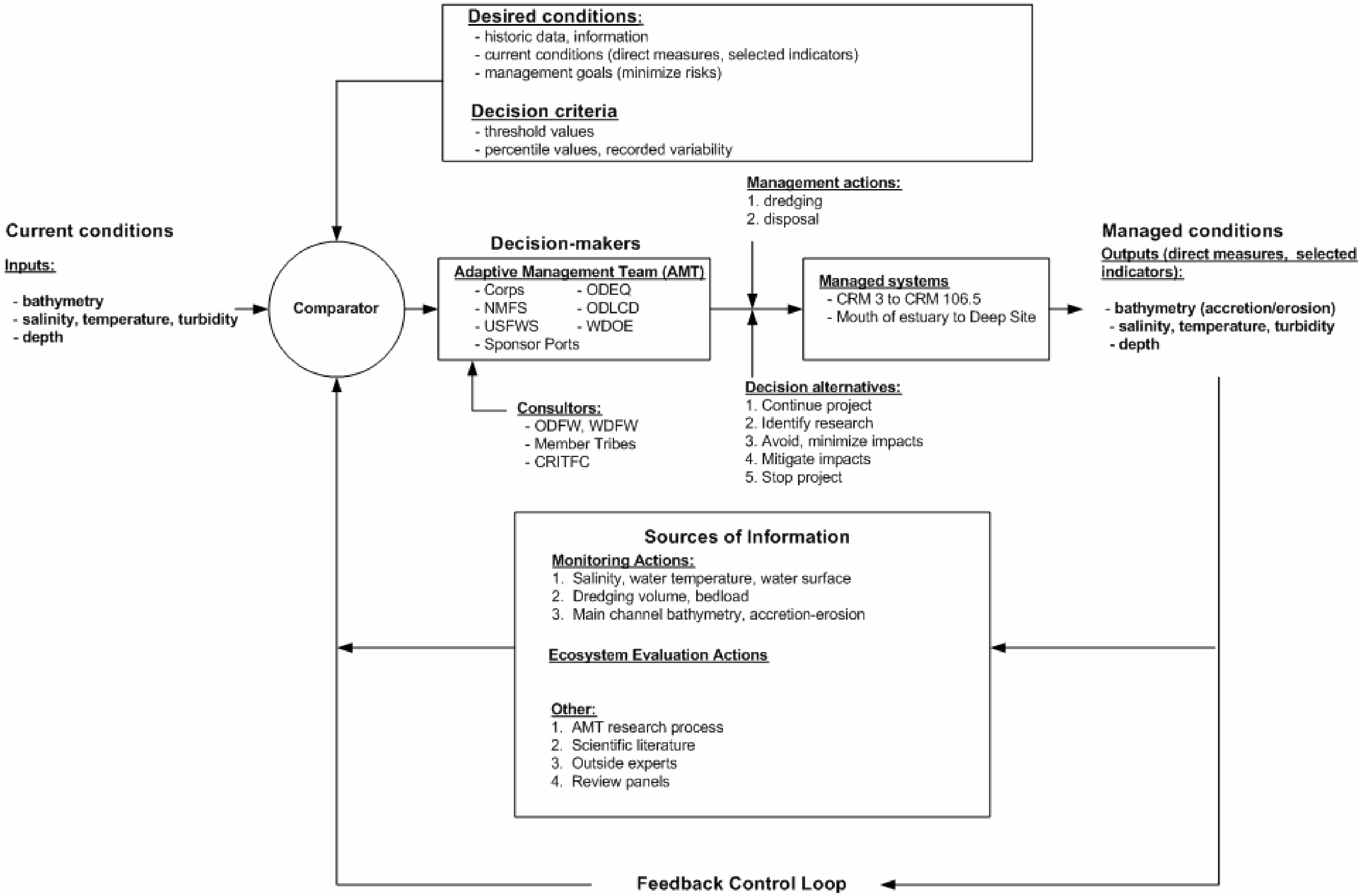

Figure 2.1. AEM model formulated in terms of control theory.

The comparison (comparator) between current and desired system conditions sets up a critical feedback mechanism between management actions and subsequent system response. Each output defines a dimension in a multi-dimensional space. The current conditions define a point in this decision space, inclusion of uncertainties redefines this point as a bounded region in this space. The desired conditions also define a point or region in this space. At any moment, the "distance" between the current and desired states provides a measure of the effectiveness of current management actions. The objective is to manage the system to achieve and maintain desired conditions (i.e., minimize distance between desired and measured system state) or be compatible within specified decision criteria (i.e., acceptable overlap of desired and measured regions) developed in relation to the desired conditions.

Dictated by the selected scale of decision making (e.g., monthly, annually), the decision makers, in this case the AMT, compare the current conditions to the desired conditions. If the current conditions are acceptably similar to the desired conditions, the decision makers may elect to continue the current management actions and wait until the next management opportunity. Alternatively, if the current conditions and trends in performance measures or risk endpoints are sufficiently dissimilar to the desired conditions, the decision makers can select from available management actions and implement changes in an attempt to improve the comparison between existing and desired conditions.

Critical to successful management in the control theory model is a quantitative understanding of the system response to different management actions. As indicated in Figure 2.1, various sources of information, including monitoring, EEA, and other scientific studies may provide or improve the necessary understanding that underpins the adaptive management effort. Empirical and process-level models might also be developed and used to project the results (outputs, outcomes) of management and decision alternatives. Models are particularly useful in estimating the expected response of system outputs to different management actions.

Clearly, future increases in understanding to improve management capabilities and decision-making skills require an investment in the various sources of information indicated in Figure 2.1. Thus, concepts and measures of sensitivity and uncertainty, as well as the value of added information become relevant to the adaptive management process. Investments should be made in data and information that provide the greatest improvement in management and decision-making.

To summarize, in the context of the control theory model, AEM is the continued process of comparing system state (management outcomes) to desired conditions using a feedback mechanism established between management actions and observed system response. New information (i.e., monitoring data, research results, and model calculations) can further develop a mechanistic understanding of the relationship between management actions (inputs) and system responses to management (outputs). Management can become more effective as a result of improvements in understanding the feedback mechanism.

The manager collects information about the desired state of the ecosystem, external processes that drive the ecosystem, and the state of the controlled ecosystem itself. These correspond to the management objectives, factors that make up "states of nature" in decision analysis terms, such as the drivers of climate and sea level for estuarine ecosystems, and monitoring data that measure the current and past condition of the ecosystem.

Based on information received, the manager takes actions to direct the conditions in the ecosystem toward the desired state. The management actions act in combination with the factors outside of the manager's control, i.e., the "states of nature." In addition, the resulting changes in the performance measures, outputs from the controlled system feed back information into the next decision-making cycle. These outputs are compared with the desired system configuration to determine future management actions or decisions as necessary. This process continues until the configuration of the managed system is sufficiently (acceptably) similar to the desired conditions. Management actions (inputs) continue indefinitely to maintain the desired configuration.

In each iteration, the manager (controller) chooses from a set of alternative actions. The information inputs defined in Figure 2.1, i.e., data on past and present conditions in the ecosystem and states of nature and the desired condition for the ecosystem, provide only part of the information that is needed. The utility assigned to each alternative depends on the manager's evaluation of how closely the estimated outcome corresponds to the desired condition for the ecosystem. To make this evaluation, the manager must be able to forecast the condition of the ecosystem that will occur if any alternative is chosen. The ability to forecast conditions in the ecosystem represents another source of information to the decision-making process, i.e., the information contained in a predictive model. As part of each iteration of the process, resources can be expended to obtain more information, perform research (i.e., increase utility), monitor, and improve the models.

2-3 Organizational Structure and Management Interactions

The proposed organizational structure for AEM in relation to the Channel Improvement Project consists of the following: (1) the formal AMT, and (2) a less formal technical support group. The organizational structure would also identify and encourage interactions with the scientific and technical community, as well as concerned stakeholders.

Adaptive Management Team

The proposed AEM Plan will be administered mainly through the actions of an AMT. Appendix B describes the composition, organization, and the operations Plan for the AMT. The AMT comprises the managers, decision makers, and technical staff ultimately responsible for initiating, implementing, and sustaining the AEM Process.

It is envisioned that the exact composition and participation of these AMT constituents will vary in relation to issues raised by the technical support group. This comprehensive organizational approach ensures the appropriate entities are informed of potential variances with the decision criteria. At the same time, depending on the specific nature of any variances (i.e., ESA concerns, state water quality mandates), the AMT provides for flexibility in organizational participation to effectively address such variances. This organizational flexibility within the operation of the AMT will undoubtedly include some overlap in participation, again depending on the nature of any variances with the decision criteria (i.e., "trigger values").

Regardless of the specific composition, the role of the various participating organizations is to identify the appropriate and effective course of actions to be undertaken by the USACOE in responding to any variances with the decision criteria. In the absence of variances with the AEM decision criteria, the technical support group would ensure that current conditions and trends were summarized and reported to all constituents of the AMT.

Importantly, the AMT receives information from the technical support group that describes current conditions and trends for selected performance measures or risk endpoints. Based on deliberations that may draw upon technical inputs of the support group, as well as advice solicited from the general scientific community and other sources deemed appropriate by the AMT, the AMT would recommend any necessary changes in the conduct of the Channel Improvement Project in order to achieve and maintain the AEM goals and objectives developed for the LCR. In this context, the AMT would evaluate the effectiveness of compliance measures, monitoring program, and research to ensure that Project construction and operation have impacts no greater than those predicted in the BA (USACOE 2001) or the BO (NMFS 2005, 2002).

Adaptive Management Technical Support

A proposed Adaptive Management technical support group can serve as a primary source of technical support for the AEM Process and the AMT. The group is envisioned as a less formal organization constituted by professionals that primarily have other duties and responsibilities, but would be available as necessary to assist the AMT. As explained in Appendix B, the AMT would establish subgroups or subcommittees as deemed necessary for the purposes of compiling information, performing analysis, discussing issues, and reporting back to the AMT. Such a group would reasonably consist of professional physical and chemical oceanographers. Fisheries biologists, ecosystem scientists, environmental toxicologists, risk analysts, and hydrologic engineers could be consulted as needed if unacceptable physical-chemical impacts are observed in relation to channel improvement. The principle functions of the technical group might include:

- assisting the AMT in review and evaluation of the monitoring results in relation to specification and modification of the AEM decision criteria;

- advising the AMT in the derivation of alternative management actions;

- interfacing with the USACOE' monitoring activities (MA-1 through MA-6) to facilitate the timely compilation, analysis, and communication of the monitoring results to the AMT;

- coordinating with other monitoring programs ongoing in the LCR [e.g., CORIE, Lower Columbia River Estuary Partnership (LCREP)] and estuary to introduce additional relevant information to the AMT;

- estimating the likely outcomes of modifications to management actions in the context of the performance measures and risk endpoints;

- overseeing the use of operational models used to forecast expected results of management actions;

- consulting with the AMT to identify critical research needs or coordinate peer review of proposals; and

- other duties as designated by the AMT.

2-4 Performance Measures and Risk Endpoints

Performance measures define those attributes of the ecosystem that provide the manager with information on the response of the ecosystem in relation to the desired conditions (i.e., goals, objectives). Risk assessment endpoints define complementary ecosystem attributes that indicate the likely occurrence of undesired, adverse impacts associated with the Project or produced by management actions.

To be useful as a performance measure or an assessment endpoint, an ecosystem attribute exhibits several specific requirements. First, the attribute should be an integrative indicator of overall ecosystem structure or function, and not one that narrowly measures a peripheral component or secondary process. Second, the measure must be responsive, that is it should be possible to measure quantifiable changes over time periods relevant to management. Third, the patterns of spatial-temporal response of the attribute should be consistent with current quantitative ecosystem understanding. Finally, it should be possible to predict quantitatively how the attribute will respond to management action as distinct from other sources of variation. AEM can be succinctly described as the continued process of tracking performance measures and risk endpoints in response to management actions over the course of the Project.

The underlying hypothesis is that the channel deepening will not significantly alter the fundamental physical or chemical conditions of the LCR and estuary. If these conditions are not substantially altered as the result of additional dredging, it is further postulated that the habitat conditions that influence the growth, survival, and ocean entry of the listed ESU will not be significantly altered. These hypotheses can be used to identify performance measures and risk endpoints and to establish priorities among these measures in the design and implementation of MA central to AEM.

Initially, the performance measures or risk endpoints include changes to depth, temperature, and salinity in the LCR and estuary in relation to channel deepening.

2-5 Decision Criteria

Selected values or conditions of the performance measures or risk endpoints will be used as criteria for implementing the adaptive management process. The criteria enter into the AEM process in several ways. Comparisons of pre- and post-construction data with the decision criteria can be used to evaluate Project impacts for some performance measures (e.g., habitat alterations). Comparisons of pre-construction data with observations made during construction can be used for physical-chemical parameters, including water temperature, salinity, depth, and fish stranding. The results of such comparisons can "trigger" adaptive management actions. Decision criteria for valued resources may derive from studies performed in association with the Project (e.g., Dungeness crab, sturgeon) or from legislative mandates (e.g., smelt).

Several alternative approaches were used to derive decision criteria (Appendix D). For example, statistical analyses of existing data, which define historical patterns of spatial and/or temporal variability were used for depth, temperature, and salinity endpoints. These historical variance structures were used to define decision criteria ("trigger values") as selected percentile values based on the historical record. Evaluations of previously conducted studies were discussed within a consensus-building process, as another approach, to define criteria for crab entrainment, crab burial and dredging-related impacts on sturgeon. In some cases, compliance measures provided by NMFS, Washington, and Oregon (Appendix E) defined decision criteria.

The CRCIP decision criteria are described briefly in this section. Appendix D provides a detailed discussion of the development of initial decision criteria for the AEM Plan. Much of the data used to develop criteria are provided by Project monitoring actions (e.g., MA-1 through MA-6). The decision criteria for water elevation, salinity, and temperature were empirically derived as selected percentiles from the analysis of CORIE monitoring data and MA-1 results obtained for three CORIE locations. MA-2 provides the annual dredging volumes associated with construction and operation of the 43-foot channel. AEM actions can be triggered if the actual volumes of dredged materials exceed the projected values by a specified amount. MA-3 will address decision criteria for side-slope changes caused by channel modifications. The criteria are defined statistically as ranges of historical depths associated with selected cross-line surveys between CRM 3 and CRM 106. Threshold values of habitat change (yet to be developed) will serve as the decision criteria for the evaluation of habitat change as a result of channel deepening. These criteria will be determined from estuary habitat surveys conducted by MA-4. Habitat complexity, connectivity, and conveyance, as well as food availability, are also addressed by MA-4. MA-5 will update and maintain a sediment contaminant data base (SEDQUAL). Toxicity benchmark data will be used as decision criteria to evaluate new data that describe potential exposure of salmonids and their prey to contaminants remobilized as the result of channel deepening. Pre- and post-Project comparisons of fish stranding at selected locations will result from studies that constitute MA-6. An increase in the number of stranded fish following channel deepening could trigger the adaptive components of the AEM Plan. Changes in susceptibility of different species to stranding can also initiate adaptive management.

Appendix E presents information used by Washington and Oregon to evaluate potential Project impacts on crab, sturgeon, and smelt. This information has been discussed by the AMT within a consensus framework to determine how to best incorporate states' concerns into the development of decision criteria. Decision criteria for these resources largely take the form of continued studies (e.g., crab entrainment, impacts on sturgeon, fish stranding) and compliance monitoring (e.g., turbidity).

Regardless of the approach used in their derivation, it is important to recognize that the initial decision criteria are subject to review, evaluation, and modification throughout the AEM process.

2-6 Proposed AEM Process

The following steps outline a process for adaptively managing the environmental resources of concern in relation to the Channel Improvement Project:

1. Results of the ongoing monitoring programs, EEA, and research are periodically (i.e., quarterly) summarized and reported.[1] This reporting might be primarily event-driven, where new observations or data suggest possible violations of existing decision criteria for one or more of the performance measures or risk endpoints. Annual (January) reporting of research results might also occasion the review of the data and information generated by the monitoring and evaluation actions and initiate the AEM Process.

2. The results of monitoring programs (MA-1 through MA-6), the EEA (EEA-1 through EEA-6), and relevant research are collated and analyzed by an informal technical support group. The technical support group would summarize current conditions and examine short-term trends.

3. The Technical Support Group would review the summaries and analyses, monitoring results and advise the AMT concerning any performance measures or risk endpoints that exceed the decision criteria. The technical group would also advise the AMT if none of the measures or endpoint criteria have been exceeded.

4. If none of the decision criteria are exceeded, the AEM Process can simply continue with the current monitoring programs until the next evaluation is performed (i.e., Step 1). Under these circumstances, the AMT might consider research needed to address key gaps in existing data, especially in relation to the AEM control model (i.e., Figure 2.1).

[1] It is recognized that some performance measures or risk endpoints are monitored almost continuously (e.g., temperature, salinity). Provisions might reasonably be made for data analysis, summarization, and reporting on time scales more commensurate with continuous monitoring. In particular, if significant fluctuations or a trend in deviations from historical values are measured, such anomalous conditions should be readily detectable by the monitoring procedures and deviations of this kind should enter on a timely basis into the AEM process. Real time data analysis and decision models, perhaps involving methods of artificial intelligence, may prove useful for performance measures or risk endpoints that are continuously monitored.

5. If any decision criteria are exceeded, the AMT requests the USACOE to develop a mitigation or management plan intended to redress the Project impacts indicated by the monitoring results. If requested by the AMT, the USACOE will provide alternative management actions to address the impacts of the Project on the performance measures or risk endpoints that exceed the decision criteria. The USACOE will provide the alternative management plan within 30 days of the request by the AMT.

6. Based on an evaluation of the USACOE' Plan, the AMT can determine that there is no justification for adapting the current management practices, or recommend adaptations to current management practices. If the AMT concludes that there is no need for adapting the current management actions given the USACOE' plan, the current management actions and supporting monitoring and evaluation actions continue until the next technical group summary and analysis. Alternatively, if the AMT decides that adaptations to the current management actions are warranted, further deliberations would initiate concerning the management changes, revisions to monitoring/ecosystem evaluation, and review of the decision criteria.

7. Following resolution of the proposed adaptive management actions and possible revisions to monitoring and research recommended by the AMT, the AEM Process continues by cycling back to review and analysis of new data and information by the technical support group (Step 1).

The steps in the above-described AEM Process are schematically illustrated in the following AEM Plan flowchart (Figure 2.2). As listed or implied by the AEM control model Figure 2.1), the AEM Process will focus initially on specific physical and chemical effects potentially impacted by the Channel Improvement Project.

2-7 Stakeholder Involvement, Documentation, and Transparency

The AEM process can benefit from the active participation of invested stakeholders (Walker et al. 2002). The AEM Plan identifies the key role played by the USACOE and underscores the initial focus on managing channel improvements to minimize potential impacts on the basic physical-chemical attributes of the LCR and estuary. Concurrently, the Plan identifies important federal and state agencies, Tribes, and the Sponsor Ports as active participants in the AEM process (see Appendix B). The roles and responsibilities of the federal and state agencies may be determined in part by their respective mandates and interests. For example, the NMFS and the USFWS are entrusted with enforcement of the Endangered Species Act. Washington and Oregon are responsible for Section 401 provisions of the Clean Water Act. The Sponsor Ports are interested in the economic aspects of channel improvement. State resource agencies are undoubtedly concerned with wetlands and water quality issues, while the Tribes focus on access to a valued salmon fishery.

The AEM Plan recommends the documentation of the adaptive management process. The risk-based decision framework (Figure 1.1) provides an organizational structure to document the management and decision-making process implementation of the Plan:

- Goals and objectives should be clearly delineated.

- The decision process should be described in detail, including identification of the decision alternatives and criteria for selecting among the alternatives.

- The specific data, information, and model results used to support particular decisions should be recorded.

- The uncertainties associated with the sources of information entering into each decision analysis should be characterized along with an evaluation of the risks implied by each decision alternative.

In each analysis, the components of the general decision model serve as templates for describing any management actions undertaken by the AMT, including the decision to continue the process (i.e., monitoring, assessment, evaluation) without any adaptive changes. The goals and objectives, decision alternatives, states of nature, expected or observed outcomes, and the value (i.e., utility) of the management actions in relation to achieving the stated goals can be described and discussed for each iteration of the AEM process. A standardized format should be developed to facilitate such reporting.

Documentation of the AEM process and making this information readily available will demonstrate the transparency of the process to stakeholders and the interested public. One convenient mechanism for making AEM information available would be to publish the information on the CRCIP internet site (www.nwp.usace.army.mil/issues/CRCIP). The site is configured to accept comments concerning various aspects of the Project. More costly and time-consuming ways to share information include formal presentations or workshops where stakeholders and the public are invited to participate.

The documentation of the AEM process will also generate coherency and credibility. Coherency, in this case, refers to the desirable aspect of the AEM process wherein independent decision-makers, given a particular decision objective and the same information, would arrive at a similar decision. Documentation and transparency of the AEM process will normally contribute to credibility among stakeholders and the public, even if there is disagreement in relation to specific management actions. Credibility is essential for effective adaptive management.

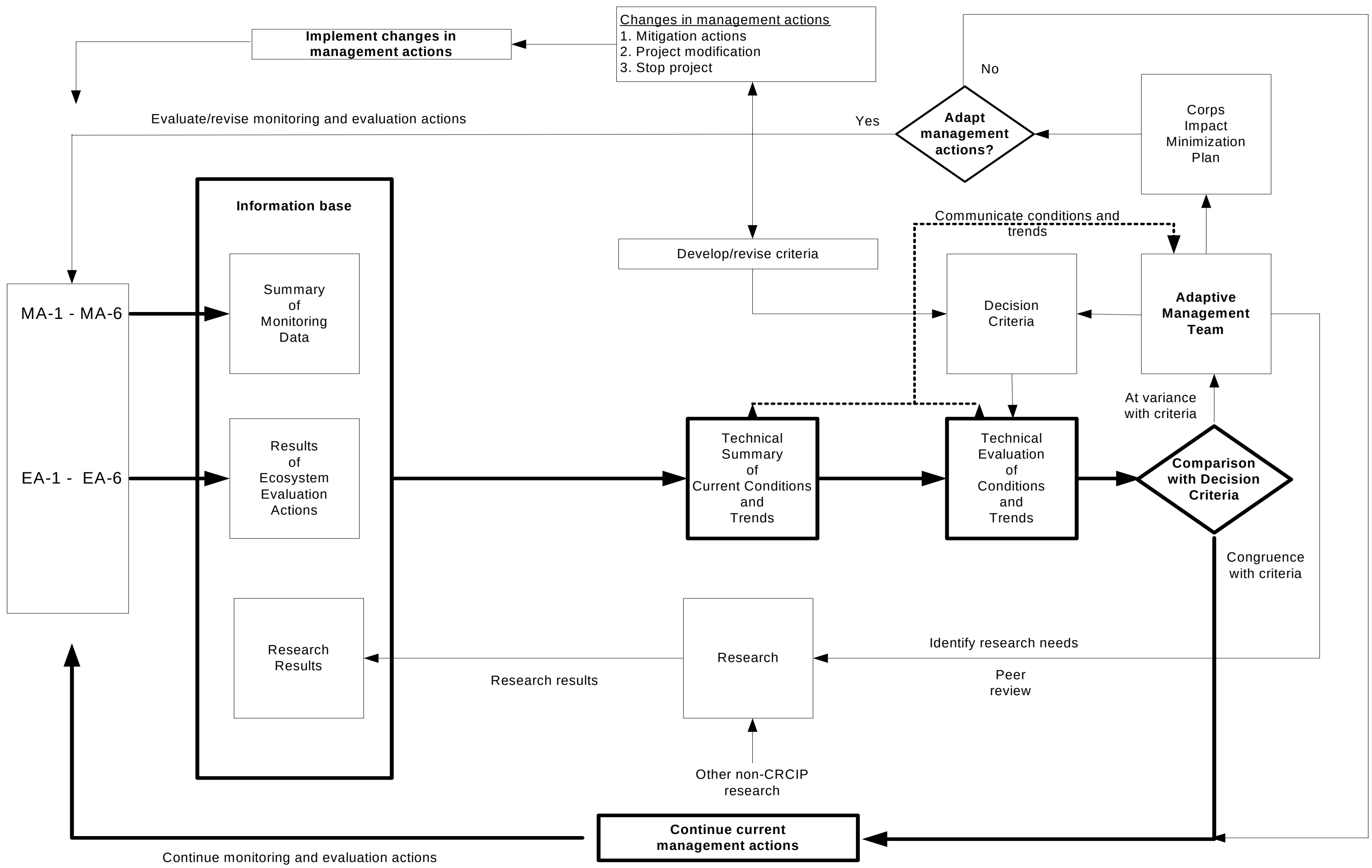

Figure 2.2. Flow chart describing the proposed AEM Process in support of the Channel Improvement Project.

Important physical-chemical effects addressed by the Channel Improvement AEM Process include:

- possible shifts in location or changes in ecological function of the estuarine turbidity maximum;
- deleterious changes in current velocity in shallow water habitats and refugia;
- undesired changes in accretion/erosion rates along the main channel and side-channels;
- undesired changes in temperature, salinity and depth that impact habitat opportunity; and
- undesired changes in bathymetry, bedload sediments, rate of suspended sediment transport, and water levels in the estuary.

Some of the longer-term benefits that should be achieved as the result of a successful AEM Process for the LCR and estuary include:

- provision of additional shallow water and intertidal marsh habitat,
- increased habitat connectivity and complexity,
- creation of additional rearing habitat for ocean-type salmonids,
- increases in detrital export,
- maintaining native tidal marsh plant communities,
- increased benthic invertebrate productivity,
- increased access/egress for ocean-type salmonids, and
- improved access for adult salmonids to headwaters for spawning.