ADAPTIVE MANAGEMENT AND INTEGRATED DECISION MAKING – AN EMERGING TOOL FOR CUMULATIVE EFFECTS MANAGEMENT[a]

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ABSTRACT

Adaptive management (AM) is being used as a follow-up tool within environmental impact assessment and cumulative effects assessment (EIA/CEA) studies. Typical AM processes incorporate management objectives, conceptual to quantitative models, management choices, monitoring, systematic decision making, and stakeholder collaboration. Such processes can be used to reduce cumulative effects uncertainties, and inform decision making relative to local and regional operational practices to minimize the incremental effects of proposed actions, as well as the management of regional cumulative effects resulting from multiple past, current, and future contributors. Based on an analysis of fundamental concepts, practices, and case studies the following key lessons and needs have been identified: (1) Due to numerous uncertainties associated with CEA, AM can be a useful tool for increasing the cumulative effects knowledge base, as well as determining the effectiveness of project mitigation and regional management measures. (2) Decision flowcharts and AM decision matrices can facilitate the learning and necessary decisions associated with AM programs. Such flowcharts and matrices should be both understandable to a range of audiences, and integrative in relation to developing a holistic perspective on management choices and their environmental implications. (3) There is a fundamental need to develop comparative case studies illustrating exactly how AM has been incorporated in National Environmental Policy Act (NEPA) compliance documents which address significant cumulative effects issues and their management. (4) NEPA practitioners, along with AM practitioners, need to recognize that AM concepts can be included within NEPA documents without specific referrals to AM itself. Further, both types of practitioners need to recognize the broad range of both AM practices and types of NEPA documents. Accordingly, "strict perspectives" on what AM is, or is not, will not be useful or encouraging. (5) Central deterrents to AM include both additional budgetary and time requirements. Accordingly, there is a need to carefully delineate the actual benefits and costs of AM requirements in a series of case studies.

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INTRODUCTION

The development of AM programs as a follow-up to the traditional preparation of environmental impact statements (EISs), particularly for large-scale planning efforts which may be fraught with many uncertainties, is currently receiving considerable attention in NEPA compliance practice in the United States and internationally. This attention in the United States is occurring as a result of the Council on Environmental Quality's NEPA compliance modernization report (Council on Environmental Quality, 2003), the increasingly frequent comments on AM by the U.S. Environmental Protection Agency in their review of EISs, and the U.S. Department of Interior's (USDOI's) guidance on AM for both natural resources management and application within the NEPA process (Williams, et al., 2007). Further, as more is learned about the usefulness of AM, many Federal agencies are realizing that they already use the basic concepts, even though the term AM is not included in their NEPA documents.

The topics addressed herein include: multiple definitions of AM; uncertainties related to CEA; the traditional NEPA model and the emerging NEPA model; the situational context relative to international and national practices, and the use of AM concepts by several Federal agencies within their NEPA compliance documentation; fundamental and additional elements of an AM program; potential relationships between AM and environmental management systems (EMSs); getting started on an AM program; case studies of selected water resources AM programs; an example of planning for integrated decision-making; two guidance documents for planning AM programs; incorporating AM within an EIS; and conclusions and lessons learned. Finally, while AM is not limited to one type of project, considerable information herein is associated with water resources programs and management. This information could be adapted to other types of projects and programs. Further, it should be noted that the included basic information and case studies have applicability for cumulative effects management beyond the United States.

MULTIPLE DEFINITIONS OF AM

There is no single definition of AM that is uniformly accepted and utilized. One reason for the absence of a uniform definition is that the term has been and is being used for a wide range of topics; for example, in relation to natural resources management (for over three decades), project planning and evaluation of resultant environmental impacts (for about one decade), and studies of project operations and their impacts (for less than one decade) (The Collaborative Adaptive Management Network, 2007). Currently, there is heightened interest in incorporating AM as a planning and operational tool when major scientific and policy uncertainties are encountered in decision making (Atkinson, et al., 2006), and when the decision making is accompanied by a NEPA compliance document (either EIS or environmental assessment (EA)). Accordingly, some "common concepts" can be found in definitions which have been used for a variety of purposes.

Examples of the range of definitions include the following:

- AM is a systematic process for continually improving management policies and practices by learning from the outcome of operational programs (a definition from the 1970s – Dragoo, 2004, p. 1).

- AM is a systematic approach for improving resource management by learning from management outcomes (Williams, et al., 2007).

- AM is a process that uses scientific methods to test management policies by monitoring impacts and adjusting subsequent actions in light of monitoring results (Dragoo, 2004, p. 1).

- AM is most simply defined as a process for monitoring and adjusting land and resource management decisions in response to development impacts (Dragoo, 2004, p. 2).

- AM is a systematic process for continually improving management policies and practices by learning from the outcomes of operational programs. Its most effective form – “active” AM – employs management programs that are designed to experimentally compare selected policies or practices, by evaluating alternative hypotheses about the system being managed (Forest Practices Branch, 2006 – British Columbia, Canada).

- AM is a system of management practices based on clearly identified outcomes, monitoring to determine if management actions are meeting outcomes, and, if not, facilitating management changes that will best ensure that outcomes are met or to re-evaluate the outcomes. AM recognizes that knowledge about natural resource systems is sometimes uncertain and is the preferred method of management in these cases (U.S. Department of the Interior, 2004).

- AM promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Careful monitoring of these outcomes both advances scientific understanding and helps adjust policies or operations as part of an iterative learning process. AM also recognizes the importance of natural variability in contributing to ecological resilience and productivity. It is not a “trial and error” process, but rather emphasizes learning while doing. AM does not represent an end in itself, but rather a means to more effective decisions and enhanced benefits. Its true measure is in how well it helps meet environmental, social, and economic goals, increases scientific knowledge, and reduces tensions among stakeholders (related to water resources planning – Panel on Adaptive Management for Resource Stewardship, 2004, pp. 1-2).

- To provide an example of a specific definition used for a large-scale ecosystem restoration plan, the following has been articulated for the

Comprehensive Everglades Restoration Plan (CERP) in central and southern Florida in the United States – AM is a science- and performance-based approach to ecosystem management in situations where predicted outcomes have a high level of uncertainty. Under such conditions, management anticipates actions to be taken as testable explanations, or propositions, so the best course of action can be discerned through rigorous monitoring, integrative assessment, and synthesis. AM advances desired goals by reducing uncertainty, incorporating robustness into project design, and incorporating new information about ecosystem interactions and processes as understanding of these relationships is augmented and refined. Overall system performance is enhanced as AM reconciles project-level actions within the context of ecosystem-level responses (Comprehensive Everglades Restoration Plan, draft, 2008, p. 1-2).

Common features from the above definitions include the use of terms or phrases such as systematic process; management goals or objectives; test and adjust polices, practices, and actions; and monitoring and feedback (inferred) relative to future decisions. Further, some definitions of AM distinguish between "passive AM" and "active AM". Passive AM refers to a situation where a single course of action is selected, monitoring is conducted, and subsequent decisions are adjusted based on the outcomes (note: this approach could be a useful entree into the NEPA process). In contrast, active AM refers to situations where multiple courses of actions are planned from the outset, experimental objectives are delineated, monitoring is conducted, and subsequent decisions are adjusted (note: this approach seems to be more aligned with the traditional use of AM for natural resources management).

UNCERTAINTIES RELATED TO CEA

An inferred theme from the above definitions is that a comprehensive scientific knowledge base does not exist regarding the sustainability of environmental resources and cumulative impacts on such resources resulting from multiple past, present, and potential future actions (Canter, 1996). Accordingly, AM can be used as a tool to supplement the knowledge base by reducing several types of uncertainties. More specifically, examples of uncertainties can be identified within cumulative effects assessment and management (CEAM); they include:

- future changes in the operation and management of the preferred alternative;
- detailed information related to reasonably foreseeable future actions (RFFAs), including project siting, size, design features, timing, and contributions to cumulative effects on selected Valued Ecosystem Components (VECs);

- the characteristics of resultant cumulative effects on VECs; that is, are such effects the result of linear or non-linear, or additive, synergistic, or counterveiling combinations;

- the site-specific and regional thresholds or carrying capacities of identified VECs (or their indicators); and

- the potential effectiveness of project-related mitigation measures, as well as regional cumulative effects management programs and practices.

To further illustrate cumulative effects uncertainties, large-scale proposed actions may be subject to both near-term and longer-term uncertainties regarding the number and sizes of impact-causing activities, and the actual impacts of such activities in various fragile to robust environmental settings. Accordingly, the need to address uncertainties, changing conditions, and expanding information bases makes AM especially relevant as a tool for the development of management programs that are planned to last for several decades. To illustrate, Table 1 lists several features of large-scale ecological and institutional systems that provide favorable conditions for planning and implementing an AM program. As can be seen, the listed features encompass ecological considerations, institutional arrangements, and opportunities for enhancing environmental sustainability. An AM program also provides opportunities for documenting the effectiveness of management and regulatory measures for curtailing undesirable cumulative environmental consequences.

An illustration related to institutional issues is included in the NEPA regulations of the Council on Environmental Quality (CEQ). The regulations specifically address the common issue of dealing with incomplete or unavailable information which can be connected to uncertainties. Such an absence of information directly contributes to uncertainties regarding resources, impacts, and the effectiveness of policies and mitigation measures for direct, indirect, and cumulative effects. Specifically, Section 1502.22 of the CEQ's regulations is entitled "Incomplete and Unavailable Information"; the key features are (Council on Environmental Quality, 1986):

> *"When an agency is evaluating reasonably foreseeable significant adverse effects on the human environment in an EIS and there is incomplete or unavailable information, the agency shall always make clear that such information is lacking. If the incomplete information relevant to reasonably foreseeable significant adverse impacts is essential to a reasoned choice among alternatives and the overall costs of obtaining it are not exorbitant, the agency shall include the information in the EIS. If the information relevant to reasonably foreseeable significant adverse impacts cannot be obtained because the overall costs of obtaining it are exorbitant or the means to obtain it are not known, the agency shall include within the EIS:*

Table 1: Features of Large-Scale Impact Studies Which are Conducive to Blending with AM Programs

- Large-scale programs, plans, or projects, and their effects, are often associated with large geographical areas which are ecologically diverse. Further, the management of associated land areas typically requires coordination among Federal, state and local governmental agencies. AM programs could be used for large areas where collaborative efforts would be useful.

- Ecological management policies and decisions for land uses in large areas should be based on integrated scientific information that addresses multiple habitats and resources, rather than addressing single, site-specific resources. Because AM programs are typically based on holistic perspectives, they can be useful.

- AM does not postpone actions until enough is known, but enables learning and action despite limitations, even taking advantage of unanticipated events. Accordingly, momentum gained during the preparation of a large-scale EIS can be a catalyst for a long-term AM program.

- AM can increase the ability to respond in a timely fashion to new information concerning large-scale activities and their interrelated effects on multiple environmental and natural resources. This response possibility exists because multiple institutional structures and stakeholder groups are already in place in many locations.

- AM can reduce decision-making gridlock by making clear that decisions are provisional, and that they can be periodically reviewed and adjusted as appropriate. Such reviews and adjustments are routinely accomplished for land areas with management plans, with such plans including AM features.

- AM promotes monitoring that focuses on significant and detectable indicators of progress toward management objectives related to environmental and species sustainability; such monitoring results can be used to enhance environmental and species sustainability at specific locations. Comprehensive monitoring programs already exist at numerous locations within large-scale areas; thus, they could be modified to facilitate AM decision-making.

- AM is a useful prospective tool that can account for the cumulative effects that occur in ecosystems that are exposed to multiple stressors from various past, present, and future actions. In fact, it could be argued that AM represents the best available approach for managing cumulative effects.

- AM goes beyond piecemeal environmental mitigation to consider environmental processes and the life cycle of protected species. Endangered species management programs developed under the auspices of the Endangered Species Act (ESA), already exist in many geographical areas, and the centerpieces of such programs involve learning, experimentation with management actions for species protection and habitat conservation planning, and adjustment of such actions based on monitoring their effects.

(1) A statement that such information is incomplete or unavailable;
(2) A statement of the relevance of the incomplete or unavailable information to evaluating reasonably foreseeable significant adverse impacts on the human environment;
(3) A summary of existing credible scientific evidence which is relevant to evaluating the reasonably foreseeable significant adverse impacts on the human environment; and
(4) The agency's evaluation of such impacts based upon theoretical approaches or research methods generally accepted in the scientific community.

For the purposes of this section, "reasonably foreseeable" includes impacts which have catastrophic consequences, even if their probability of occurrence is low, provided that the analysis of the impacts is supported by credible scientific evidence, is not based on pure conjecture, and is within the rule of reason."

Careful examination of the above requirements reveals that a four-step procedure is delineated when the overall costs for obtaining the necessary information are exorbitant, or the means to obtain it are not known. An example of "means to obtain (information)" could be related to obtaining a time-sequence of data prior to making a decision. Accordingly, suggestions have been made that AM could be used when the "means" to obtain data are initially unknown (Dragoo, 2004, p. 28).In addition, information on the four steps may need to be included in EISs or EAs when there are uncertainties about cumulative effects. Further, a recent review of United States case law related to the four-step procedure has indicated that the Federal courts rely upon the procedure in evaluating compliance in NEPA documents (Atkinson, et al, 2006).

TRADITIONAL NEPA MODEL AND EMERGING NEPA MODEL

An external issue related to EISs prepared for large-scale programs, plans, and projects is associated with an evolving model regarding the NEPA process and associated documentation requirements. In this regard, and irrespective of the type of action, in the United States there has been increasing attention given to monitoring and AM within the NEPA process. For example, by incorporating AM into the process, the traditional "predict-mitigate-implement" model could be expanded to incorporate the "predict-mitigate-implement-monitor-adapt" model (CEQ, 1997b and 2003). It should be noted that without any "follow-up" (monitor and adapt), the traditional model does not account for unanticipated changes in environmental conditions, inaccurate predictions, or subsequent information that might affect the original environmental protection or mitigation and management measures. The latter model could be referred to as the "adaptive management model". In addition, CEQ's guidance on considering cumulative effects under NEPA, which is expected to be relevant in large-scale EISs, highlighted monitoring and AM in the final step of an 11-step process. Specifically, when determining environmental consequences, it was noted that agencies should monitor the cumulative effects of the proposed action and adapt management as appropriate (CEQ, 1997a).

SITUATIONAL CONTEXT

Although many institutional and policy factors, along with scientific concerns, are related to the implementation of AM programs, it can be instructive to briefly consider the interest in and use of this "tool" from three perspectives – international, the United States via the initiatives of the CEQ, and within example programs of several Federal agencies.

International Perspective

An emerging emphasis in strategic-level (programmatic) impact studies, also referred to as Strategic Environmental Assessments, or SEAs, is the use of targeted monitoring and an AM approach to address large-scale issues and future timeframes that may involve both policy and scientific uncertainties. AM is a tool which can be used to recognize that scientific uncertainties regarding continuing and future actions and unforeseen environmental changes are inevitable when certain management and regulatory programs or policies are implemented in particular environmental settings. Accordingly, recent trends are pointing to the emergence of AM as an environmental management tool for inclusion in Programmatic Environmental Impact Statements (PEISs) and EISs, both in the United States and Canada, and for Strategic Environmental Assessments (SEAs) in the European Community, and elsewhere (Arts and Morrison-Saunders, 2004) suggest that the tool can be used for addressing direct, indirect, and cumulative effects. The scientific community and stakeholder groups are also interested in the use of AM for natural resources protection and management, the current emphasis on incorporating AM in PEISs, EISs and SEAs, and the use of follow-up monitoring and decision-making to effectively manage environmental impacts. Regarding terminology, the monitoring and AM can thus be seen as "post-EIS activities" or as "follow-up activities" (Marshall, Arts, and Morrison-Saunders, 2005).

CEQ Perspective and Initiatives

The CEQ's NEPA Task Force Report included a chapter on AM and monitoring (CEQ, 2003). This Report was preceded by agency and public inputs (Content Analysis Team, 2002); and followed by further agency and public comments in a "roundtable format" (The Clark Group, 2005). A systematic review of these pre-Report, Report, and post-Report documents provides useful information on a variety of perspectives on the benefits and concerns associated with the use of AM as a follow-up activity to the completion of project-level EISs, PEISs, and Supplemental EISs (SEISs). Tables 2 and 3 contain composite lists of key concerns and benefits of AM, respectively. As can be seen, for several topics, concerns and benefits represent different perspectives on common issues.

Table 2: Key Concerns Related to AM within the NEPA Process (excerpts from Content Analysis Team, 2002; CEQ, 2003; The Clark Group, 2005)

- AM should not be used to sidestep required NEPA analysis, nor should it be used as a substitute for up-front affirmative steps to protect natural resources.
- AM is inconsistent with Federal agencies' trust responsibilities to protect tribal rights and resources; e.g., rights to natural resources needed for subsistence, traditional, ceremonial, religions, and other purposes. This concern is based on agencies focusing on follow-on AM in lieu of addressing pre-project environmental responsibilities.
- AM could reduce "up-front" data and analytical requirements; however, it should not lead to up-front non-identification of effects in the NEPA process (e.g., a basic concept of NEPA is that it is necessary to understand the possible consequences of an action before a decision is made to take the action).
- Inadequate long-term funding for monitoring and AM is a widely-held concern.
- There is a poor "track record" of agencies relative to monitoring of mitigation measures included in EISs.
- A general concern is that AM would extend the NEPA process beyond the completion of an EIS (or PEIS) and ROD (Record of Decision). Specific concerns are related to the need for multiple Supplemental EISs over the time period for the AM program. More generally, the key question is related to conditions that would "trigger" additional NEPA-driven reviews. Further, it is perceived that adjustments in AM should be allowable without automatically requiring additional NEPA documentation.
- There is a widely held viewpoint that there is insufficient guidance on how to incorporate AM into the NEPA process.
- The availability of long-term funding for monitoring and the AM program is critical to its success.

Table 3: Key Benefits Related to AM within the NEPA Process (excerpts from Content Analysis Team, 2002: CEQ, 2003; The Clark Group, 2005)

- The AM process should be open to the public, and the public should be notified of changes that take place; stakeholder views should be sought; local knowledge and practices should be incorporated; and information distribution should be planned.

- NEPA is widely perceived as a procedural statute (Sec. 102); AM would move NEPA toward becoming a more substantive statute (Sec. 101).

- AM can already be found in programmatic studies even though the specific term is not used. Such PEISs may call for research and monitoring to help understand ecosystem functions and linkages, with subsequent actions planned in accordance with the results.

- It should be possible, based on additional legal review, to demarcate the procedural responsibilities of NEPA when a monitoring and AM program is incorporated in a separate Environmental Management System (EMS). In fact, EMS can provide an operational framework for an AM program

- Integration of AM and EMS can facilitate more robust post- NEPA document environmental management efforts. Such integration could also be used to prevent or minimize environmental degradation, promote sustainability, and further the policy goals of Sec. 101 of NEPA. (Boling, 2005; Council on Environmental Quality, 2007a)

- Appropriate collaboration with regulators and the affected public is a necessary requisite of AM. An oversight committee or advisory group to the proponent agency could be used. Such collaboration is particularly important when complex processes are involved, or the potential magnitude of the impacts is large.

- AM could be used as a tool for the mitigation and management of cumulative effects, thus reduced cumulative effects could be anticipated.

In June, 2005, CEQ established several work groups to address prioritized recommendations to modernize NEPA implementation. In 2006, one group issued a draft handbook addressing the relationship between NEPA requirements, features of AM, and the use of EMSs (Council on Environmental Quality, 2006). The "draft handbook" indicated that AM is appropriate when: (1) explicit and measurable management objectives, as well as thresholds for triggering changes in management direction, can be identified and developed; (2) resource management decisions can be revisited and modified over time; (3) alternative decisions affecting resource systems and outcomes can be made; and (4) uncertainty can be reduced through learning over time. In contrast, AM would not be appropriate for situations where the management objectives, as well as thresholds for triggering changes in management direction, cannot be clearly identified or developed; the natural system does not have the resiliency to respond or the responses to actions are not measurable; and where there is little uncertainty regarding the outcome of the proposed action (Council on Environmental Quality, 2006).

<u>Brief Examples of Agency Incorporation of AM Concepts in Environmental Planning and Management Activities</u>

Several Federal agencies in the United States have been or are embracing AM within their programs or initiatives. Examples include the Bureau of Land Management, Bureau of Reclamation, Corps of Engineers, Fish and Wildlife Service, National Marine Fisheries Service, National Park Service, and various services in the Department of Defense. To provide one illustration, all Federal agencies have several responsibilities regarding compliance with the Endangered Species Act (ESA); examples include participation in the Section 7 process for threatened or endangered species, information gathering for listing and evaluating such species, incidental take permitting of various activities, preparation of biological assessments, and collaboration in the development of recovery plans and their associated implementation. In addition, ESA Section 10 requirements related to habitat conservation planning are also germane to AM practices. However, numerous scientific and policy uncertainties are associated with these responsibilities. Therefore, the inclusion of an AM program could be useful for negotiating permit conditions, planning and evaluation of recovery plans and development of habitat conservation plans. Two useful informational documents in this regard include Ruhl (2004) and Small (2006). Ruhl (2004) provides a legal, policy, and process review of the ESA and the potentially applicability of AM, while Small (2006) briefly reviews how AM has been included in the recovery plan for the endangered Steller sea lions in Alaska.

AM is also used as a tool within the National Wildlife Refuge System managed by the U.S. Fish and Wildlife Service. Management planning for designated Refuges requires the development of Comprehensive Conservation Plans (CCPs), Habitat Management Plans (HMPs), and Annual Habitat Work Plans (AHWPs). Because both scientific and policy uncertainties are related to various refuge management strategies, AM provides an opportunity to explore the effectiveness of options and use the monitoring results to "fine tune" or formulate new strategies (U.S. Fish and Wildlife Service, 2002). The development of CCPs is typically supported by the preparation of EISs or EAs that routinely refer to AM. Further, revisions in strategies (based on the AM findings) may also be accompanied by EAs rather than Supplemental EISs.

FUNDAMENTAL ELEMENTS IN AN AM PROGRAM

The AM process is currently a "work-in-progress", particularly with regard to its inclusion as a "follow-up" activity to the traditional NEPA model. As was seen earlier, there is no uniform definition for AM across the wide range of its potential and actual uses. Further, there is no uniform prototype, or set of elements, that would be applicable in every case. Rather, it must be recognized that the key elements must be identified and tailored to the action-specific, site-specific, and impacts-specific concerns. However, despite the absence of a unifying set of elements, six such elements which are commonly associated with AM were identified by the Panel on Adaptive Management for Resource Stewardship (2004). While they have generic applicability, the 2004 report by the National Research Council was primarily related to AM applications in water resources planning and management. They are briefly described as follows and could be easily adapted for large-scale PEISs, EISs, SEAs, or even EAs, as appropriate, which address other types of projects or programs.

- Element 1 – Management Objectives that are Regularly Revisited and Accordingly Revised – "Political differences among stakeholders, or competing paradigms among cooperating scientists, are inherent and unavoidable. Recognition and discussion of such differences should be part of AM and its learning processes. But AM participants must have some level of agreement if AM is to be useful; a setting in which there is no agreement on goals, or modes of progress, is likely to render potential AM applications ineffective… As AM proceeds, not only will ecosystem understanding by participants increase, but social and political preferences are likely to evolve, and environmental and social surprises may occur. Key questions, paths of inquiry, and programmatic objectives should be regularly reviewed in an iterative process to help participants maintain a focus on objectives and appropriate revisions to them" (Panel, …, 2004, p. 24).

  Numerous Federal agencies already have various program and management objectives related to environmental compliance and management, as well as for the promotion of environmental sustainability. Reviews of existing objectives could be used as a basis for delineating management objectives which could serve as a basis for building a consensus for an AM program for a specific project, plan, or widespread program.

- Element 2 – A Model(s) of the System Being Managed – "An explicit baseline understanding of and assumptions about the system being managed will help provide a foundation for learning… A system model(s) helps explain responses to management actions and helps identify gaps in and the limits of scientific and other knowledge… Model sophistication and complexity should be tailored to the decision at hand. Active AM employs multiple, quantitative models to generate hypotheses about the system… These models contain clearly-defined variables that characterize the state of the system and its rates and directions of change. Mathematical models of the managed system are often developed to help understand systems behavior. But in poorly understood systems, or when the scale or risks of the actions being considered do not justify the expense of rigorous models, simple schematic diagrams can serve as useful conceptual models… Simple models can educate decision makers and participants by organizing information, highlighting missing information that might be acquired by monitoring, providing a framework for comparing alternatives, and forcing managers to consider their understanding and assumptions of the system… No matter what the setting or types of models used, it is important that AM participants understand model assumptions and limits so that model results are not equated with reality" (Panel, …, 2004, pp. 24-26).

The primary points of the above discussion are that one or more models could be used in specific impact studies; however, a conceptual model may provide the greatest usefulness early on. An instructive discussion paper on "conceptual models" was generated for use by the National Park Service in ecological monitoring and environmental management (Thomas, 2001). Four types of models were defined as follows (Thomas, 2001, pp. 2-3):

<u>Conceptual model</u>: Represents the synthesis of current scientific understanding, field observation and professional judgment concerning the species, or ecological, environmental, or economic system

<u>Diagrammatic model:</u> Pictorially indicates interrelationships between structural components, environmental attributes and ecological and transport and fate processes; it could be based on one or more conceptual models

<u>Mathematical model:</u> Quantifies relationships between components, attributes, and processes by applying coefficients of change, formulae of correlation/causation, and fundamental scientific knowledge and understanding

<u>Computational model:</u> Aids in exploring or solving the mathematical relationships by analyzing the relationships and formulae through the use of computers.

Regarding scientific knowledge about species, ecosystems, and processes, and the associated effects from numerous activities, the use of one or more conceptual and diagrammatic models appears to have the greatest general merit relative to planning an AM program at this time.

- Element 3 – A Range of Management Choices – “Even when an objective is agreed upon, uncertainties about the ability of possible management (or regulatory) actions to achieve that objective are common. That is, existing data rarely point to a single “best” policy. For each objective, the range of possible management (or regulatory) choices should be considered at the outset. This evaluation addresses the likelihood of achieving management objectives and the extent to which each alternative will generate new information or foreclose future choices. When possible, simultaneously implementing two or more carefully monitored actions can allow for rapid discrimination among competing management (or regulatory) actions” (Panel, …, 2004, p. 26).

  The above suggests that a range of activities and management measures should be considered for different environmental settings and in different phasing patterns. Further, this infers a type of “experimental design” for the management and regulatory actions.

- Element 4 – Monitoring and Evaluation of Outcomes – “AM requires some mechanism for comparing outcomes of management decisions. The gathering and evaluation of data allow for the testing of alternative hypotheses, and are central to improving knowledge of ecological, economic, and other systems. Monitoring should focus on significant and detectable indicators of progress toward management objectives. Monitoring should also help distinguish between natural perturbations and perturbations caused by management actions… Monitoring programs and results should be designed to improve understanding of environmental and economic systems and models, to evaluate the outcomes of management decisions, and to provide a basis for better decision making (ideally, independent estimates of the value of monitoring information and programs will be periodically conducted)” (Panel, …, 2004, p. 26).

  In addition, it is critical that “thresholds” for interpreting the monitoring results are identified during the planning of a focused monitoring program. This element of AM will require a design based upon scientific knowledge and principles. Practical questions to be addressed include what indicators to monitor, and when and where to monitor. Regarding large-scale programs, plans, or projects, it is assumed that scientifically-designed monitoring efforts will need to be focused on natural resources, stresses (human use activities), effects on the resources, and the effectiveness of the various management measures, along with their social and socioeconomic consequences.

- Element 5 – A Mechanism for Incorporating Learning Into Future

Decisions – "AM aims to achieve better management decisions through an active learning process. Objectives, models, consideration of alternatives, and formal evaluation of outcomes all facilitate learning. But there should be one or more mechanisms for feeding information gained back into the management process. The political will to act upon that information must also exist. Without a mechanism to integrate knowledge gained in monitoring into management actions, and without a parallel commitment and the political will to act upon knowledge gained from monitoring – which will not eliminate all uncertainties – monitoring and learning will not result in better management decisions and policies" (Panel, …, 2004, p. 27).

The above suggests the need for an information dissemination program, and a streamlined and efficient decision process for adjusting various management measures in view of the monitoring findings. Further, a key need is for a strategic framework that includes periodic evaluations of the implementation of features of the proposed action, the monitoring data and other related policy information, and decision-making, as appropriate, relative to adapting management policies or measures for the resources of concern. Through such a strategy, AM becomes an iterative process in which management objectives are regularly revisited and revised accordingly (Canter and Swor, 2004). Accordingly, careful deliberations will be needed to develop a decision process for EISs or SEAs prepared for large-scale actions. A subsequent section herein provides an example of an integrated decision making approach.

- Element 6 – A Collaborative Structure for Stakeholder Participation and Learning – "The inclusion of parties affected by ecosystem management actions in decision making is becoming a broadly-accepted management tenet of natural resources management programs in the U.S. and around the world... Achieving meaningful stakeholder involvement that includes give and take, active learning (through cooperation with scientists), and some level of agreement among participants, represents a challenge, but is essential to AM. This implies that some of the onus for AM goes beyond managers, decision makers, and scientists, and rests upon interest groups and even the general public… Stakeholders may also need to exhibit flexibility and some willingness to compromise in order for AM to be implemented effectively" (Panel, …, 2004, p. 27; Shindler and Cheek, 1999).

  This element includes both information dissemination to relevant stakeholders, as well as a proactive program focused on soliciting decision-related inputs from a variety of stakeholder groups. However, despite the existence of opposing viewpoints, it should be noted that Federal agencies must fulfill their mission and statutory responsibilities.

  The importance of integrating stakeholder groups and individual citizens in

AM planning and decision making has been specifically addressed by Shindler and Cheek (1999). Based upon their analysis of common characteristics from multiple cases related to natural resources management, as well as other unique contextual factors, the following six propositional themes were identified as concepts which would be useful for enhancing the success of collaboration for an individual AM program developed as part of the NEPA compliance process. The briefly stated themes are:

- Proposition 1: Open and inclusive public processes enjoy increased support

- Proposition 2: Skilled leadership and interactive forums contribute to long-term relationships among participants

- Proposition 3: Innovation and flexibility improve the quality of decisions

- Proposition 4: Early and continuous involvement improves public understanding of the issues and managers understanding of participant perspectives

- Proposition 5: Efforts that result in tangible outcomes demonstrate accountability and build ownership among those involved

- Proposition 6: Incorporating citizens ideas and experiences in decisions builds trust in natural resource institutions

Collaboration between multiple agencies and specific stakeholder groups is important in planning and implementing an AM program as a follow-up to the NEPA process, as well as using collaborative results in cumulative effects management. The potential benefits of such a collaboration process include (Council on Environmental Quality, 2007b, pp. 4-5):

- Better information would be available for all collaborators in the management evaluation and modification process.

- The process will be fairer in that traditionally disadvantaged or under-represented communities, or other non-involved stakeholder groups, will be invited to participate.

- Better integration of ideas and opinions, and even the sharing of personnel and monetary resources, can be accomplished.

- Differences among the collaborators can be identified and hopefully resolved, thus preventing subsequent conflict or at least mitigating its influence.

- Innovative tools such as joint fact-finding (an inclusive and deliberative process to foster mutual learning and resolve disputes over scientific and technical issues), collaborative monitoring (where the collaborative group participates in the monitoring of environmental impacts), and others can bring parties to a common understanding of the facts that underlie issues being tackled by a collaborative group.

- Long-lasting intangible benefits such as building trust between people who will work together on other projects can lead to the formation of future partnerships and increase public confidence in government.

- The implementation of decisions can be enhanced. For example, if stakeholders feel vested in a decision, they will have a stake in its implementation. They can also bring the knowledge they gained during the process to bear on subsequent AM-related decisions involving monitoring, enforcement, and other issues.

- Stewardship of human and natural resources can be promoted through mutual understandings and cooperation.

- The likelihood of litigation can be reduced by including key stakeholders early and often, solving problems at the lowest possible level as they arise, and building agreements between stakeholders. Further, if litigation does ensue, the collaborative process may help narrow issues and make them more amenable to agreement.

ADDITIONAL ELEMENTS IN AN AM PROGRAM

Despite the comprehensiveness of the above six elements, they may not encompass all of the necessary considerations in planning an AM program. Further elements or sub-elements for consideration include (Canter and Swor, 2004; Canter and Hollins, 2005):

- The assemblage of information on historical and current conditions of key indicators for environmental resources (VECs) that are potentially subjected to impacts from a plan, program, or project; and the quantitative prediction or qualitative description of these anticipated impacts, along with impacts from other past, present, and reasonably foreseeable future actions (i.e., the cumulative effects), on the key indicators. Further, assemblage of information on organizations with responsibilities for resources management, resource-specific models and tools, and existing monitoring programs is an important foundational element (Canter, et al., 2005a).

- Collaborative long-term agreements among pertinent Federal, state, tribal, and local environmental agencies; and a program management board (or steering committee) comprised of representatives from these agencies. A recently issued handbook on collaboration in NEPA describes opportunities and challenges, along with practical approaches, for developing and benefiting from such collaboration (Council on Environmental Quality, 2007b). The benefits from such collaboration were noted above.

- Adequate budgetary and personnel resources. Given the finite nature of public funds and other resources, ecological management enables agencies to engage in careful selection of achievable goals, to efficiently allocate resources, and to generate useable and cost-effective outcomes.

- A peer group of advisors. Engaging individuals with expertise in public policy analyses, the planning and conduction of environmental monitoring and research, and environmental decision-making will strengthen the AM process.

AM AND ENVIRONMENTAL MANAGEMENT SYSTEMS (EMS)

As noted above, interest is being given to aligning AM and EMS as coordinated follow-up activities to the traditional NEPA process (Eccleston, 2003; Boling, 2005). One reason for considering a closer alignment between the NEPA-compliance process and a follow-on EMS is that several fundamental EMS elements could be used in the implementation of an AM program (Council on Environmental Quality, 1997a). Examples of useful EMS elements include objectives, targets and environmental management programs (related to AM Element 1 – Management Objectives…), monitoring and measurement (AM Element 4 – Monitoring and Evaluation of Outcomes), and nonconformity, corrective and preventive action (AM Elements 3 – A Range of Management Choices, and 5 – A Mechanism for Incorporating Learning into Future Decisions).

GETTING STARTED ON AN AM PROGRAM

Planning and implementing a follow-up AM program for a local or regional project could occur over time through the efforts of many stakeholders, but it would be unlikely to take place unless several key initiating actions take place in a timely manner. From the viewpoint that a governmental agency would lead in these efforts, the following initiating actions would need to occur (Canter, et al., 2005b):

- Authorization of an agency or public organization to promulgate an AM program, provide continuity, and ultimately assume responsibility for the program's implementation.

- Formation of a broadly representative stakeholder group, including members that would identify and conduct monitoring and other tasks and would be capable of recommending management adaptations in response to monitoring outcomes and other information.

- Allocation of collaborative funding and personnel to initiate and sustain the AM program over a test period of several years.

Following authorization and funding, and assuming that the lead agency or organization has formed a stakeholder group, efforts could then be directed toward specific implementation actions. Examples include:

- Conduction of a comprehensive survey of existing databases and institutional information related to selected VECs; e.g., aquatic and riparian habitats.
- Establishment of a management (decision making) board comprised of responsible officials from several governmental agencies.
- Development of the management objectives for the AM program, with such objectives reviewed by the management board and stakeholder group.
- Establishment of an external peer review committee to examine the scientific and policy features of the AM program.
- Delineation of specific questions to be addressed, and monitoring to be conducted, for the initial period (e.g., 2 to 5 years) of the AM program, with the questions and monitoring plans reviewed by the management board, stakeholder group, and external peer review committee.
- Over the initial implementation period, conduct the monitoring, review and interpret the collected data in the context of historical information and management objectives, and adapt actions or policies as necessary.
- Dissemination of the findings should be accomplished via annual reports and annual conferences; and inputs relative to AM should be sought from the external peer review committee, stakeholder groups, and management board.

CASE STUDIES OF AM WITHIN SELECTED WATER RESOURCES PROGRAMS

Based upon several recent literature reviews, examples (case studies) related to planning and implementing AM programs for water resources management, including ecosystem restoration, were identified; they include:

- Committee on Grand Canyon Monitoring and Research (1999) – addresses the scientific bases, planning, and implementation of an AM program for Glen Canyon Dam and the downstream Colorado River ecosystem.
- Committee on Water Resources Management, Instream Flows, and Salmon Recovery in the Columbia River Basin (2004) – includes the use

of AM in an overall scheme for decision support related to Columbia River salmon and water management decisions.

- Canter and Hollins (2005) – this conference paper describes preliminary planning considerations for an AM program for the Ohio River navigation system, including the cumulative effects from multiple federal and non-federal contributing actions.

- Northwest Power and Conservation Council (2006) – this guidance document describes monitoring and evaluation planning in relation to fish and wildlife management in the Columbia River Basin.

- Barko, et al. (2006) – this panel report is focused on implementing AM in relation to planned ecosystem restoration projects in the upper segment of the Mississippi River System

In 2004, the Tennessee Valley Authority released a Programmatic EIS which addressed the operation of the highly integrated, multipurpose system of 49 dams and reservoirs in relation to TVA's goals for navigation, flood control, and power production in the Tennessee River Valley (Tennessee Valley Authority, 2004). Uncertainty about, and the need to periodically reassess the balance and focus of TVA's management of the Tennessee River system was a major factor in taking an AM approach to decision making on reservoir operational policies. In the record of decision (ROD) for the Programmatic EIS, TVA established new reservoir operational policies directing and bounding actions to be taken, but allowing for the necessary information and flexibility to respond to changing, uncertain or unforeseen conditions on both daily and long-term bases. As part of this process, TVA set measurable targets for several key goals and objectives of water resource management, but allowed for a breadth of possible operational decisions and responses to achieve these goals. The targets included average daily flow targets for key points in the river system; reaffirmation of target summer pool elevations at certain dates; adequate flood storage volumes in reservoirs at particular times; thermal compliance of TVA coal-fired and nuclear generating electric facilities; and minimum flow and dissolved oxygen level targets for releases from particular TVA dams to protect and enhance aquatic habitats. The ROD also addressed uncertain impacts to numerous biological, physical, cultural, economic, and social resources resulting from implementing changes in the operational procedures for a constantly varying reservoir system across an 80,000 square-mile area. The ROD either renewed commitments to ongoing resource monitoring of select parameters or established additional operational factors that vary by the month, week, day, and hour.

An additional water resources-related example is the Comprehensive Everglades Restoration Plan developed by the Corps of Engineers in partnership with the South Florida Water Management District and other federal and state stakeholders, and non-governmental organizations (Panel, …, 2004, pp. 52-59; Committee on the Restoration of the Greater Everglades Ecosystem, 2003). This ambitious undertaking is proving to be challenging relative to funding, the analysis of early findings, and their incorporation into decision-making processes. The final example is related to moving toward an AM program for the Missouri River dam and reservoir system. This movement was described in a 2001 draft EIS related to the master operational manual for the River basin. Extensive conflicts are related to water flow management for various needs and uses, including requirements for the ESA listings for the pallid sturgeon, least tern, and piping plover (Panel, …, 2004, pp. 59-66; and Committee on Missouri River Ecosystem Science, 2002).

PLANNING FOR INTEGRATED DECISION MAKING – A BRIEF EXAMPLE

As noted in the above definitions of AM, as well as the section on elements of an AM program, three key features include management objectives, a decision process, and a range of management choices. Four related graphics prepared for a U.S. Army Corps of Engineers EIS on a salt marsh restoration project adjacent to the Napa River about 30 miles north-northeast of San Francisco, California (Jones and Stokes, 2004) will be used as an example.

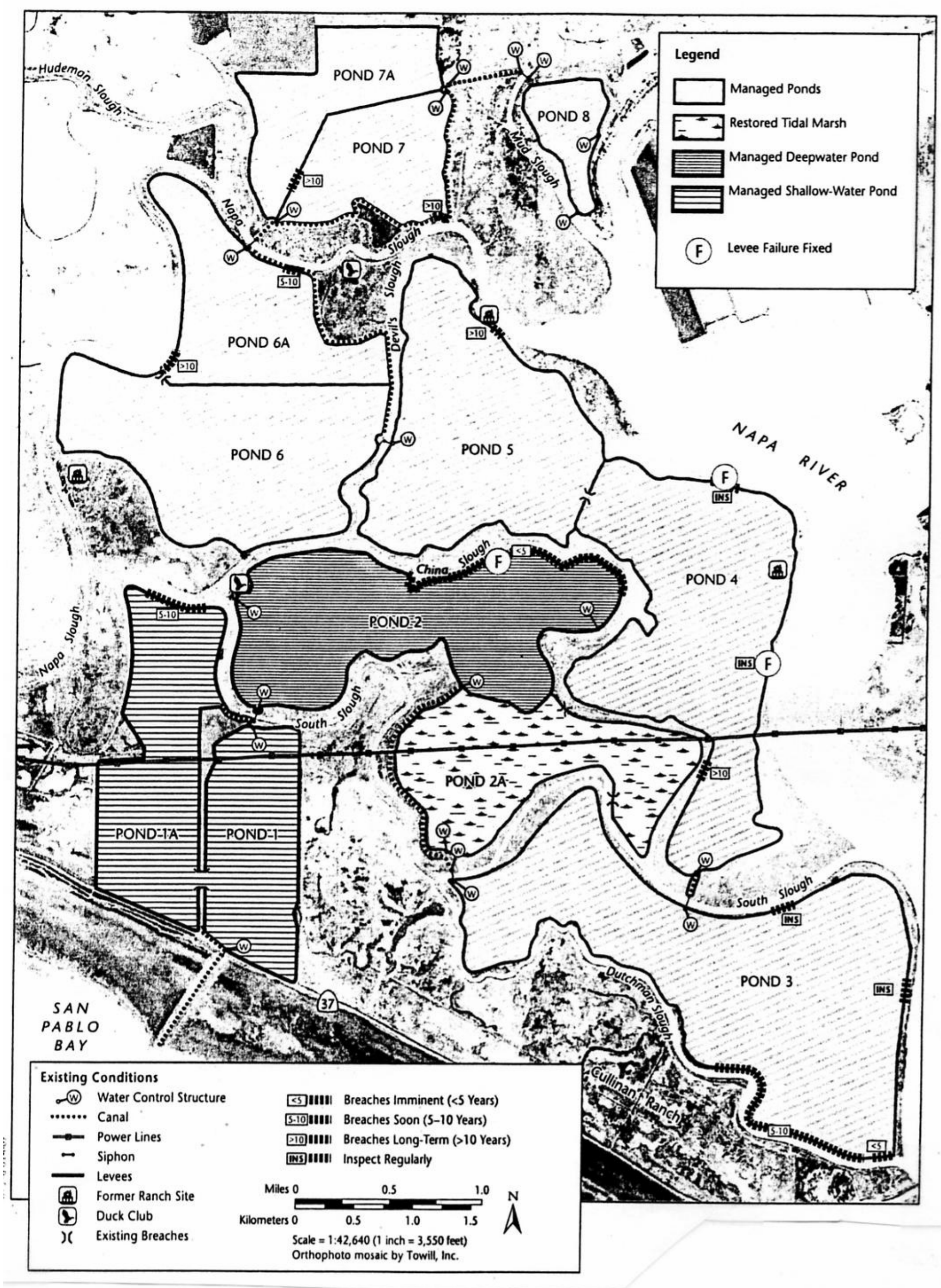
The Napa River Unit (9,456 acres) is located at the northeast edge of San Pablo Bay (this Bay connects to the San Francisco Bay to the south. This Unit is now a part of the Napa-Sonoma Marshes Wildlife Area. The Unit is comprised of 7,190 acres of salt ponds and levees and 2,266 acres of fringing marsh and slough. A total of 11 ponds needing attention are currently at the site, with three being denoted as upper ponds (in elevation), and eight called lower ponds. The upper group includes Ponds 7, 7A, and 8; while the lower group includes Ponds 1, 1A, 2, 3, 4, 5, 6, and 6A. Figure 1, labeled as the No Project Alternative, depicts the locations of these ponds (Jones and Stokes, 2004, p. S-6a).

The Unit was first diked off from San Pablo Bay during the 1850s for hay production and cattle grazing (Jones and Stokes, 2004). Dike construction continued for several years and much of the land was converted to salt ponds in the 1950s for salt production through the solar evaporation of bay water. In the early 1990s, Cargill Salt Company stopped producing salt in the ponds on the west side of the Napa River and sold the evaporation ponds to the State of California. The State then assigned ownership to the California Department of Fish and Game (DFG).

Restoration of the tidal nature of the Unit, as well as enhancement of the aquatic and terrestrial habitats, has, for several decades, been a vision of resources agencies, conservationists, and planners. The EIS noted above is for a salinity reduction and habitat restoration project for the Unit. The project proponents include the DFG, the California State Coastal Conservancy, and the U.S. Army Corps of Engineers. The goals for the project are included in a regional Baylands Ecosystem Habitat Goals project and report (Jones and Stokes, 2004).

Due to the large-scale of the Napa River Unit project, as well as numerous uncertainties as to the effectiveness of water flow management measures for

Figure 1: No Project Alternative (Jones and Stokes 2004, p. S-6a)



salinity control, and habitat restoration efforts, the project proponents decided to integrate AM within the planning and implementation schedules. Accordingly, the EIS includes management objectives, a decision process, and a range of management choices. Figure 2 summarizes the three management objectives, two broad and six specific hypotheses, six success criteria for salinity reduction and habitat restoration, and planned monitoring (Jones and Stokes, 2004, p. 2-68a). Figure 3 displays a decision flowchart for the 11 ponds in relation to the first objective listed in Figure 2 (Jones and Stokes, 2004, p. S-4a). Finally, Figure 4 contains an AM decision framework which could be used as a basis for evaluating monitoring results, assessing potential changes, and developing AM scenarios (Jones and Stokes, 2004, p. 2-68b).

GUIDANCE DOCUMENTS FOR PLANNING AM PROGRAMS

Brief information on two guidance documents will be noted herein. First, the U.S. Department of the Interior (USDOI) recently published guidelines for AM (Williams, et al., 2007). The guidelines address four key questions – what is AM, when should it be used, how should it be implemented, and how can its success be recognized? While the focus is on applying AM in natural resources management, it does address compliance with the requirements of NEPA, the ESA, and the Federal Advisory Committee Act.

The guidance also addresses a two-phase operational sequence for AM. The first phase, referred to as the "set-up phase", contains five structural elements; while the second "iterative phase" uses these elements in an on-going cycle of learning and management. More specifically, the set-up phase involves five steps as follows (Williams, et al., 2007, pp. 22-32).

- Step 1 – Stakeholder involvement – ensure stakeholder commitment to adaptively manage the enterprise for its duration

- Step 2 – Objectives – identify clear, measurable, and agreed-upon management objectives to guide decision making and evaluate management effectiveness over time

- Step 3 – Management actions – identify a set of potential management actions for decision making

- Step 4 – Models – identify models that characterize different ideas (hypotheses) about how the system works. Note: models can range from a verbal description of system dynamics (for example, a simple description of reservoir size that is positively influenced by runoff and negatively influenced by water release), to a formal detailed mathematical expression of change (for example, an age-structured multi-species model with density-dependent vital rates that are affected by random environmental changes" (Williams, et al., 2007, p. 29).

Figure 2: Project Objectives, Hypotheses, Success Criteria, and Monitoring (Jones and Stokes, 2004, p. 2-68a)

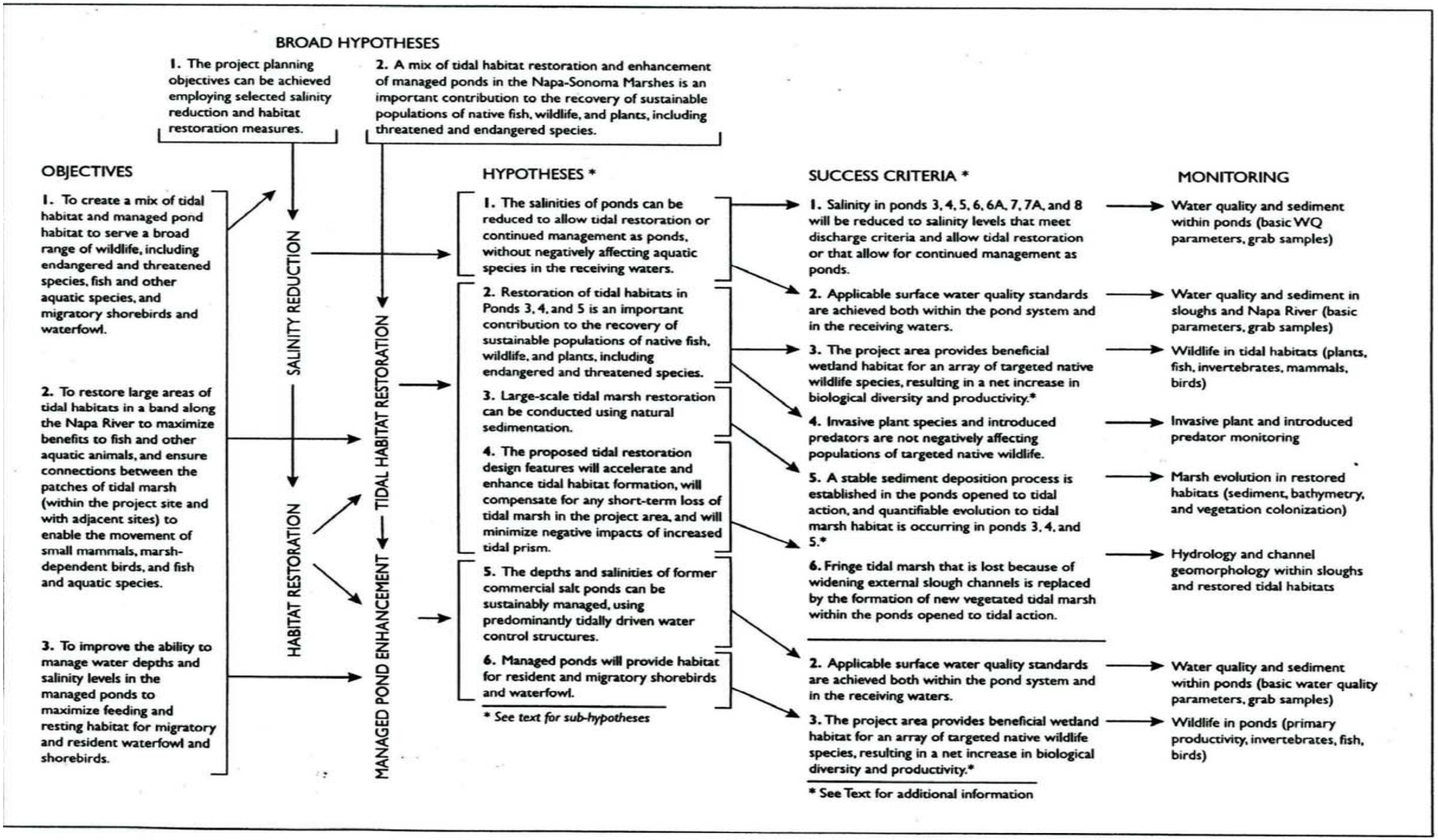


Figure 3: Napa River Salt Marsh Restoration Project Decision Flowchart (Jones and Stokes, 2004, p. S-4a)

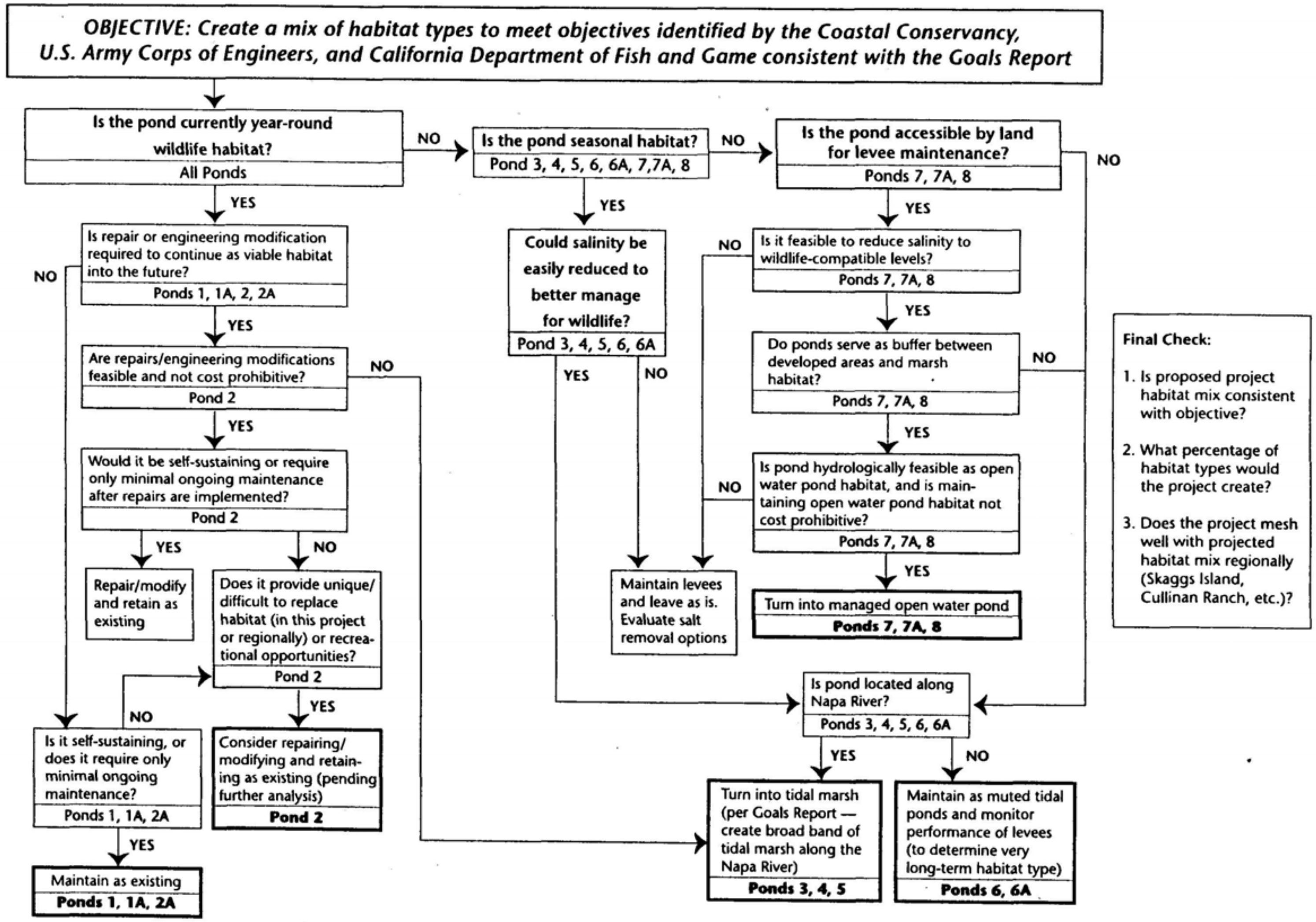
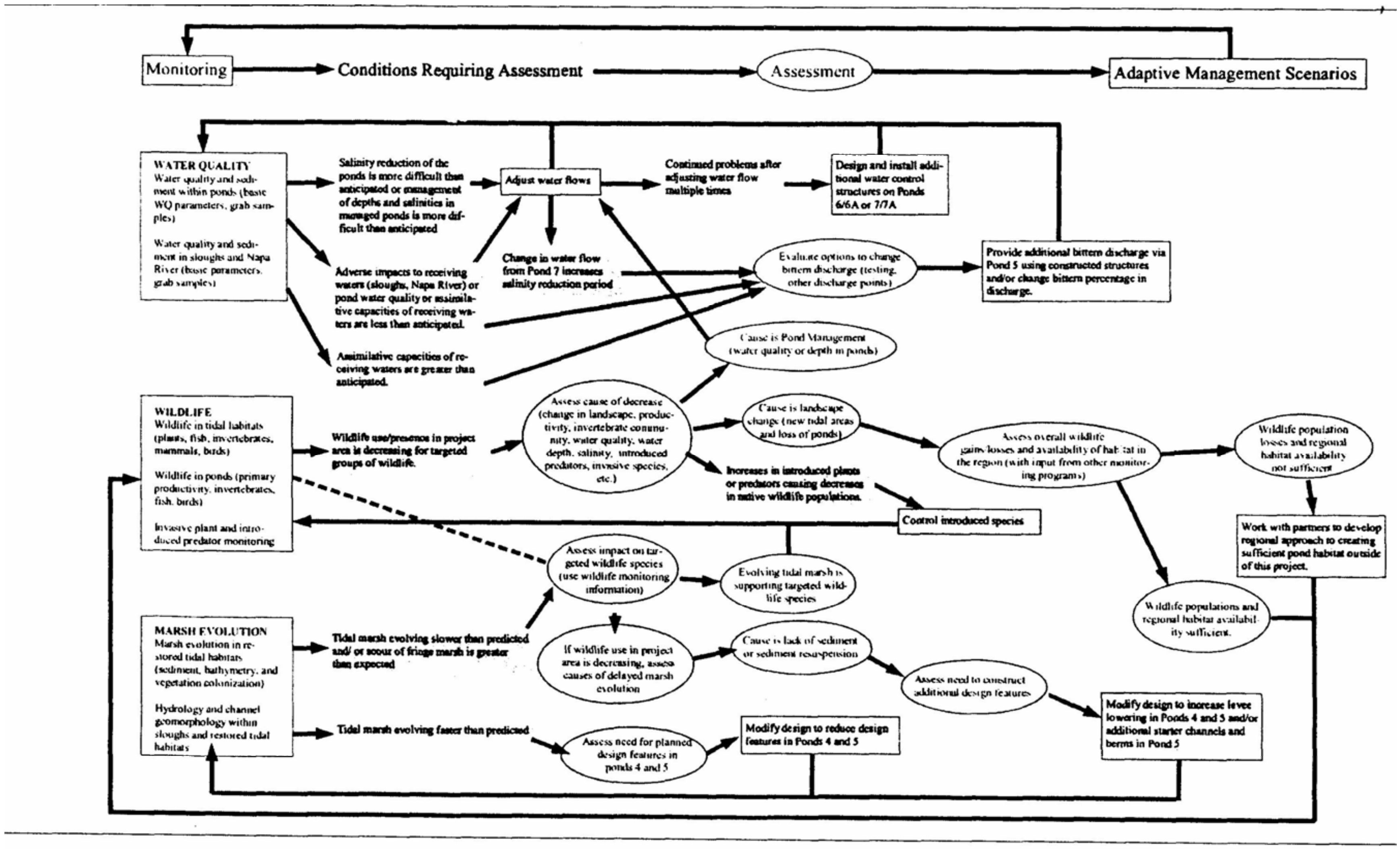


Figure 4: Adaptive Management Decision Matrix (Jones and Stokes, p. 2-68b)



- Step 5 – Monitoring plans – design and implement a monitoring plan to track resource status and other key resource attributes

The iterative phase involves three steps utilized in a cyclical manner as follows (Williams, et al., 2007, pp. 33-38):

- Step 6 – Decision making – select management actions based on management objectives, resource conditions, and understanding

- Step 7 – Follow-up monitoring – use monitoring to track system responses to management actions

- Step 8 – Assessment – improve understanding of resource dynamics by comparing predicted and observed changes in resource status

The iterative phase would be continued by returning to Step 6 followed by Steps 7 and 8. Further, in an overall AM program, it may be useful to periodically review and adjust Steps 1 through 5 in the set-up phase.

To summarize, comparisons of the six elements described above with the eight steps from the USDOI guidelines reveals both their consistency and compatibility. The elements/steps could be used in a blended manner to actually plan and conduct an AM program.

Finally, an AM guidance manual is under development for the Comprehensive Everglades Restoration Plan (CERP). CERP provides a framework and guide to restore, protect and preserve the water resources of Central and Southern Florida, including the Everglades. It covers 16 counties over an 18,000-square mile area, four south Florida ecosystem regions, and a multitude of unique species and habitats endemic to the Everglades system (Comprehensive Everglades Restoration Plan, 2008). CERP is designed to capture, store and redistribute fresh water previously lost to tide and to address the quality, quantity, timing and distribution of water flows that have been altered by 1,000 miles of canals, 720 miles of levees, and several hundred water control structures.

The draft manual includes nine identified activities (elements) to help guide CERP agencies, tribes, and stakeholder groups through the planning and implementation of the overall program. These elements are conceptually similar to the six generic elements described above, and to the above-listed USDOI elements. The nine CERP elements (activities) include (Comprehensive Everglades Restoration Plan, 2008, pp. 1-3 and 1-4): (1) stakeholder engagement and interagency collaboration; (2) establishment of restoration goals and objectives; (3) identification and prioritization of unanswered questions; (4) use of conceptual modeling, hypotheses, and performance measures; (5) AM integration into restoration planning; (6) monitoring ecosystem response; (7) assessment of ecosystem response; (8) decision making; and (9) implementation and refinement.

INCORPORATING AM WITHIN AN EIS

Incorporation of AM within the NEPA process could occur in several ways. For example, following traditional NEPA practice, alternatives could be identified and evaluated, and the preferred alternative which is selected could be enhanced by the incorporation of an AM program. At the opposite end of the spectrum, AM could be included in each identified and evaluated alternative, thus the decision process would incorporate AM considerations, and the preferred alternative would already include such a program. Further, for either case, the resultant EIS or EA could either address AM in a cursory manner, or it could include more detailed information. The cursory approach could include a commitment to an AM program, but no detail would be provided. In contrast, the detailed approach could include a description of the anticipated AM actions associated with each alternative and the preferred alternative, their expected environmental consequences, and a presentation of information on the management objectives, monitoring program, decision process, stakeholder involvement, and information dissemination. Further, it would be desirable to indicate any known “thresholds” which might trigger the need to prepare a Supplemental Environmental Report or Supplemental EIS or EA.

A pragmatic issue associated with incorporating AM within a project-level EIS, PEIS, or supplemental EIS, is related to the topics to actually be addressed. One suggestion for the topical contents is as follows (Content Analysis Team, 2002): (1) identify the goals (objectives) and desired outcomes of the AM program; (2) identify collaborating agencies and groups and their responsibilities relative to funding, mitigation, and AM program implementation; (3) delineate plans for funding and the associated time schedule; (4) identify quantifiable performance measures and “trigger levels” (thresholds) for considering management options; (5) identify commitments to mitigation and monitoring (could be done in a ROD – record of decision, but could be subject to litigation if not carried out); (6) delineate the review and decision-making process; (7) connect AM to identified environmental concerns/effects; and (8) identify the responsibilities of collaborating agencies for evaluating the effects of AM measures. As an aside, it should be noted that these topics are similar to the “commonly listed” elements for AM programs.

One approach for incorporating the above information in an EIS is to prepare a separate chapter to discuss follow-up activities. It is assumed that such a chapter should be near the end of the EIS. Further, specific commitments to plan and implement an AM program should be included in the ROD.

Another approach is to integrate AM information throughout the traditional chapters in an EIS. An example of this approach, which is also an excellent example of planning and describing an AM program, is the National Park Service's Draft EIS on Elk and Vegetation Management in the Rocky Mountain National Park in Colorado (National Park Service, 2006). This Draft EIS includes AM features in each of five alternatives, and the specification of quantitative criteria to be used as triggers for management changes when monitoring results for specified indicators exceed stated thresholds.

CONCLUSIONS AND LESSONS LEARNED

Based upon the above information, concepts, practices, and examples, several lessons and needs related to incorporating AM within the NEPA process can be identified. The following non-prioritized list provides a brief statement of such lessons and needs:

- Based upon prior interests, it should be recognized that natural resources management agencies will probably be able to more readily include AM within their NEPA processes. This is in contrast to the relative newness of the subject to infrastructure, energy, and military agencies.

- Due to numerous uncertainties associated with CEA, AM can be a useful tool for increasing the cumulative effects knowledge base, as well as determining the effectiveness of project mitigation and regional management measures.

- Decision flowcharts and AM decision matrices can facilitate the learning and necessary decisions associated with AM programs. Such flowcharts and matrices should be both understandable to a range of audiences, and integrative in relation to developing a holistic perspective on management choices and their environmental implications.

- There is a fundamental need to develop comparative case studies illustrating exactly how AM has been incorporated in NEPA compliance documents which address significant cumulative effects issues. Further, it should be recognized that AM can be accomplished in the absence of an EMS, and vice versa; however, the benefits of a blended approach can accrue, thus comparative case studies illustrating such benefits would be useful.

- Central deterrents to AM include both additional budgetary and time requirements. Further, problems can arise when such requirements extend over several years, or even decades. Accordingly, there is a need to carefully delineate the actual benefits and costs of such requirements in a series of case studies, and then use this information in governmental decision making.

- NEPA practitioners, along with AM practitioners, need to recognize that AM concepts can be included within NEPA documents without specific referrals to AM itself. Further, both types of practitioners need to recognize the broad range of both AM practices and types of NEPA documents. Accordingly, “strict perspectives” on what AM is, or is not, will not be useful or encouraging.

- NEPA document review agencies need to recognize that “calls” for the inclusion of AM in such documents can be problematic. Thus review agencies need to be prepared to assist action agencies in the incorporation of AM in the NEPA process.

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