

**Lessons Learned from Programmatic
Adaptive Management of Large-scale
Coastal Ecosystem Restoration**

Justin R. Boevers

A thesis submitted in partial fulfillment of the
requirements for the degree of

Master of Marine Affairs

University of Washington

2008

Program Authorized to Offer Degree:
School of Marine Affairs

University of Washington
Graduate School

This is to certify that I have examined this copy of a master's thesis by

Justin R. Boevers

and have found that it is complete and satisfactory in all respects,
and that any and all revisions required by the final
examining committee have been made.

Committee Members:

Thomas Leschine

Martha Groom

Date: _____

In presenting this thesis in partial fulfillment of the requirements for a master's degree at the University of Washington, I agree that the Library shall make its copies freely available for inspection. I further agree that extensive copying of this thesis is allowable only for scholarly purposes, consistent with "fair use" as prescribed in the U.S. Copyright Law. Any other reproduction for any purposes or by any means shall not be allowed without my written permission.

Signature _____

Date _____

University of Washington

Abstract

Lessons Learned from Programmatic Adaptive Management of Large-scale
Coastal Ecosystem Restoration

Justin R. Boevers

Chair of the Supervisory Committee:
Professor Thomas Leschine
School of Marine Affairs

Adaptive management (AM) is considered a best management practice for ecosystem restoration, yet successful examples of adaptive management approaches for large-scale ecosystem restoration programs are few. I conducted a multi-case study analysis of three restoration programs in the US to identify how AM is organized and implemented at the program level. I developed seven criteria for programmatic adaptive management based on the literature. The programs were evaluated against these criteria using evidence drawn from program documents, AM artifacts and interviews with program representatives. Through the analysis I identified a set of lessons learned for future applications of adaptive management for large-scale restoration. Many lessons emerged from this study, including: the importance of formal institutional structures dedicated to AM; the necessity of system-wide modeling and monitoring to facilitate AM; the importance of stakeholders in the AM process; the value of leadership being committed to an AM approach; the need for interagency cooperation; and the significance of institutional capacity to realize an AM process. The final discussion includes a series of recommendations for future restoration planners who want to incorporate adaptive management in a restoration program.

TABLE OF CONTENTS

List of Figures.....	ii
List of Tables	iii
Introduction	1
Methodology.....	8
Results	18
Comprehensive Everglades Restoration Plan	18
Louisiana Coastal Area.....	34
CALFED Bay-Delta Program.....	45
Discussion.....	59
Recommendations	66
Bibliography	70
Appendix A: Multi-Case Study Methodology.....	76
Appendix B: Interview Methodology	81
Appendix C: Program Results Explanations	87

LIST OF FIGURES

Figure Number	Page
Figure 1 The Adaptive Management Process	3
Figure 2 Definitions of Sub-Types of Adaptive Management.....	4
Figure 3 Summary of Program Interviews by Agencies & Association.....	13
Figure C-1 CERP Adaptive Assessment Flow Chart	88
Figure C-2 CERP's 2004 Adaptive Management Process	89
Figure C-3 CERP's 2006 AM Strategy Overview	90
Figure C-4 CERP's AM Webpage	91
Figure C-5 Boundaries of the SFWMM system-wide model for CERP.....	92
Figure C-6 Linkage of MAP with Box 2 of CERP AM Strategy	93
Figure C-7 The Integration of Stakeholders for Maximum Opportunity of CERP's Success	94
Figure C-8 Box 3 of CERP's AM Strategy	95
Figure C-9 Box 4 of CERP's AM Strategy	95
Figure C-10. Organizational Roles in the LCA AEAM Process	98
Figure C-11 S&T Program Approach Using AEAM for Restoration Planning	98
Figure C-12 Proposed AM Program in the LACPR Management Strategy	99
Figure C-13 LCA CLEAR Ecosystem Model	100
Figure C-14 Conceptual Linkage of Modeling and Monitoring to AM	101
Figure C-15 Screenshot of the CWPPRA Coast-wide Reference Monitoring System	102
Figure C-16 Public Input into the LCA Study	103
Figure C-17 Inclusion of Stakeholders in 2-phase Learning in AM	104
Figure C-18. AEAM as the communication tool between the LCA PET and the LCA S&T Program	105
Figure: C-19 Typical Interagency Communication between Participants in Louisiana Restoration	106
Figure: C-20 CALFED Diagram of the AM Process	107

Figure: C-21 Indicators Linking Science, Management and Adaptive Management	109
Figure C-22: Summary of Changes in Governance Learning from CALFED's New Organization	110

LIST OF TABLES

Table Number	Page
Table 1 CERP Criteria Scores for Programmatic Adaptive Management	33
Table 2 LCA Criteria Scores for Programmatic Adaptive Management.....	46
Table 3 CALFED Bay-Delta Program Criteria Scores for Programmatic Adaptive Management	58
Table 4 Multi-Case Comparison of PAM Criteria Results	60

Acknowledgements

I offer my sincerest gratitude to the faculty, staff and student colleagues at the School of Marine Affairs for their support in my academic endeavors. I am especially grateful to my advisor Dr. Tom Leschine and my committee Dr. Martha Groom for their guidance through my thesis process and Professor Dave Fluharty and Professor Marc Hershman for their mentoring in my graduate studies. I would also like to thank Professor Si Simenstad and Dr. Thomas Mumford for their commitment to my thesis research. Thank you to the Puget Sound Nearshore Partnership, notably Curtis Tanner and Bernie Hargrave for the funding support of this thesis research via the US Army Corps of Engineers – Seattle District as well as members of the Nearshore Science Team for the opportunity to work with the team and for providing valuable and critical insight into my research. Finally, I appreciate the time offered by all the interviewees who made this thesis possible from the Central Everglades Restoration Plan, the Louisiana Coastal Area Study and the CALFED Bay-Delta Program.

Dedication

To my late mother for believing in her only child's talents, knowing how to gently push me towards discovering my abilities and expecting nothing less from me than achieving my potential.

Introduction

Background and Rationale

The purpose of this study is to identify lessons from current uses of adaptive management (AM) for large-scale ecosystem restoration programs. This investigation focuses on the system-wide application of AM to guide large-scale ecosystem restoration and asks how adaptive management is structured and used for programmatic decision-making for large-scale restoration programs. Adaptive management applied at the program scale is programmatic adaptive management (PAM). To identify a set of lessons learned for future applications of programmatic adaptive management, this study uses a multi-case study methodology to investigate three restoration programs that explicitly refer to the use of adaptive management as part of their overall restoration program.

The term ‘*adaptive management*’ was coined in the 1970’s by Holling and Walters as an abbreviated term for ‘adaptive environmental assessment and management’ (Holling 1978, Walters 1986). The original intent of the term ‘adaptive management’ was to describe a process that uses models to implement management experiments in place of the trial-and-error approach to management (Walters 1997). The concept of AM is often simplified to ‘learning by doing,’ but the genuine form of adaptive management is better stated as “experimental management” (Walters 1997, p.2).

Adaptive management is based on the principle that environmental policies are experiments (Walters 1986, Lee 1993). However, there are multiple views and definitions regarding adaptive management (see National Research Council 2004). The concept of adaptive management is widely promoted yet widely misunderstood (Gregory 2006). Murray (2003) claims that the term has lost much of its meaning because it is used to describe any type of real-time change.

Success stories in the application of AM are scarce. Renowned AM authority Carl Walters notes his participation in 25 planning exercises for AM of riparian and coastal ecosystems and asserts that only seven resulted in a meaningful management experiment (Walters 2007). The popularity of AM, despite its limited success to date in use, comes from a simple, intuitive theoretical construct that is appealing for dealing with ecological problems with high uncertainty (Gunderson and Holling 2002, Gregory 2006); it is espoused to be a “best management practice” for ecosystem restoration (Science Board of the Louisiana Coastal Area Ecosystem Restoration Study 2007, p.2).

This study defines adaptive management as *a rigorous approach for learning through experimental design and an iterative process* (adapted from Murray 2003). Adaptive Management is a process often depicted as a sequential series of steps. Nyberg (1999) developed a six-step framework (Fig. 1) that serves as a widely accepted conceptual model describing the adaptive management process. Nyberg’s framework serves as the foundation for how this study differentiates adaptive management from trial-and-error management. It is important to note that the progression among these steps is simple in theory, but in reality the sequence is likely less clear (Murray 2003). Adaptive management is rarely realized in sequential steps and the different moving parts of a PAM process occur simultaneously in overlapping phases.

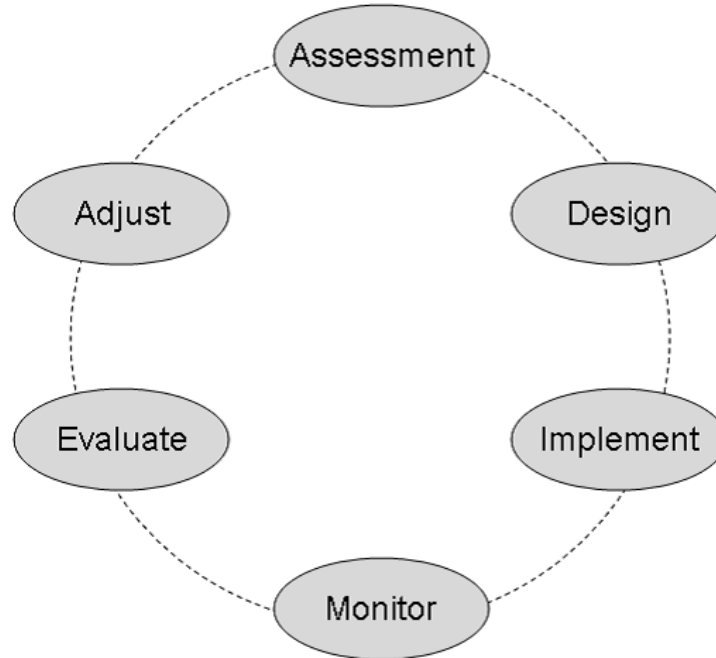


Fig. 1 The Adaptive Management Process (Nyberg 1999)

This study will not address a common distinction of adaptive management in the analysis, but does identify that the literature on AM often describes two forms of AM: ‘passive AM’ and ‘active AM’ (Gregory et al. 2006). These two forms of AM are useful in providing further insight into how AM is different than trial-and-error approaches and helps clarify the complexity of programmatic adaptive management. Passive AM involves testing of a single hypothesis or model. Active AM requires testing multiple models or multiple hypotheses for the same result (Gregory et al. 2006). For example, if a restoration action involved the removal of a levee, a passive AM approach reduces uncertainty about how best to remove the levee, whereas an active AM approach reduces uncertainty about whether removing the levee is the right action given the overall goals of the restoration program. It is often not possible to test multiple hypotheses at the system-wide level because of budgetary, political, spatial and temporal reasons (RECOVER 2007d).

Therefore, the important distinction between passive and active adaptive management for programmatic AM is that at the program scale, adaptive management most resembles a passive form (Healey 2007).

Although the term ‘programmatic adaptive management’ has not been used, others have similarly examined the use of AM for large scale environmental management approaches such as the National Research Council (NRC) (2004) and Gregory et al. (2006). Programmatic adaptive management requires the explicit claim of using AM at the system-wide scale. Because a restoration program is composed of the collective set of restoration projects, programmatic AM integrates project-scale learning and system-wide goals to inform program-level decision-making. Figure 2 provides definitions of the different sub-types of adaptive management.

- (1) “**Adaptive Management**” is a rigorous approach for learning through experimental design and an iterative process (Murray 2003)
- (2) “**Passive Adaptive Management**” uses historical data and one design to test hypothesis (Gregory et al. 2006). Preferred when relative uncertainty is low or evaluating multiple designs is not feasible for technical, political or spatial reasons. (CERP 2007)
- (3) “**Active Adaptive Management**” reduces uncertainty by testing multiple, often competing hypotheses to achieve a desired response which is then field tested (Gregory et al. 2006). Active AM increases learning faster than passive AM (CERP 2007)
- (4) “**Programmatic Adaptive Management**” is the integration of project-scale learning with system-wide goals for program decisions (author’s definition).

Figure 2: Definitions of Sub-types of Adaptive Management.

Research Goals

In this study I sought to characterize the extent to which adaptive management is established programmatically in three large-scale restoration programs and to determine how AM processes are designed and implemented for ecosystem restoration. From the literature on AM I identified a list of criteria (see following section on Criteria) for evaluating the extent to which each program is implementing programmatic AM. I investigated each program for the existence of structures established specifically for programmatic AM, evaluated how each program is implementing adaptive management and identified how adaptive management is being used at the program level. From the results, I identified how each program established AM at the programmatic level and evaluated the extent to which each program executes a programmatic adaptive management approach to restoration. Finally, I identified common challenges, issues and experiences as a set of lessons learned for current and future programmatic adaptive management applications for restoration.

Program Selection & Case Study Criteria

I selected three large-scale ecosystem restoration programs to inform this study: the Central Everglades Restoration Plan (CERP), the California Bay-Delta Ecosystem Restoration Program (CALFED) and the Louisiana Coastal Area Study (LCA). All three case studies are explicit in their program documentation about their espoused commitment to using adaptive management at the program level. In a study by Van Cleve et al. (2006), CERP and CALFED scored a '3' and LCA scored a '1' on a scale of 0-3 for use of AM in the restoration program. The Van Cleve et al. study looked at the quality of science in these restoration programs as well as the effective use of science in these restoration programs, for which adaptive management was one criterion in the effective use of science inquiry. This study differs from Van Cleve *et al.*'s work by looking specifically at adaptive management and how it is designed for and used in system-wide restoration.

There exist some important similarities and differences among the cases regarding the context of each program. Each program exists within the jurisdiction of one state (Florida, Louisiana and California respectively) and includes both federal and state agencies as participants in their ecosystem restoration approach. CERP and LCA are led at the federal level by the United States Army Corps of Engineers (USACE) with a single co-sponsor state agency: the South Florida Water Management District (SFWMD) and Louisiana Department of Natural Resources (LDNR), respectively. CERP also has strong participation at the federal level from the US Fish and Wildlife Service (USFWS) and to a lesser extent the National Park Service (NPS) and at the state level from the Florida Department of Environmental Protection (FDEP). In addition to the USACE, LCA has strong participation at the federal level from the U.S. Geological Survey (USGS). CALFED is led at the state level by a coordinating agency that oversees the Ecosystem Restoration Program (ERP) between state and federal implementing agencies. The primary state implementing agency for CALFED's Ecosystem Restoration Program is the California Department of Fish and Game (CDFG). CALFED has two primary federal implementing agencies: the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS).

All of these programs share similar attributes in their ecosystem restoration plans. The ecosystems cover regional-scales with implementation planning horizons to occur over several decades. Each ecosystem includes fresh water and salt water habitats and includes a wide range of participants in addition to the primary federal and state sponsors. The differences in context of each case along with the similarities across all three cases allow for a comparison informing PAM.

I chose to research fewer cases in greater depth that are more similar in nature than to investigate more programs at a coarse level that are less similar collectively. I used four criteria for selecting programmatic adaptive management case studies: 1) restoration program is focused on restoring ecosystems rather than select species or habitats; 2) spatial scale is regional encompassing multiple counties or multiple states; 3) the program organization is complex and includes state and federal participation as well as a collection of projects designed to achieve larger system-wide goals; and 4) program documentation explicitly uses the term ‘adaptive management’ as part of the espoused programmatic approach to restoration.

Applying these criteria resulted in the omission of several cases that are often recognized with restoration and adaptive management, namely the Chesapeake Bay Program (CBP) and the Glen Canyon Adaptive Management Plan (GCAMP). The CBP is a long-standing, large scale restoration program that is based on an ecosystem-based management approach to restoration. However, the program does not explicitly use the term adaptive management and there is no formal implementation of AM (Boesch 2006). Conversely, Glen Canyon is an example of the explicit use of adaptive management for restoration but it is based on making changes from a single type of action at a single location. The Glen Canyon program lacks the complexity of multiple experiments in multiple places and thus would not be comparable to programs that employ AM across a suite of projects under a program umbrella. The intent to apply adaptive management across multiple projects arrayed across a broad landscape and defined in an integrative way is the hallmark of programmatic adaptive management.

Methodology

Multi-Case Study Design

Case study methodology is an appropriate research approach when investigating organizational and managerial processes. Unique to case study methodology is to understand that context is inherent to the study, and the case cannot be studied separate from its context (Yin 2003). Multi-case study methodology (see Appendix A) treats each restoration program as its own case that is comparable to the other cases. The power of a multi-case study comes from the identification of trends across cases with different contexts (Yin 2003).

A multiple-case study design is not the same as the more common scientific approach of testing multiple samples within the same experiment. Instead, each case is an experiment in its own right (Yin 2003). The ability to make comparisons across multiple case studies is dependent on the similarity in context among the cases. However, the results are not based on frequency and statistical significance. The result is an identification of trends across the case studies investigated with some predictive ability but there is no expectation on being able to calculate probability for future experiments (Yin 2003). The results are based on analytical and not scientific generalizations, and the generalizations are applied to theories and not populations (Yin 2003).

Successful case study design requires a triangulation of multiple forms of evidence that converges on the same analytical conclusions (Yin 2003). This study uses three forms of case study evidence to attempt convergence of the analytical results: documents and academic literature, case study artifacts, and interviews with senior scientists and senior managers at each of the three large restoration programs.

Primary Research Questions

There are three questions I set out to answer. First, how is adaptive management established programmatically? Second, how is adaptive management being implemented at the program level? Third, how is adaptive management being used at the program level? My method for identifying how programs are institutionalizing adaptive management is to construct a list of criteria that evaluates several components of programmatic adaptive management. I generated the following list of PAM criteria through two primary sources: a National Research Council report on Adaptive Management of Water Resource Project Planning (2004) and a paper by Gregory et al. (2006) on deconstructing adaptive management.

I created a list of seven criteria to identify each program's approach and use of AM programmatically. The first criterion addresses my own device of identifying formal institutional structures developed specifically for programmatic AM (formal institutionalization). The other six criteria come from the literature on AM. The NRC (2004) summarizes several criteria for AM identified through theory and practice. I evaluated the existence and level of use of the following four elements derived from the NRC study: system-wide models, system-wide monitoring, stakeholder collaboration, and interagency cooperation. Gregory et al. (2006) identified 4 categories of criteria developed for evaluating AM at four different scales. Some of these criteria are similar to the criteria I selected from the NRC and other criteria are not feasible at the system-wide level as identified by Gregory et al. As a result I evaluated the degree of presence or absence of two of Gregory's criteria: leadership commitment and institutional capacity. Collectively, these seven attributes represent a broad picture of how AM is being realized across three restoration programs.

Programmatic Adaptive Management Criteria:

1. **Formal Institutionalization:** The creation of specific institutional structures for AM is assumed to be necessary for executing an AM process programmatically. This criterion focuses on the formalization and accountability of structures specific to executing AM at the system-level. Formal structures may include, but are not limited to: funding commitment, developed programs, ad-hoc or permanent committees, workshops or meetings, website pages, or other artifacts dedicated to a programmatic AM process. These formal structures represent tangible evidence describing how AM is institutionalized programmatically. In addition to the establishment of these structures, this criterion also addresses whether or not the designed structures have been implemented.
2. **System-wide models:** System models can help identify responses to management actions and highlight the limitations of the current scientific understanding of the system being modeled (National Research Council 2004). Models do not need to be perfect and their limitations need to be understood by AM participants. This attribute is less about whether the models are rigorous quantitative models or simplified conceptual models, but rather the case that system-wide models exist and are being used in a PAM process.
3. **System-wide monitoring:** The gathering and evaluation of data is necessary to improve the knowledge of the system and allows for testing hypotheses. However, monitoring itself does not equate to adaptive management and monitoring programs should be designed to improve understanding of models, evaluate outcomes of management and should be an integral part of program design (National Research Council 2004).

4. **Collaborative structure for stakeholders:** Achieving meaningful stakeholder participation is challenging but necessary for successful applications of AM. Stakeholder involvement in AM needs to include active learning by the stakeholders as well as an understanding that stakeholders must possess willingness to compromise in order for effective implementation of AM (National Research Council 2004).
5. **Interagency Cooperation:** Improvements in the realm of interagency cooperation are necessary to move towards more comprehensive management regimes and effective adaptive management (National Research Council 2004). Information must be communicated so that all participants understand the AM process (National Research Council 2007) and the different priorities among participating agencies can be collectively resolved.
6. **Leadership Commitment to AM:** One perspective on AM is that all management actions are experiments in that implementation of actions will have uncertain consequences (Lee 1993, Gregory et al. 2006). For successful implementation of AM there needs to be strong leadership that recognizes reducing this uncertainty will lead to improved management strategies. This recognition is more important when the decisions involve a large and diverse body of decision-makers (Gregory et al. 2006).
7. **Institutional capacity:** AM plans are only as effective as the implementing institutions' competence and resources committed to understand the AM process as planned and too few individuals may have the training required for implementing a successful AM process (Gregory et al. 2006). For purposes of this study, institutional capacity

includes both technical competence and managerial dedication by implementing agencies

Methods of Data Collection

Document & Artifact Review

I first reviewed documents and collected artifacts related to each program's attention to AM at the program scale. The documents came in several formats such as management plans, implementation guides, annual reports, meeting notes and peer reviews. Each program operates an official website with summary information and provides some of each program's official documentation. Representatives of the programs I contacted also recommended and sent me unpublished documents in draft form and other material relevant to my investigation that were not generally available to the public.

Artifacts are one of six sources of evidence for triangulating case study findings (Yin 2003). My investigation used conceptual diagrams, flow charts and PowerPoint presentations as artifacts for evidence of programmatic AM. The PowerPoint files differ from the documents in their purpose and their format and can act as a proxy for a document or interview (discussed in the next section). Presentations were only considered artifacts if they came from program representatives and were available in the public domain (usually found on program websites). The PowerPoint files were evaluated as stand-alone evidence, so only verbatim text from the slides or slide notes were considered.

Interviews

Interviews provided the third form of evidence. I conducted elite (Dexter 1970), semi-structured (Kvale 1996) interviews (Appendix B). The intent of the interview process was to identify the experiences and opinions of program-

level scientists, engineers and managers who have first-hand experience with the programmatic adaptive management efforts of their respective programs. The interviews collected information unavailable in program document or artifacts. I conducted 26 interviews with twelve representatives from the CERP, and seven representatives from each of the LCA Study and CALFED. All interviews were conducted by telephone, one-on-one with the exception of one 2-person team interview in Louisiana. A summary of interviewees for each program by agency or program association is detailed in Figure 3. Each interview lasted between 60-120 minutes in length. The number of interviews was limited by the small pool of candidates that are qualified to speak to programmatic AM in each program. I identified interviewees by lead authors of adaptive management documents, members of science boards and science programs, members of adaptive management groups or committees, managers from implementing agencies, and others recommended by interviewees themselves. The interviewees are a proxy source of information for their program and therefore all communication is considered to come from the program and not from specific individuals.

- **CERP (12):** USACE (3), USFWS (3), NPS (2), SFWMD (1), FDEP (1), Consultants (2)
- **LCA (7):** USACE (2), USGS (2), LDNR (2), LCA Science Board (1)
- **CALFED (7):** CALFED Science Program (3), CALFED Science Board (2), CDFG (1), Consultant (1)

Figure 3: Summary of Program Interviews by Agencies & Association. (Total number of interviewees by group in parentheses)

Data Analysis

I developed a rating system for identifying the degree of presence for each criterion for each restoration program. The scale has three points of HIGH, MEDIUM and LOW. Generally, a rating of 'HIGH' translates into the

existence of the criterion and a strong link to the program's system-wide AM approach. A rating of 'MEDIUM' is assigned when the attribute exists but is not clearly linked to programmatic AM. Conversely, a rating of 'LOW' indicates either the overall absence of that attribute in the program or the criterion is missing in the case study's programmatic AM approach. Programs may also receive a rating of 'MEDIUM-HIGH' or 'MEDIUM-LOW' where evidence suggests the program's efforts do not fit neatly on this three-point scale. A summary of how this rating system applies to each criterion is detailed below:

Formal Institutionalization:

HIGH- Permanent program-level structures established and implemented for AM. This includes permanent programmatic elements such as standing committees and may include ad-hoc elements such as temporary workgroups and one-time workshops.

MEDIUM- Programmatic organization for AM may include designs for permanent structures and development of temporary or ad-hoc elements for PA but implementation is inconsistent or absent.

LOW- Formal program-level organizational structures for AM are absent

System-wide models:

HIGH- System-wide model(s) exists and is clearly used in the programmatic AM approach.

MEDIUM- System-wide models exist but are not clearly linked to the programmatic AM process.

LOW- System-wide conceptual models are absent.

System-wide monitoring:

HIGH- System-wide monitoring exists and monitoring is designed to provide results that are used to evaluate outcomes associated with the AM process.

MEDIUM- System-wide monitoring exists but is not designed and integrated with adaptive management approach or implemented according to design.

LOW- System-wide monitoring is absent or plans have not been implemented.

Collaborative structure for stakeholders:

HIGH- Collaborative process for stakeholders exists and is specifically designed in coordination with the program's PAM process.

MEDIUM- Coordination process for stakeholders exists, but the process is not a collaborative process specifically linked with programmatic AM.

LOW- Process for program-level stakeholder involvement is absent.

Interagency Cooperation:

HIGH- Structures identifying interagency agreements are formalized and evidence of commitment for interagency cooperation to achieve programmatic AM approach exists.

MEDIUM- Structure(s) for interagency cooperation exists, but lack dedicated resources or commitment to cooperate in order to achieve PAM approach.

LOW- Process or structures for interagency cooperation are absent.

Leadership Commitment to AM:

HIGH- Senior leadership promoting adaptive management is clearly evident at the program level.

MEDIUM- Leadership promoting AM exists, but leadership is not at the senior level of program or implementing agencies.

LOW- Leadership promoting AM is absent at all levels.

Institutional capacity:

HIGH- Technical competence of the AM process & managerial dedication for implementing AM exists at the senior level and sub-levels of the program.

MEDIUM- Technical competence and managerial dedication exist but competence and dedication is absent at the senior level.

LOW- Technical competence or managerial dedication are absent at the senior level and sub-levels of the program.

Certainty of Programmatic AM Attribute Scores:

In addition to scoring each restoration program on its ability to achieve each of the seven criteria, I also include a level of certainty to each score based on the convergence of the three types of evidence: program documents, interviews and AM artifacts. For each program and each element I assigned a level of confidence based on the degree to which the available forms of evidence identify each attribute and agree with each other on its presence. The inclusion of evaluating the certainty of the score for each criterion follows a similar approach by Drinker Briggs (2008). This measure includes three categories of certainty: a 'Strong' level of certainty that all the evidence is in agreement with my scoring; a 'Fair' level of certainty that the majority of evidence is in agreement with my scoring; and a 'Weak' level of certainty when evidence is scarce or contains strong disagreement.

Interpretation

For each criterion I evaluated the degree to which all available forms of evidence converged on the same conclusion. In some cases all three forms of evidence were not available, such as the absence of artifactual evidence or when interviewees were not comfortable commenting on some of my criteria. After analyzing each program on its own merits I then compared the rating scores for each criterion across the three programs to identify similarities and differences and developed explanations for these trends and anomalies. I also asked each interviewee for their recommendations on how to achieve programmatic adaptive management for other large-scale restoration programs. I identified the recommendations that were repeated by interview subjects

within each program and across each program and these are included in the Discussion section of this thesis.

Results

Comprehensive Everglades Restoration Plan Background

The Comprehensive Everglades Restoration Plan is an approved modification of the Central & South Florida (C&SF) Project authorized in the Water Resources and Development Act (WRDA) of 2000. The Central and South Florida Project was first authorized by Congress in 1948 to address flood control and water conservation. The USACE has been involved with the C&SF project from the start and worked with the Southern Florida Flood Control District the predecessor of the SFWMD. In 1992, the C&SF underwent a comprehensive review study authorized under the WRDA of 1992, known as the 'Restudy' as a response to declining ecological conditions in the Everglades (National Research Council 2004). The Restudy led to the formulation of CERP and the program was authorized in the WRDA of 2000. CERP covers a geographic area of 18,000 square miles that is home to six million residents. The Comprehensive Plan includes 68 major projects designed to achieve an overarching goal of restoring the Everglades and providing water for South Florida through 2050 at a cost of \$7.8 billion (Central and Southern Florida Project 2000, National Research Council 2004).

The CERP has thirteen programmatic components that including a Restoration Coordination and Verification (RECOVER) program area that is responsible for ensuring that a system-wide focus is maintained during implementation, science guides implementation of the plan, and planning and integration activities are developed to support the adaptive management program (RECOVER 2004a). The role of RECOVER is to organize technical information and to link the tools of science to system-wide planning, evaluation, and assessment tasks.

The terminology of adaptive management becomes enshrined in CERP starting in 2003 as evidenced in the 2003 CERP Vision Statement, bullet #6: “CERP implementation will include the application of a system-wide science strategy and adaptive management program” (Central and Southern Florida Project 2003, p.2). CERP’s programmatic regulations define adaptive management as “the continuous process of seeking a better understanding of the natural system and human environment... seeking continuous refinement in and improvements in the Plan to respond to new information” (2) (RECOVER 2006a, p. 2).

The National Research Council (2004, p.58) concluded that AM in the CERP is “more of a concept rather than a fully executed management strategy.” The National Research Council (2004) asserts that the Comprehensive Plan is “on the leading edge” (p. 59) of efforts by the USACE to apply AM for ecosystem restoration and that progress and shortcomings from the CERP’s efforts in AM provide “important lessons learned for adaptive ecosystem restoration” (p. 59). The first biennial review of CERP by the National Research Council in 2006 highlights significant progress in the development of the plan’s adaptive management strategy (National Research Council 2006).

CERP PAM Criteria Results:

The following summaries explain the general findings and contribute to the discussion section of this study. For additional explanation of results, including artifacts see Appendix C.

Formal Institutionalization – The document and artifact evidence for formal institutionalization for the CERP AM approach is extensive. The science body RECOVER is the organization assigned responsibility for developing and implementing the CERP AM Program. However, within RECOVER there is some confusion in the documents as to whether the RECOVER Leadership

Group of the Assessment Team is the primary entity for ensuring the use of AM in the program. In addition to RECOVER, CERP also executed two adaptive management workshops in 2003 to develop a robust AM strategy and developed an AM Steering Committee, which includes several past and present participants on RECOVER. CERP representative also participated in the 2006 Greater Everglades Ecosystem Restoration Conference which included program staff conducting a plenary session on AM as well as conducting a series of concurrent adaptive management workshops (see Appendix C).

CERP has produced several flow charts and diagrams detailing programmatic AM including an 'Adaptive Assessment Flow Chart' (Central and Southern Florida Project 2000), the CERP AM Process (RECOVER 2004b), and the CERP AM Strategy (RECOVER 2006a) (See Appendix C). Each of these flow charts is an evolution of the predecessor and increases in complexity with each generation. The Adaptive Assessment Flow Chart is a simple diagram that is more generic in nature and the various phases of AM such as implement, monitor, evaluate, and adjust are easy to identify. The most recent version of the flow chart, the CERP AM Strategy, is a very complex four-box diagram with each box unfolding into its own sub-process. The fundamental phases of AM are included within each of the four boxes, but are scattered about and the feedback loops and linkages between the four boxes move in multiple directions.

Documentation evidence of formal institutionalization of adaptive management within CERP includes both sections on AM embedded in larger documents as well as stand-alone documents. The primary documents that are partially dedicated to the institutionalization of programmatic AM are the CERP Master Program Management Plan (Central and Southern Florida Project 2000) and the Monitoring and Assessment Plan: Part 1 (RECOVER 2004b). There are two stand-alone documents that make-up the CERP AM Program: the

Comprehensive Everglades Restoration Plan Adaptive Management Strategy (2006), and the yet-to-be released Adaptive Management Implementation Guidance Manual (RECOVER 2006a). The CERP AM Strategy document is the document that includes the four-box strategy and refers to the AM Implementation Guidance Manual, originally scheduled to be released in spring 2006. The CERP also includes a page dedicated to AM on the program's website (See Appendix C).

Evidence from interviews regarding how AM is organized describe the organization of programmatic AM in CERP as “poorly organized,” and “organized anarchy.” Interviewees also revealed that those who participated in the development of the AM strategy document were selected in an ad-hoc manner by those “interested in AM” (CERP Interviews May 9 through June 5, 2008). No one person in a senior leadership role is exclusively focused on AM, it is just one of many responsibilities RECOVER participants must track; as one interviewee stated: “adaptive management is a job within a job.” Furthermore, interviewees pointed out that the 2006 AM Strategy document and AM Implementation Guidance Manual are being developed independent from the designs of the Comprehensive Plan's projects. Finally, one interviewee indicated that the RLG assigns tasks to the three teams and approves the work products of these three teams, but the RLG itself does not produce plans or documents. Rather, the RLG provides guidance and approval to the documents developed by the three teams. It is difficult to discern how the RLG can develop the AM program it has been entrusted with when it does not produce plans or documents products itself.

The presence of numerous flow charts and documents, the establishment of multiple workshops convened specifically for AM, and a program webpage dedicated to AM show a strong institutional commitment to AM. However, the interviewee responses indicating their dissatisfaction with the current

organization of AM is a concern and suggests the approach is more ad-hoc than permanent. Additionally, the confusion over which group or team is accountable for maintaining a programmatic AM approach is significant. As a result, CERP scores ‘MEDIUM-HIGH’ on this criterion. The level of certainty for this evaluation is rated as ‘Fair’ because the key literature that addresses how CERP plans to address AM at the system-wide level, the final draft of the AM Implementation Guidance Manual, has still not been released and an earlier draft version of the guidance manual provided to me by the program only includes a place holder for this detail (RECOVER 2007).

System-wide Models - “South Florida restoration activities are supported by an enormous modeling effort” (National Research Council 2007, p. 116). There are two primary system-wide models used in the CERP program: the South Florida Water Management Model (SFWMM) and the Natural Systems Model (NSM). The SFWMM is a “surface water-groundwater interaction model” and the NSM simulates the natural hydrology of South Florida prior to the building of canals, levees, dikes and pumps (RECOVER 2005). Documentary evidence of the CERP’s system-wide approach to modeling includes the ‘Report on Evaluation Tools, Models, Work Plans, and Budgets’ (RECOVER 2005) and ‘Documentation of the South Florida Water Management Module Version 5.5’ (South Florida Water Management District 2005).

Evidence of CERP’s commitment to system-wide modeling is further demonstrated with a dedicated webpage to system-wide modeling on the program’s website (See Appendix C). Responses from multiple interviewees regarded the importance of modeling as fundamental to CERP’s programmatic AM approach. One interviewee remarked “modeling is how we expect to identify (system-wide) responses... and (modeling) is a driver of decision-making at all levels” (CERP Interviews May 9 through June 5, 2008).

The linkage of these system-wide models to the programmatic AM exists conceptually. CERP's '4-box' AM strategy includes use of models, updated models and model refinement in Box 1 and Box 2 of the AM strategy. The extensive development of models to inform the Comprehensive Plan's restoration strategy, the large number of interviewee responses on the use of modeling to guide decision-making and the conceptual linkage of modeling in CERP's AM Strategy are well established. However, most models were not developed for CERP and there is a lack of necessary linkages between the models to support AM (National Research Council, 2007). The NRC (2007) concludes that the system-wide models are at a scale too coarse (2 X 2 mile grid cells) to be useful in projecting ecological responses.

The program scores 'MEDIUM' on this criterion for a strong commitment to modeling, but system-wide modeling in the CERP still lacks a strong linkage to programmatic AM. The certainty of this rating is 'Strong' as evidence from interviewees as well as the conclusion of the National Research Council (2007) are all in agreement that the linking of modeling to AM is limited to documents and is not currently evident in practice.

System-wide Monitoring - CERP's system-wide monitoring plan is known as the Monitoring and Assessment Plan, or MAP, and is "an essential element of AM... to analyze and understand responses of the system to the implementation of the plan" (RECOVER 2006a, p. 4). The purpose of the MAP is to "establish the framework for measuring and understanding system responses to the CERP" (RECOVER 2004b, p. 1-1) and includes a \$100 million budget for a 10-year collection of baseline data starting in 2000. The goal of this monitoring effort is to characterize the ecosystem and identify what will need to be monitored in the future to test for system-wide responses from projects (CERP Interviews, May 9 through June 5, 2008). To support the adaptive management program, the CERP monitoring plan is designed to: 1)

Measure the status of, and trends in, the selected performance measures; 2) Determine baseline (pre-project) variability for the measures' responses; 3) Address uncertainties through cause-and-effect research; and 4) Detect unexpected and unintended system responses (Central and Southern Florida Project 2003)

There are several program documents for system-wide monitoring for CERP but the two primary documents are the Monitoring and Assessment Plan Part 1 (RECOVER 2004b) and Monitoring and Assessment Plan Part 2 (RECOVER 2006b). The MAP Part 2 includes subsection 7.3 'Linkages to Adaptive Management' conceptually linking system-wide monitoring to Box 2 in the CERP AM Strategy four-box overview (see Appendix C).

Interviewees responded that the MAP addresses monitoring at the system-wide scale to attempt to detect change in the system as a response from CERP projects and differentiate these responses from natural variability. Interviewees also highlighted two considerations from their experiences with system-wide monitoring in CERP. First, much of the monitoring can't determine if changes are from CERP implementation or from natural variability. Second, CERP monitoring is not regulatory monitoring and it competes with existing regulatory monitoring among different agencies with the result that there is heightened sensitivity to avoid redundancies in monitoring. Finally, the ten year funding for MAP expires in 2010 and various interviewees stated that there is a big concern that funding beyond 2010 might not be in place and the current monitoring will be discontinued (CERP Interviews May 9 through June 5, 2008).

CERP gets a score of "MEDIUM-HIGH" for this criterion because the system-wide monitoring program is clearly in place and there are conceptual linkages to the programmatic AM approach. However, the design of the MAP is not

coupled with the programmatic AM process. The certainty of this evaluation is ‘Strong’ as all of the evidence is in agreement about the absence of a strong linkage between the MAP and programmatic AM strategy.

Stakeholder Collaboration - Intent to involve stakeholders in the CERP is prevalent throughout program documentation. Documents such as the ‘CERP Master Program Management Plan’ (Central and Southern Florida Project 2000), and the draft version of the MAP (RECOVER 2003), detail the importance of involving stakeholders in the plan (see Appendix C). The CERP AM Strategy (RECOVER 2006a) is the first program document to address how stakeholders and AM are linked. The CERP AM Strategy claims that stakeholder collaboration takes place in all four boxes of the AM four-box overview, but stakeholders will be most involved in the processes of boxes 3 and 4 of the AM framework. However, the key diagrams that include a detailed process of steps do not explicitly incorporate a role for stakeholders. There is no box that is identified as ‘stakeholders’ leaving the exact nature of their intended involvement unclear in the AM strategy (see Appendix C).

The draft version 1.2 of the AM Implementation Guidance Manual (RECOVER 2007d) provides greater detail on how stakeholders are involved in programmatic AM for CERP. This draft manual states that stakeholders must be actively engaged in decision-making at the program level to ensure success of the restoration programs and includes four forms of stakeholder involvement (see Appendix C). Although this thesis study is only concerned with AM at the program-level, the AM Implementation Guidance Manual outlines twelve steps of applying AM at the project level and Step 1 is ‘Stakeholder Engagement and Collaboration.’

The twelve interviewees expressed strong opinions on the program’s lack of success in effectively including stakeholders in programmatic AM. One

interviewee stated that CERP's "biggest failing" is inadequate attention to stakeholders. Interviewees collectively responded with generally similar themes. Many stated that during the re-study period from 1992-1999 stakeholders were very active and engaged in the planning process. It was easy for stakeholders to participate in a central planning process. In contrast, the public is not really involved currently and stakeholder participation is limited to federal and state agencies with a financial interest, some tribes and very few non-profits. This lack of more comprehensive stakeholder involvement stems from the cumbersome process of involving stakeholders across the system-wide set of projects. Both agencies and stakeholder groups lack resources to keep stakeholder engagement consistent across the vast geographic scale of CERP. Interviewees reflected that stakeholder engagement is limited also by adherence to the Federal Advisory Committee Act (FACA) process in which the strict formality of the FACA process prevents a truly collaborative process to engage stakeholders. Interviewees revealed three examples of how CERP developed strategy documentations and recommendations were erased under threat of lawsuit for not complying with FACA regulations. All of the interviewees who discussed the challenges of complying with FACA emphasized that this continues to be a major challenge in successfully working with stakeholders, implementing programmatic AM and moving forward with the overall Comprehensive Plan (CERP Interviews May 9 through June 5, 2008).

CERP scores a "MEDIUM-LOW" for this criterion. The program does have a process for stakeholders to participate and the program's AM strategy recognizes the importance of stakeholders in the AM process, but there is no collaboration and the level of coordination with stakeholders is minimal. The level of certainty for the criterion score is 'Strong' as there is an ample amount of evidence that is in agreement.

Interagency Cooperation - The CERP Master Program Management Plan (Central and Southern Florida Project 2000) document is the primary evidence detailing interagency cooperation in CERP. The management plan highlights the sharing of responsibility between the USACE and SFWMD for designing and constructing projects (see Appendix C). The Master Program Management Plan lists additional federal and state agencies needed to address specific regulations such as the Endangered Species Act and Clean Water Act, including: the U.S. Fish and Wildlife Service, the U.S. Environmental Protection Agency, and the Florida Department of Environmental Protection. In addition to the two lead implementing agencies, the RECOVER Leadership Group is an interagency team that is required to have representation from six federal agencies (US Army Corps of Engineers, US Fish and Wildlife Service, Environmental Protection Agency, U.S. Geological Survey, National Park Service, and National Oceanic and Atmospheric Administration), four state agencies (South Florida Water Management District, Florida Department of Environmental Protection, Florida Fish and Wildlife Conservation Commission, and the Florida Department of Agriculture and Consumer Services) and two tribes (Seminole and Miccosukee). However, program documentation does not include any attention to how these different agencies work together during implementation or how they cooperate within the day-to-day operations of RECOVER.

Interviewees made several cogent observations about interagency cooperation for programmatic AM in CERP. First, non-implementing agencies have different levels of involvement in CERP, and their respective agency commitments outside of CERP influence resources available for CERP. The external commitments and different levels of resources committed to CERP results in agencies having different priorities in how the CERP should proceed. The difference in priorities has often led to disagreements about what should come first and how scarce resources should be allocated, resulting in is “lots of

agency in-fighting [sic].” Further, AM has a lot of moving parts and each implementing agency has a different notion of what AM means. Another difficulty has been a lack of federal funding for six years which has caused a shift in the relationship between the USACE and SFWMD; “the holy marriage between the USACE and SFWMD is on verge of divorce everyday” and “[mid-level project managers at the two implementing agencies] rarely agree on anything.” Interviewees identified two reasons for the strained relationship: the USACE failed to deliver funding when the SFWMD expected it and the SFWMD went ahead with their own investments as they thought appropriate; and the priorities between the USACE and SFWMD are fundamentally different (the USACE wants restoration and the SFWMD wants flood protection and water supply). (CERP Interviews May 9 through June 5, 2008).

Interviewees indicated there is a lack of coordination within RECOVER between the Assessment Team, the Planning Team and the Evaluation Team. The current RECOVER organization chart only shows lines from the RLG to each team and there are no lines between the three teams which supports the interviewee responses that the three teams operate independently. Interviewees revealed that the Assessment Team and the Evaluation Team are scheduled to meet quarterly but the two teams have difficulty finalizing on an agenda for the joint meeting. (CERP Interviews May 9 through June 5, 2008).

CERP receives a criterion score of “LOW” because the implementing agencies’ relationship is not integrated to meet a common set of goals as indicated by numerous interviewees. Also, the documentation about interagency cooperation only briefly mentions the importance of the non-implementing agencies with no detail of how these agencies work with the implementing agencies outside their participation on the RLG. I did not find any evidence describing how interagency teams reach decisions or how the Comprehensive Plan resolves the competing objectives of different agencies. The lack of

coordination among the three RECOVER teams further demonstrates the program's challenge with achieving interagency cooperation. The certainty for this evaluation is 'weak' as the evidence informing this conclusion came primarily from interviews and program documentation included only a few, coarse details of addressing interagency cooperation. There might be interagency documents that detail interagency cooperation but I was unable to find them and my interview subjects did not mention that any existed.

Leadership Commitment – Documentation of how the AM process will be lead at the program level with the CERP is identified in the Master Program Management Plan (Central and Southern Florida Project 2000). Previously mentioned under the *Formal Institutionalization* criterion, the management plan indicates that the RECOVER program component of CERP is responsible for adaptive assessment. RECOVER's accountability for AM was also reinforced in the Comprehensive Everglades Restoration Plan Annual Report (Central and Southern Florida Project 2004). Within RECOVER, the Assessment Team is tasked with guiding the system-wide Adaptive Management Plan and the RLG is tasked with developing and implementing the AM program. The documents indicate that the responsibility for AM lies within RECOVER, although it is not clear how the RLG and the Assessment Team share this responsibility. Furthermore, the responsibility for guiding the AM plan falls on a group and there is no specific point-of-contact or dedicated position for AM within RECOVER or the CERP.

To further identify leadership for AM within RECOVER I collected four contact lists of participants on the RECOVER Leadership Group and Assessment Team over a 15-month period: May 2007 (RECOVER 2007b), December 2007 (RECOVER 2007c), February 2008 (RECOVER 2008a) and July 2008 (RECOVER 2008b) I identified considerable turnover in both the Assessment Team and the RLG as only two of four participants remained the

same on the Assessment Team, while the RLG maintained eight of twelve positions (see Appendix C).

Interviewee responses regarding leadership commitment included both the importance of leadership in successfully executing programmatic AM and the state of leadership in the CERP. Regarding the importance of leadership, one interviewee remarked that even with the necessary money, science and legislation, leadership is the most important element for adaptive management to be successful. This assertion was supported by several other comments of other interviewees such as: there is a need to “pin the (AM) rose on a credible, relevant group;” “senior leadership and management has to be the driving force (for programmatic AM);” and “top leadership within each implementing agency must be committed to the use of science for AM to be successful” (CERP Interviews May 9 through June 5, 2008).

Regarding the state of leadership for programmatic AM in CERP, interviewees indicated that leadership in the two lead agencies has seen tremendous turn-over with four different individuals holding leadership positions in a five-year span. Currently, there is no single point-of-contact for AM at the SFWMD. The AM program itself is “rudder-less” as the most respected AM Champion has retired and there is no one senior-level manager or scientist dedicated to AM. The leadership condition in CERP is further brought into question with the disagreement among interviewees on who should be the champion for programmatic AM. Some feel it lies with RECOVER, others feel it exists within the USACE and SFWMD, and one respondent believes the champion of AM in CERP is a contractor for the USACE. Finally, the group tasked with leadership according to management plans, RECOVER, thought they were going to have more influence than they currently have and feel the current level of influence is ineffective for successful advocacy of adaptive management (CERP Interviews May 9 through June 5, 2008).

CERP scores a “MEDIUM” for the Leadership Commitment criterion. There is clearly leadership within RECOVER and among private consultants working for the CERP, but this leadership no longer exists among senior-level managers and scientists following the retirement of two of the biggest advocates for AM. The certainty of this evaluation is ‘Weak’ because the majority of evidence informing this criterion came from a single source of evidence, interviews.

Institutional Capacity - The only form of evidence to inform the institutional capacity of the participating agencies in CERP’s AM program comes from interviews. Interviews revealed two themes for institutional capacity for programmatic AM: First, the processes of the USACE have hindered progress towards realizing AM. Second, the implementing agencies lack a scientific mission. Although this study does not evaluate the number of interview respondents who agree or disagree, it is noteworthy that nine out of twelve interview subjects explicitly mentioned the institutional process of the USACE as a primary challenge to achieving programmatic AM in the CERP. Interviewees stated several reasons for why the USACE hinders programmatic AM: the USACE culture is has a long institutional history based on engineering certainty and this culture is not easily adjusted to include the uncertainty associated with biological study; any forward thinking from local offices gets push back from traditional thinking of higher offices; the USACE process is not suitable for ecosystem restoration; and staff turn-over of engineers roughly every three years prevents long-term institutional commitment for programmatic AM (CERP Interviews May 9 through June 5, 2008).

Interviewees had collective comments about the absence of incentive and purpose among agencies involved in the CERP for implementing AM.

Comments included: science is beyond many agency missions, there is no advocacy for the use of science across agencies or within agencies and there is resistance to an AM approach in the SFWMD. Furthermore, interviewees felt that agencies will avoid using science if they expect the results will interfere with individual agency missions. One respondent asserted that the biggest challenge for achieving programmatic AM is at the level of middle management, where staff are evaluated on short-term results and thus will not be rewarded for learning that takes place in the future. Interviewees responded that agencies don't get a grade for how well they implement programmatic AM, it is not tied to professional advancement and there is no measurement for assessing the effectiveness of the AM approach (CERP Interviews May 9 through June 5, 2008).

CERP receives a criterion score of 'LOW' for institutional capacity from a consistent response from all interviewees that vertical buy-in within agencies for AM is not being promoted and the incentive system for implementing managers does not reward applications of science or effectiveness of contributing to a system-wide AM approach. Because this criterion is only informed by the twelve interviews, the certainty of the criterion score is 'Weak.'

Table 1 consolidates the criteria ratings for the CERP including the level of certainty and a brief summary explaining the rationale behind the score:

Table 1. CERP Criteria Scores for Programmatic Adaptive Management

Programmatic AM Criteria	Criteria Score	Level of Certainty	Explanation of Criteria Scoring
Formal Institutionalization	MEDIUM-HIGH	Fair	Substantial evidence of formal institutionalization, but interviewees dissatisfied with how AM is organized programmatically and lack of permanent staff dedicated to AM
System-wide models	MEDIUM	Strong	Significant evidence demonstrates the existence and use of modeling but lacks linkages to support programmatic AM
System-wide Monitoring	MEDIUM-HIGH	Strong	Very strong system-wide monitoring plan linked conceptually to PAM but not designed together
Stakeholder Collaboration	MEDIUM-LOW	Strong	Traditional stakeholder participation through FACA but not linked to AM and very little evidence of collaborating with stakeholders
Interagency Cooperation	LOW	Weak	CERP is fundamentally a cooperation between the USACE and SFWMD but many other agencies are required and no evidence of <i>how</i> agencies work together
Leadership Commitment	MEDIUM	Fair	Top advocates for PAM in CERP have retired and not replaced; existing level of support for AM exists within RECOVER but not clearly identifiable
Institutional Capacity	LOW	Weak	Consistent interview responses that the institutional processes of the USACE are an obstacle to PAM and similar sentiments exist for the SFWMD

Louisiana Coastal Area Study Background

The Louisiana Coastal Area Study (LCA) is the primary case study for this investigation but includes two related USACE programs: the Coastal Wetlands Protection Preservation and Restoration Act (CWPPRA) and the Louisiana Coastal Protection and Restoration (LACPR) program. LCA is selected as the primary case because it explicitly addresses programmatic AM in the study's design. Adaptive management is absent in CWPPRA, while LACPR is only in the planning stages for AM and the only document sources of information regarding this program are in draft form.

The three programs are separate but have strong overlaps and share resources. CWPPRA (1990) is the oldest of the three Louisiana restoration programs. Although CWPPRA has an extensive history of restoration in Southern Louisiana it is not a feasible stand-alone case study for programmatic AM. CWPPRA is compromised of mostly small projects pursued in a piecemeal approach that has proven inadequate in scale to have a positive impact on reducing loss of wetlands in Louisiana. Furthermore, the funding level for CWPPRA did not allow for the scale of projects experts felt were needed to reverse the loss of wetlands (National Research Council 2004). However, some of the planning for CWPPRA is consistent with the LCA Study and provides nearly twenty years of experience relevant to the LCA Study. The ability of the LCA Study to learn from CWPPRA specifically relates to the LCA Adaptive Environmental and Assessment and Management (AEAM) approach summarized accordingly: "The LCA (Study) has benefited from a review of lessons learned over the past several years in CWPPRA, and AEAM would be more effectively implemented due to those lessons learned" (Louisiana Coastal Area 2004c, p. MR 4-74). Documentation of the integration of CWPPRA and LCA is found in a presentation on the program's website. This presentation explains that the members of the CWPPRA task force double as members of the LCA Regional Working Group, Project Execution Team, and the Science

Coordination Team (<http://www.lca.gov/cwppra-TIcommittee-18feb05.pdf>). Similarly, several individual LACPR planned projects overlap with the LCA Study as detailed in the LACPR Draft Technical Report. Further the coverage area for the LCA and LACPR are nearly identical in spatial extent (U.S. Army Corps of Engineers 2008).

The goal of the LCA Study is to “reverse the current trend of degradation of the coastal ecosystem” (Louisiana Coastal Area 2004a). The coastal zone of Louisiana encompasses a region of approximately 20,000 square miles (<http://www.mvn.usace.army.mil/prj/lca/>) and is home to over 2.5 million residents (U.S. Army Corps of Engineers 2008). The original cost estimate of executing the LCA Study was \$14 billion (National Research Council 2005), but was reduced to \$2 billion in the final plan (<http://www.lca.gov/lcafactsheet15jan05tempv2.pdf>).

Adaptive management is included as principle #8 in the ten guiding principles for the LCA Study formulation: “The rehabilitation of the Louisiana coastal ecosystem will be an ongoing and evolving process. The selected plan should include an effective monitoring and evaluation process that reduces scientific uncertainty, assesses the success of the plan, and supports adaptive management of plan implementation” (Louisiana Coastal Area 2004a, p.MR 3-14). Additionally, the Science and Technology (S&T) program was developed as part of the LCA Study to “facilitate integration of science and technology into the decision making processes for Program Management” (Louisiana Coastal Area 2004). The LCA S&T Program has five primary elements: 1) Science Information Needs; 2) Data Acquisition and Monitoring; 3) Data and Information Management; 4) Modeling and Adaptive Management; and 5) Research (Louisiana Coastal Area 2004b). Note that terminology for the LCA study uses AEAM and AM interchangeably.

LCA PAM Criteria Results:

The following summaries explain the general findings and contribute to the discussion section of this study. For additional explanation of results, including artifacts see Appendix C. Note: Because of the overlap between CWPPRA, LCA and LACPR evidence from all three programs is considered as evidence under the LCA case study.

Formal Institutionalization - Evidence of attention to AM in documents for CWPPRA, LCA and LACPR exists primarily as sections of larger documents. CWPPRA prepared an AM Review Final Report (Raynie and Visser 2002), but it is a project-by-project evaluation and does not address programmatic AM as defined by this thesis. CWPPRA held a 2-day AM Workshop August 12-13, 2002 and the agenda items show the same project-by-project focus for AM (<http://www.lacoast.gov/news/press/2002-07-09.htm>). Documentary evidence of AM is strong in the LCA Ecosystem Restoration Study Main Report. The Main Report states that “the key to success is the implementation of AEAM principles into the program management” (Louisiana Coastal Area 2004a). The LCA Study also developed a Science and Technology (S&T) Program that includes AEAM as one of five primary elements of the S&T Program.

The appendix of the LCA Study final report details how the S&T Program will formally institutionalize AEAM and identifies the Program Manager as responsible for the overall AEAM program. Evidence from documents of formal institutionalization of AM also exists in The LACPR Draft Technical Report. The LACPR report lists nine implementation principles, one of which is Adaptive Management. The LACPR Draft Technical Report outlines a clear institutionalization of programmatic AM by proposing an Adaptive Management Program. The proposed AM Program includes an Adaptive Management Office as the center of the AM Program (U.S. Army Corps of Engineers 2008) (see Appendix C).

Artifacts for the formal institutionalization of AM were found in the LCA Study Final Report and in the LACPR Draft Report. The LCA Study includes two flow charts detailing the organizational roles in the AEAM process and the S&T Program approach that uses AEAM for restoration planning. The LACPR Draft Report includes one flow chart proposing a management strategy based on an AM Framework that details the aforementioned Adaptive Management Program (see Appendix C).

Evidence collected from interviewees regarding the formal institutionalization of programmatic AM indicated that implementation of a formalized structure for LCA has yet to occur at the program level. There are two primary reasons for this inactivity. First, the first five projects for LCA were funded on individual annual authorities and the program is waiting for long-term appropriations through a WRDA authority. Second, the Hurricane Katrina event caused a major shift in priorities that led to the state reorganizing its agency structure, something which as yet has not been finalized. This reorganization has put hurricane protection as a priority no less than important than coastal restoration. Furthermore, this reprioritization has in essence created a marriage between coastal restoration and hurricane protection. One interviewee remarked that restoration is not in a “holding pattern,” but rather a “transition period” waiting for the reorganization to be complete. There is a reluctance to build the “nuts and bolts” of an AM approach with a framework that will be invalid once the reorganization is complete (LCA Interviews May 16 through July 11, 2008).

The LCA Study receives a score of ‘MEDIUM’ for formal institutionalization and would receive a lower score were it not for the LACPR proposed AM program and AM office (yet to be implemented). The conceptualization of AM is strong in the LCA documents with the inclusion of AM as one of five core

elements of the Science and Technology Program but the lack of progress towards formalizing pieces of the AM process is a major limitation. There are suggestions in both the LCA Study and the LACPR Draft Technical Report of permanent organizational structures for AM, but the current state of transition has prevented development. The level of certainty for this criterion score is ‘Fair’ because of the consistency among interviews and documentation, but there remains significant questions about how AM will be organized once the state reorganization is complete.

System-wide Models - Documentary evidence for the importance of models in the LCA program exist in the appendices of the 2004 LCA Main Report, which details “increase understanding using models” (p. A-13) as a primary goal within the AEAM framework proposed by the LCA Study. The S&T Program is tasked with developing spatially explicit models to evaluate management alternatives across the landscape (Louisiana Coastal Area 2004b). Evidence of the development and planned use of The Coastal Louisiana Ecosystem and Restoration (CLEAR) model to support decision-making in the LCA Study is found in an appendix titled ‘Hydrodynamic and Ecological Modeling’ which states “modeling also can be used in adaptive management to modify or adjust restoration programs or actions, and to provide analysis and guidelines as to the efficiency of different rehabilitation strategies” (Louisiana Coastal Area, 2004c, p. C-250). Two artifacts exist for the use of models: one details a conceptual map of how CLEAR works and the other identifies how system-wide modeling is linked to programmatic AM (see Appendix C).

Interview responses indicated an emphasis on modeling to improve understanding for the LCA Study at the program level and reliance on conceptual models in the LCA Study to consolidate understanding at the system-level. Responses stressed the importance of using a triple linkage of monitoring, modeling and research to develop a strong adaptive management

program. However, given the lack of a permanent director in the S&T office, interim staff were reluctant to establish a formal structure for modeling out of a concern of constraining the incoming director. Finally, one interviewee clarified that CLEAR is not a specific programmatic component for AM. Rather it was designed separate of the AEAM approach and then linked conceptually. (LCA Interviews May 16 through July 11, 2008)

LCA receives a score of “MEDIUM-HIGH” for the system-wide modeling criterion. The conceptual linkage of the system-wide model with AM exists and interview responses are consistent regarding how important modeling is in the formulation of the LCA Study Final Report (2004). However, interviewees also clarified that an explicit use of modeling in the programmatic AM approach is absent. The level of certainty of this score is ‘Fair’ as the evidence collected is consistent, but limited in quantity.

System-wide Monitoring – Documentary evidence for system-wide monitoring exists in Appendix A of the LCA Study Final Report. Appendix A states: “monitoring programs are critical to AEAM” (Louisiana Coastal Area 2004b). The LCA AEAM effort is relying on CWPPRA’s existing Coastwide Reference Monitoring System (CRMS) (Louisiana Coastal Area 2004b) (see Appendix C). However, this system-wide monitoring plan is not designed as part of the AEAM approach. Interviewees revealed that the majority of monitoring for programmatic AM in Louisiana is using what is already in place and that the monitoring is not designed around a programmatic AM process. Furthermore, the existing CRMS is limited to project-level monitoring and fails to address programmatic uncertainties (LCA Interviews May 16 through July 11, 2008).

LCA receives a score of ‘MEDIUM’ for the presence of system-wide monitoring that was pre-existing from CWPPRA and the conceptual linkage of

monitoring to the AEAM approach. However, the system-wide monitoring is not designed in conjunction with the AEAM approach. The certainty for this score is ‘Strong’ as the documents and interviews are in agreement.

Stakeholder Collaboration - Documentation of stakeholder involvement in the LCA Study includes Section 5 of the LCA Study Final Report ‘Public Involvement’ (see Appendix C). The LCA Study included public participation meetings, public scoping meetings and stakeholder meetings. Section 5.3 of the LCA Main Report identifies the need for continued public involvement as integral to implementation, monitoring and evaluation, but does not specifically link stakeholder involvement to the AEAM process (Louisiana Coastal Area 2004a). The National Research Council (2006) reached a similar conclusion: “stakeholder participation is missing from the AEAM process, and meaningful stakeholder involvement seems to be absent in the overall implementation of the LCA Study.”

The LACPR Draft Technical Report (U.S. Army Corps of Engineers 2008) states: “stakeholder engagement and the use of a collaborative approach to problem solving are critical components to ensure the success of LACPR.” The report includes a list of nearly 300 stakeholders contacted in the preparation of the report, such as banks, churches, colleges, tribes, non-profits, local governments, farm bureaus and parishes. The USACE held 68 events for stakeholders between June 1, 2006 and September 28, 2007 as part of formulating the LACPR Report (U.S. Army Corps of Engineers, 2008). Language in the LACPR report also proposes a strong link between stakeholders and programmatic AM (see Appendix C).

Interview responses regarding stakeholder involvement reinforced the impression of early involvement of stakeholders in plan formulation. However,

interview respondents had conflicting opinions on the use of AM for stakeholders: a scientist felt AM should not be used as a collaborative tool to engage stakeholders compared to a manager who is trying to apply AM especially for stakeholder collaboration. (LCA Interviews May 16 through July 11, 2008)

LCA scores “MEDIUM” for this criterion because of the strong attention to stakeholders under LACPR and the conceptual linking of a collaborative stakeholder process to AM. However, stakeholders are missing from the LCA AEAM process. Furthermore, the disagreement among interviews on the appropriateness of using AM for stakeholder involvement is reason to question if AM and stakeholders will be well connected as implementation begins. The large amount of documentation of stakeholder involvement in the planning documents results in a ‘Strong’ certainty for the scoring of this criterion.

Interagency Cooperation - The LCA Final Report documents the need for cooperation among the different participants: “Modeling and AEAM requires broad interactions among scientists, Program Management, and the Program Execution Team” (Louisiana Coastal Area 2004). Each team includes multi-agency staff from different disciplines designed to work together to implement programmatic AM (see Appendix C).

The LCA plan also indicates a point of disagreement between the current USACE regulations over budgeting for monitoring and adaptive management. The state of Louisiana feels the USACE budget limits for monitoring and adaptive management, 1% and 3% of total budgets, respectively, are insufficient and will limit the program’s ability to improve the restoration program if applied to monitoring and adaptive management of the LCA Program. The state requests that these limitations not be applied to the

implementation of the LCA Program because they believe greater funding will be necessary for accomplishing AM (Louisiana Coastal Area 2004a).

LACPR documentation explicitly addressed interagency communication as part of the AM process and developed a flow chart of the traditional communication channels to demonstrate the challenge of interagency communication and cooperation (U.S. Army Corps of Engineers 2008) (see Appendix C). Additionally, the LACPR has nine implementation principles of which one is “utilize interdisciplinary and interagency teams.” This principle is founded on the recognition that a multi-agency approach is “essential to facilitate the flow of needed information among agencies” (U.S. Army Corps of Engineers 2008).

Interview responses regarding the LACPR approach to AM stated that the “essence” of programmatic AM is communication. However, interviewees revealed a lack of communication and coordination between the National Park Service and the restoration program. The NPS is a large land-owner in Louisiana and is concerned about what happens to their land under a restoration plan. The NPS opposes non-natural restoration because it wants the land to be managed in as natural a state as possible, which calls for not protecting against natural events such as hurricanes. An additional concern raised from an interviewee regarding coordination centered on how two state agencies (Department of Transportation and Department of Natural Resources) have never worked together but will be forced to coordinate for combining ecosystem restoration with hurricane protection (LCA Interviews May 16 through July 11, 2008).

The LCA Study receives a score of “MEDIUM” for this criterion. There is documentation that identifies and conceptualizes the importance of interagency cooperation but it focuses on using interagency teams without detailing any

process of how the interests of different agencies will be addressed. The only linkage of interagency communication with AM comes from the LACPR draft plan. The certainty for this criterion score is 'Fair' because only a small number of documents and interviewees provided information and the lack of implementation prevents any examples of how well the different agencies will cooperate in actuality.

Leadership Commitment - The only documentation of leadership for the AEAM process assigns the LCA Science & Technology Program with the responsibility of developing the AEAM plan in the LCA Final Report (Louisiana Coastal Area 2004a). The LACPR proposes an AM Office as part of the AM program but it is not clear who would staff such an office. Interview responses indicate that leadership of AM in LCA is not clear, and it is easier to identify in LACPR. Part of the problem is attributed to the day-to-day changes in the transitioning governance of LCA and it is difficult to know who is in charge. Various interviewees indicated that the absence of a permanent director for the LCA Science and Technology Program for nearly two years created a paralysis in developing programmatic AM processes for the LCA Study. The interim directors did not want to set formal structures for adaptive management out of a concern that the incoming official director could see this as a constraint (the new director for the S&T Program declined an interview based on a lack of familiarity with 'adaptive management'). Multiple interviewees indicated that managers from the USACE are the most likely candidates to fill this leadership role, but the commitment to AM from these individuals is inconsistent (LCA Interviews May 16 through July 11, 2008).

LCA scores a "LOW" for leadership commitment as no documents or interviewees could name any individual that successfully advocates for AM. Additionally, the two year absence of an official director for the S&T Program combined with the large level of inactivity as a direct result demonstrates that

leadership has been absent in the LCA Study. The certainty for this criterion score is “Fair” because although there is evidence that the S&T program lacked official leadership, the amount of available evidence to inform this assessment comes from a small pool of information.

Institutional Capacity - Interviews provided all of the evidence informing this criterion. Various respondents expressed their opinion that the USACE is not capable of AM at this time because the planning horizon takes considerable time. The ten year planning process is long and requires significant financial investment that is not easily changed through a shorter adaptive management process once implementation has started. Further, it requires a long time period to get funding in place, and there is a reluctance to change budgets that took several years to finalize. One response regarding AEAM stated: “if the USACE is involved with programmatic AM it probably will not work” (LCA Interviews May 16 through July 11, 2008). The USACE in New Orleans and Mississippi Valley division have an enormous task to build levees and their attitude is oriented toward the certainty of engineering rather than the uncertainty associated with experimental management (LCA Interviews May 16 through July 11, 2008).

Interviewee responses regarding LACPR stated that the use of AM goes beyond ecosystem restoration, focusing on how AM can be used for areas such as hurricane protection, socioeconomics and human dimensions. However, there is no indication that the expertise to address these areas is in place. Interviewees revealed that the institutional resistance in Louisiana lies in two main areas: first, a common response is that “we are already doing it”; and second, individuals have had “bad experiences with AM” and do not wish to repeat those experiences. Others feel that “AM is a luxury” that Louisiana doesn’t have time for. In LA, there is a sense of urgency post-Katrina, and the state cannot afford to wait ten years before implementing a plan. Because of

the immediate flood peril problems, policies are not receptive to AM at the state level and the total buy-in that is needed for AM is missing (LCA Interviews May 16 through July 11, 2008).

LCA receives a score of “LOW” on this criterion because the interview evidence showed a high level of doubt regarding the USACE’s ability to implement programmatic AM, and indicated that the level of buy-in needed at the state level has not been achieved. The certainty of this evaluation is “Weak” because although there was strong consistency among respondents, there was limited evidence available to inform this assessment.

Table 2 consolidates the criteria ratings for LCA including the level of certainty and a brief summary explaining the rationale behind the score:

Table 2. LCA Criteria Scores for Programmatic Adaptive Management

Programmatic AM Criteria	Criteria Score	Level of Certainty	Explanation of Criteria Scoring
Formal Institutionalization	MEDIUM	Fair	AEAM is fundamental to the S&T program, and proposed AM Program in LACPR is strong. However, formalization of AM components was on hold for ~2 years and reorganization at state level could change everything
System-wide models	MEDIUM-HIGH	Fair	CLEAR System-wide model designed for restoration and conceptually linked to PAM
System-wide Monitoring	MEDIUM	Strong	System-wide monitoring is robust but not designed to address key uncertainties necessary for PAM
Stakeholder Collaboration	MEDIUM	Strong	Stakeholder participation includes collaborative process but not directly linked to AEAM process. Disagreement regarding appropriateness of AM for stakeholder involvement
Interagency Cooperation	MEDIUM	Fair	Attention to interagency cooperation is strong in documents, especially in LACPR, but not explicit to AEAM approach
Leadership Commitment	LOW	Fair	Leadership for AEAM in LCA is not clear and the S&T Program did not have an official director for nearly two years.
Institutional Capacity	LOW	Weak	Consistent interview responses that the institutional processes of the USACE are an obstacle to PAM and buy-in at the state level is not sufficient to support AEAM.

CALFED Bay-Delta Program Background

The CALFED Bay-Delta Program is defined as a 30-year plan to address ecosystem health and water supply reliability problems in the San Francisco Bay-Delta region. There are four interrelated resource management objectives for achieving program goals: water supply reliability, water quality, levee system integrity and ecosystem restoration (CALFED Bay-Delta Program 2000a). For purposes of this investigation the Ecosystem Restoration Program (ERP) is the primary program of interest. The CALFED Record of Decision (ROD) describes the need for a “single coherent vision” for ecosystem restoration and that “adaptive management will be vital in guiding efforts to improve ecosystem quality” (CALFED Bay-Delta Program 2000a, p.12).

The ERP includes over 600 programmatic actions to achieve program objectives using a science-based adaptive management approach. The adaptive management approach is described as a stepwise process and is based on a single blueprint approach to restoration. The adaptive management approach that is designed to guide long-term implementation of the ERP is described in the Ecosystem Restoration Program Plan Strategic Plan for Ecosystem Restoration (CALFED Bay-Delta Program 2000d). The CALFED Record of Decision includes an attached ‘Implementation Memorandum of Understanding (MOU)’ that further identifies the inclusion of AM in the CALFED program. The Implementation MOU outlines eleven implementation principles; ‘Science-Based Adaptive Management Approach’ is Principle 10 (CALFED Bay-Delta Program 2000c).

CALFED Bay-Delta Program PAM Criteria Results:

The following summaries explain the general findings and contribute to the discussion section of this study. For additional explanation of results, including artifacts see Appendix C.

Formal Institutionalization - Documentation of the formal institutionalization of programmatic AM is evident in several documents starting with the Programmatic Record of Decision. The ROD defines adaptive management as an “overarching principle” of the Science Program (CALFED Bay-Delta Program 2000a). The CALFED Memorandum of Understanding includes AM as one of the implementation principles. The Multi-Species Conservation Strategy has a one page chapter (chapter 8) summarizing how important AM is to the CALFED program and states how AM can be used to comply with endangered species laws at the state and federal level (CALFED Bay-Delta Program 2000b). The final documentation of AM is Volume 3 of the Ecosystem Restoration Program Strategic Plan which dedicates Chapter 3 to the adaptive management process (CALFED Bay-Delta Program 2000d) (see Appendix C).

CALFED also hosted an Adaptive Management Symposium on July 10-11, 2001 (see Appendix C). The workshop’s goal was to both help move CALFED’s programmatic approach more towards an AM approach as well as to share practitioners’ experience with implementing adaptive management for large regional ecosystem restoration and implementation.

The most significant evidence uncovered of formal organizational structure specifically for AM is the Adaptive Management Planning Team (AMPT). The AMPT is not an ERP programmatic team; rather it was designed for a smaller component of the ERP, the Delta Regional Ecosystem Restoration Plan (DRERIP). The DRERIP is the first implementation plan under the Ecosystem Restoration Program (CALFED Bay-Delta Program, 2004). However, the only evidence of a written document for the DRERIP and the associated use of AM is a draft table of contents. Further, I was unable to find any evidence detailing membership or participation of the AMPT.

Interview evidence confirmed that AM is not organized across all the CALFED programs, only within the ERP. Interviewees remarked that there is a lack of organization and it is not clear if or how learning is being used. One interview indicated that an AM document was developed addressing AM across three scales but this document was never released. Regarding the AMPT, interviewees stated that the AMPT has not produced any products and there is no way to tell if the approach taken by the AMPT resembles adaptive management or trial-and-error (CALFED Bay-Delta Program Interviews May 12 through June 11, 2008).

CALFED scores “LOW” on this criterion as the evidence demonstrates little formal institutionalization of AM at any level outside of the original programmatic documents. The AMPT is the primary evidence of formal institutionalization but it is not at the ERP program level. Moreover, the committee, although formed on paper, appears to be an inactive group and current membership may not exist. The certainty for this score is “Strong” based on the consistency between the lack of evidence I found and the feedback from interviewees.

System-wide Models – Evidence from documents for the use of system-wide models in CALFED is absent, but there is evidence of developing sub-system conceptual models. The ERP Implementation Strategy Step 3, ‘Prepare Conceptual Models’ states that: “in adaptive management, the most important uses of conceptual models are for: linking human activities to valued outcomes, highlighting key uncertainties where research or adaptive probing might be necessary, and identifying monitoring needs” (CALFED Bay-Delta Program 2000e, p. 6). The ERP Strategic Plan asserts that conceptual models can provide the basis for quantitative modeling and that exploratory simulation modeling can provide preliminary predictions of the consequences of different management actions (CALFED Bay-Delta Program 2000d). The use of

conceptual models is identified in CALFED's AM diagram, but there is no indication of whether the scale of the conceptual models is system-wide, how conceptual models link together or evidence supporting the existence of a conceptual model of the Bay-Delta Ecosystem. Rather, it appears there is only an interest in having models as part of the program's adaptive management approach.

Interviews indicated that program staff struggled to connect habitat and species subsystem conceptual models and as a result never got to the development of a system-wide model. Underlying this struggle has been the inability of the implementing agencies to determine how to link species recovery models within a system recovery model. There is also a debate about the feasibility of being able to effectively model at the system level. One interviewee revealed a substantial internal debate among CALFED participants about modeling at the system-wide level with many who doubt this is possible (CALFED Bay-Delta Program Interviews May 12 through June 11, 2008).

CALFED receives a score of "LOW" for this criterion because modeling is not addressed at the system-wide level and only conceptually linked to the program's AM process. The certainty for this score is 'Strong' based on the consistency between the lack of evidence of modeling and the agreement from the interviews that modeling is not occurring.

System-wide Monitoring - Evidence from documents for the importance of monitoring is ubiquitous throughout program literature. The ERP Strategic Plan refers to the proposed Comprehensive Monitoring and Assessment Research Program (CMARP) (CALFED Bay-Delta Program 2000d). CMARP is designed to build upon a pre-existing Interagency Ecological Program to provide information on all of the CALFED programs. CMARP's objective for AM is to "ensure that results from the monitoring are... incorporated as

feedback to facilitate adaptive management” (CALFED Bay-Delta Program 2000e, p.8). CMARP is proposed to address the monitoring needs of CALFED’s programs and related agency programs and falls under the CALFED Non-native Invasive Species (NIS) Program to coordinate all pertinent CMARP activities (CALFED Bay-Delta Program 2000d). However, there has been no documentation of system-wide monitoring post 1999. One other document, a draft report titled ‘Framework for indicators for science, management and adaptive management in the CALFED Bay-Delta Program,’ asserts that indicators can be used to facilitate adaptive management and link science, management and adaptive management (CALFED Bay-Delta Program 2006) (see Appendix C).

Various CALFED interviews confirmed both the absence of comprehensive monitoring and that existing monitoring is not directly related to the ERP. Interview subjects confirmed that there is no centralized comprehensive programmatic monitoring for CALFED although there are several non-integrated project-level monitoring efforts. Furthermore, monitoring for program assessment is not a priority and the non-integrated monitoring efforts emphasize status and trends monitoring with no effectiveness monitoring. Interviewees stated that the current monitoring only measures status and trends and thus far the greatest value of this effort has been in demonstrating that existing monitoring is insufficient to measure restoration effectiveness. One interviewee remarked that “monitoring is the greatest failing in CALFED.” This failing is in part due to funding monitoring one year at a time. The program was not able to develop a sustained monitoring approach that could be depended on year after year. This is problematic because it is not possible to monitor system-wide ecological response in one year’s time. Interviewees acknowledged that data from monitoring were collected but they are not sure what happened with these data. Furthermore, there is a high sensitivity to duplicating existing monitoring efforts. CALFED officials also found it

challenging to justify incremental monitoring above current agency efforts (CALFED Bay-Delta Program Interviews May 12 through June 11, 2008).

CALFED scores a “LOW” on system-wide monitoring because there is no programmatic monitoring for the ERP or CALFED program and integrating existing monitoring has also proven unsuccessful. The certainty of this score is “Strong” from the consistency in responses from interviewees and absence of any evidence that documents a system-wide monitoring effort.

Stakeholder Collaboration – Evidence from documents for stakeholder involvement falls under two implementation commitments in the ROD: ‘stakeholder consultation’ and ‘environmental justice.’ The stakeholder consultation is stated to continuously incorporate diverse stakeholder perspectives. The goal of the environmental justice commitment calls for CALFED agencies to collaborate with community stakeholders to develop a comprehensive environmental justice plan. Under the ROD planned operation of the Science Program, the program is tasked with conducting itself in a “collaborative manner to allow and encourage involvement of stakeholder(s)” (CALFED Bay-Delta Program 2000a).

The ERP Strategic Plan includes stakeholders in the ERP Focus Group, a joint agency/stakeholder forum convened in 1999 to assist CALFED in addressing policy issues associated with the ERP and future implementation (CALFED Bay-Delta Program 2000d). Consideration for stakeholders is included under one of the CALFED Solution Principles- ‘Be Affordable’ which suggests that program solutions are able to be implemented within the resources of stakeholders. The ERP Focus Group created five consensus principles with the third principle, ‘Setting Priorities,’ to be accomplished using a collaborative process involving stakeholders (CALFED Bay-Delta Program 2000d).

Evidence from interviews regarding the role of stakeholders in CALFED indicated that the biggest role for stakeholders is in goal setting and providing input in the restoration project proposal process. Various interview responses indicated concerns with the stakeholder involvement. Many interview subjects opined that CALFED has incorporated stakeholders with a “nauseating” amount of meetings to the point of slowing things down. Interviewees pointed out that stakeholders are mostly technical, and only a few opportunities for the general public to participate exist. Another concern is that the CALFED stakeholder process is planned on a month-by-month basis making it difficult for consistent stakeholder participation because there is little advance notification and an inconsistent schedule (CALFED Bay-Delta Program Interviews May 12 through June 11, 2008).

CALFED receives a criterion score of “MEDIUM” for stakeholder collaboration. Stakeholder involvement is not linked conceptually or otherwise to the AM process in CALFED, but overall stakeholder involvement is emphasized as collaborative. The certainty of this score is ‘Fair’ because the evidence available to inform this assessment is minimal and not all interviewees were able to comment on stakeholder participation in CALFED.

Interagency Cooperation - Evidence from documents of agency coordination exists in the 2000 CALFED ROD. ‘CALFED Agency Coordination’ is one of the implementation principles outlined in the ROD which asserts that CALFED is an “important precedent in coordinated and cooperative State and Federal agency relationships” (CALFED Bay-Delta Program 2000a). The ROD identifies the importance of including agencies that are not part of the CALFED governance structure, focusing on identifying conflicts as soon as possible, and “establish[ing] contractual relationships with non-CALFED Agencies to implement certain CALFED programs” (CALFED Bay-Delta Program 2000a, p.34). Implementation of the ERP is designed to occur through

an interagency advisory council but the only interagency team I found in the ERP Strategic Plan focuses specifically on non-native invasive species (CALFED Bay-Delta Program 2000d).

Booher and Innes (2006) prepared a report describing adaptive management and collaborative governance in CALFED titled ‘Complexity and Adaptive Policy Systems: CALFED as an Emergent Form of Governance for Sustainable Management of Contested Resources.’ This report specifically addresses how CALFED uses a collaborative effort of 25 agencies which has led to “adaptation of system operations and created innovative practices” (p. 1) (see Appendix C).

Interview results regarding interagency cooperation for AM indicate a tension between scientists and managers exists where scientists are regarded as “egg-heads” by non-biologists. Interviewees stated a difference among agencies to their receptiveness of science: CDFG staff appeared to enjoy interaction with scientists, but water managers did not want to use science if the anticipated results could interfere with current water management practices. Similarly, responses indicated that the NMFS appreciates AM but won’t allow “take” permits under the Endangered Species Act that allows for experiments with water releases. Moreover, the conflict between prioritizing management actions that favor fish or management actions that favor water supply is not only unresolved but becoming increasingly contentious. Furthermore, due to the competitive nature of allocating project funding, agencies compete for funding. One interviewee remarked that one agency proposal will claim certainty in their approach while another agency claims a need for research in their proposal and the funding decision usually favors the agency that claims certainty. Interviews also revealed the lack of process to find a common ground between supporters of restoration and supporters of endangered species whose interests sometimes compete. It was also mentioned that expected

federal funding has not come through preventing implementation of some planned restoration actions (CALFED Bay-Delta Program Interviews May 12 through June 11, 2008).

CALFED receives a score of “MEDIUM” for this criterion. The basic premise for governance at CALFED is based on interagency cooperation, however this process is not linked with the AM approach and interview responses indicate the level of cooperation among agencies needs much improvement. The certainty for this score is “Fair” because the interviews I was able to conduct only included representation from CDFG and did not include the two primary federal agencies for the ERP, the USFW and the NMFS.

Leadership Commitment - Documentation evidence of leadership for adaptive management is vague. The Implementation Memorandum of Understanding asserts that “adaptive management will be conducted within the programs” (CALFED Bay-Delta Program 2000c, p.35). CALFED’s Lead Scientist is assigned the responsibility to collaborate with the agencies to develop an adaptive management strategy and is charged with reporting annually on the implementation of the scientific aspects of the adaptive management process. The Lead Scientist has limited oversight in collaborating with the agencies and overall leadership responsibility does not involve senior-level leadership among all the necessary agencies.

Various interview subjects explained that the CALFED Lead Scientist was able to get ideas of AM communicated across the program. Multiple interviewees revealed the level of the Lead Scientist’s influence was so strong that the AM diagram took on the personal name of the scientist. Interviewees also mentioned that those who were learning the concepts of AM did not necessarily understand the concepts as necessarily referred to as adaptive management. It is not clear whether this lack of explicit association of knowing

adaptive management by name poses a problem. One interviewee remarked that AM proponents are still trying to sell many senior-level leaders of the implementing agencies on the value of using science, let alone adaptive management. Interview responses indicated that “there is no one person at CALFED” to contact about AM and “no one individual is responsible for overseeing AM at a programmatic level.” Interviewees indicated that other agency figure-heads that support AM have left and not been replaced (CALFED Bay-Delta Program Interviews May 12 through June 11, 2008).

CALFED receives a score of “LOW” for leadership commitment. Program documentation places responsibility of AM within each agency and neither interviewees nor documentation indicated any such leaders existed. The only leadership identified is that of the Lead Scientist who has limited influence across the array of CALFED agencies. Interviews with program representatives are consistent in the assessment that leadership for AM is lacking at the program level across the state and federal implementing agencies. Because of this consistency from all forms of evidence, the certainty for this criterion score is “Strong.”

Institutional Capacity - The majority of evidence informing this criterion came from interviews. However, there is a document, ‘Reinitiation of Consultation: Assessing Progress Towards Milestones and the Efficacy of the Environmental Water Account’ (CALFED Bay-Delta Program 2004) that discusses the program’s technical capacity of accurately understanding adaptive management. This document was prepared by the three implementing agencies of the Ecosystem Restoration Program (USFW, NMFS and CDFG). The document identifies three forms of AM: trial-and-error, passive adaptive management and active adaptive management. CALFED’s assertion that trial-and-error is a form of AM conflicts with the fundamental intention that AM is different than trial-and-error. Defining trial-and-error as a form of adaptive

management demonstrates a lack of technical capacity within the program in understanding what adaptive management is and what it is not.

Interview responses indicated that state and federal agencies have made considerable progress in understanding AM. However, there are still questions about individual agency capacity to conduct science and achieve an AM approach within CALFED. Interviewees expressed concerns that agencies either think they are already doing AM or they do not like to hear they should be doing something different. Interviewees felt that basic science is “revelatory” to non-scientists in the implementing agencies. Interview responses also indicated various resource constraints for achieving programmatic AM in CALFED. Frustration was expressed that the Science Program has great research ideas for the restoration program but no funding or resources to conduct studies. Respondents indicated that AM is constrained because the program is unable to experiment with water because the demand for this resource is too high. Interviewees revealed existing concerns over internal agency priorities. For example, one interviewee highlighted the competition and unresolved priorities within the USACE over investing in resources to build levees versus investing in resources for adaptive management of ecosystem restoration (CALFED Bay-Delta Program Interviews May 12 through June 11, 2008).

The score for this criterion is “LOW” as all of the interviewees expressed concerns in one form or another about the technical and managerial capacity of individual agencies to pursue AM approaches. Because this score is only informed by interviews, and the interviews were not representative of all the primary agencies of the ERP the certainty for this score is “Fair.”

Table 3 consolidates the criteria ratings for CERP including the level of certainty and a brief summary explaining the rationale behind the score:

Table 3. CALFED Bay-Delta Program Criteria Scores for Programmatic Adaptive Management

Programmatic AM Criteria	Criteria Score	Level of Certainty	Explanation of Criteria Scoring
Formal Institutionalization	LOW	Strong	PAM exists in original documents and flow chart but no formal structures for AM at program-level
System-wide models	LOW	Strong	Use of conceptual models is linked to AM flow chart, but no evidence of system-wide models
System-wide Monitoring	LOW	Strong	No effectiveness monitoring for program objectives, only status and trends. Proposed system-wide monitoring plan is only a proposal
Stakeholder Collaboration	MEDIUM	Fair	Stakeholders are not linked to the AM process, but available evidence of stakeholder participation indicates it is collaborative participation
Interagency Cooperation	MEDIUM	Fair	CALFED ERP implementation is based on interagency cooperation and consensus but not linked to AM approach
Leadership Commitment	LOW	Strong	Program documentation spreads leadership across agencies with no program leader and interview responses expressed the lack of buy-in for AM among agency leads
Institutional Capacity	LOW	Fair	All interviewees expressed concerns that individual agencies do not have capacity for scientific AM approach and there is a lack of resources dedicated to programmatic AM

Discussion

Table 4 summarizes the three case studies for each of the seven programmatic adaptive management criteria. There were no scores of “HIGH” given indicating the difficulty large-scale restoration programs are having in creating components that are effectively designed and integrated with programmatic adaptive management. CERP and LCA both received two “LOW” scores and were otherwise similar in ratings. CALFED had five “LOW” scores and two “MEDIUM” scores, indicating that systematic failures are inhibiting the program’s execution of programmatic adaptive management. The only criterion for which no program scored higher than “LOW” is ‘Institutional Capacity’ suggesting that achieving both technical understanding from a wide diversity of implementing and non-implementing agencies and having dedicated resources for implementation of adaptive management is quite difficult. The following discussion highlights general themes across each criterion followed by a recommendation section for future applications of programmatic adaptive management for ecosystem restoration.

Table 4. Multi-Case Comparison of PAM Criteria Results

AM Criteria SCORES	CERP	LCA	CALFED
Formal Institutionalization	MEDIUM-HIGH	MEDIUM	LOW
System-wide models	MEDIUM	MEDIUM-HIGH	LOW
System-wide Monitoring	MEDIUM-HIGH	MEDIUM	LOW
Stakeholder Collaboration	MEDIUM-LOW	MEDIUM	MEDIUM
Interagency Cooperation	LOW	MEDIUM	MEDIUM
Leadership Commitment	MEDIUM	LOW	LOW
Institutional Capacity	LOW	LOW	LOW

Formal Institutionalization – The similarities among the three restoration programs for institutionalizing adaptive management are several. The strongest similarity across the three programs is the dependence each program has on the science component to take responsibility for implementing and managing the programmatic adaptive management process. This reliance on the science body to be held accountable for AM is in some ways problematic. Each of the three science bodies is set-up more as a sounding board to answer questions as needed as opposed to being empowered to actually design and execute experiments. While, the science programs are held accountable for AM in the programmatic guidelines, they are in each case too far removed from the design and daily operations of the components for AM for this expectation to

be realistic. It appears that the science bodies are called upon to address the most difficult scientific questions but their involvement is avoided on matters that are politically sensitive.

Another trend across the programs is the longer than expected time it is taking to produce AM plans. The CERP is two years overdue on the self-imposed delivery date of the program's AM Implementation Guidance Manual. LCA's AM approach was stalled for two years while the program was seeking a permanent director of the Science and Technology Office. While CALFED developed a draft table of contents for the only document describing AM in detail, the document itself has still not been completed nearly three years after the table of contents was released. Planning paralysis seems to be preventing AM processes from getting integrated as other parts of these programs move ahead.

The final similarity the three programs share for institutionalizing AM is the ad-hoc nature by which it is organized. There are neither systematic structures nor dedicated budgets to facilitate the establishment of AM within any of the programs. It is not always clear who participates in the discussions for AM or which organizational components are going to keep things moving. Senior scientists and managers participating in AM planning for each program are only dedicating a small part of their time to AM, there are very few other staff that dedicate the majority of their time to AM and the level of turn-over in staff is high. These are all likely reasons why it is difficult for these programs to sustain momentum for AM planning.

System-wide models – All three programs are in agreement on the importance of modeling to both ecosystem restoration and programmatic AM. However, the degree to which each program was able to develop a system-wide model varies. The CERP has the most robust use of modeling with sub-system and

system-wide models in place for use in restoration planning. The LCA has identified sub-system and system-wide models but they are not as developed as the efforts from CERP. CALFED developed sub-system models but never got past the debate and difficulty of developing a system-wide model.

The three case studies are also similar in their lack of clear integration of system-wide modeling with strong links to their programmatic AM approach. Modeling appears as a box on a flow chart, but the model outputs do not appear to be designed specifically to inform AM. The system-wide models in the CERP and the LCA are designed to inform managers of results from different actions, but the outputs are not clearly aimed at addressing the uncertainties the restoration program's AM process intends to clarify. Finally, the disagreement within CALFED regarding the program's ability to develop system-wide models was not expressed in the interviews from the other two programs, but stands out as an important difference of opinion.

System-wide Monitoring – The strongest trend in monitoring among all three programs is the absence of effectiveness monitoring. The CERP has the only monitoring plan designed at the system-wide level specifically for restoration. However, the CERP's Monitoring and Assessment Plan is only capturing status and trends over a 10-year period to establish a baseline to then enable future effectiveness monitoring of restoration actions. Both the LCA Study and the CALFED Bay-Delta Program are relying on existing monitoring to inform the program and monitoring is not designed to provide information that can directly feed into the adaptive management process.

In all three programs, any new monitoring is competing with existing monitoring and programs are feeling pressure to ensure there is no redundancy in monitoring efforts. This sensitivity is making it difficult to justify additional monitoring. The challenge remains in all three programs to establish a

monitoring approach that can demonstrate change that comes from restoration versus change that comes from natural variability.

Stakeholder Collaboration – The common findings for including stakeholders in large-scale restoration planning are two-fold. First, programs found the relative ease of involving stakeholders during a centralized planning process versus the cumbersome process of including stakeholders during a decentralized implementation. The implementation process is scattered across very large spatial scales and stakeholders such as small NGO's do not have the resources to track several different pieces. Nor does the program have resources to involve stakeholders across these large areas. Second, the stakeholders that are involved are those with a financial interest and the ability to include the general public or those without their own resources is lacking.

The differences in stakeholder involvement are notable as well. The CALFED Bay-Delta Program was able to realize a more collaborative process than either the CERP or the LCA program both of which are constrained by FACA compliance. For the CERP and the LCA there is a strong difference in their ability to work within FACA requirements. The CERP has been significantly hindered by the FACA process from multiple threats of lawsuits. Several documents that involved extensive stakeholder involvement were not issued as official program documents due to threats of litigation. Similar issues do not exist in the LCA program where interviewees stated that many documents are created in a format that is not subject to FACA requirements. However, the disagreement within the LCA program about the appropriateness of using AM in conjunction with a stakeholder process is in direct opposition to the CERP's AM Strategy which espouses to include stakeholders in every part of the AM process.

Interagency Cooperation – All three programs are fundamentally based on interagency agreements and they all share some common challenges to achieving interagency cooperation. Programs are seeing conflicting goals both between the implementing agencies and between implementing agencies and non-implementing agencies. In the CERP, the SFWMD prioritizes flood control and water supply while the USACE's priority is restoration. In the LCA program, the USACE has shifted priorities from restoration to hurricane protection and restoration and the LDNR and Louisiana Department of Transportation are focused on restoration and hurricane protection respectively. The CALFED Bay-Delta Program is experiencing challenges between state and federal agencies that disagree on prioritizing the protection of endangered species in a political climate that demands water supply.

All three programs also have experienced delays in the planned timing of funding from the federal agency partners, namely the USACE. In the CERP, the SFWMD went ahead with their plans and reduced delaying implementation by not waiting for the anticipated federal funds. In the LCA program, the lack of federal funding through appropriations tied to approved WRDA authorizations, along with the shift in priorities following Hurricane Katrina, has stalled implementation of restoration plans. The CALFED Bay-Delta Program did not get expected funding from federal partners resulting in the CDFG bearing the burden of costs for restoration plans.

Leadership Commitment – The three case studies all lacked a clear point of contact for programmatic AM. In the CERP and CALFED, the lead scientists were the biggest advocates for AM. In LCA the lack of a permanent director for the S&T Office appears to have stalled the process of defining leadership roles for programmatic adaptive management. Interviewees from all three programs expressed the belief that leadership commitment is critical for AM to penetrate the program. Additionally, the turn-over in leadership, either in the

lead scientist position or within the implementing agencies, and senior science and management staff creates a loss of momentum in programmatic AM approaches.

Institutional Capacity – The most common feedback from interviewees across all three programs, but primarily in the CERP is the USACE as an institution is not capable, by virtue of its agency culture, of achieving AM. The reasons for this included: local offices that design AM approaches are not able to get buy-in at either the regional level or the national level; the long planning timelines of the USACE do not allow for timely adjustments based on learning; and a misunderstanding within the agency that the common trial-and-error approach is adaptive management. The thinking that a current trial-and-error approach is adaptive management is not limited to the USACE as several other agencies were mentioned as having this same pattern.

Across the three programs the underlying theme of agencies not being invested in science in general emerged as a deficiency in agencies tasked with pursuing an adaptive management approach. Scientific research is not a part of most agency missions and non-science professionals are not rewarded for attention to conducting science. The professional cultures of engineering and other managers are not instilled with a focus on the scientific process with individual career advancement being independent from the use of science. It follows that the capacity to implement AM is deficient. The three programs were also similar in lacking metrics for measuring their programmatic AM approaches. Feedback from each program regarding success in implementation of AM was based on whether the restoration program itself was judged a success. The AM literature, on the other hand, is clear that if learning is achieved and uncertainty is reduced this signals successful adaptive management and determining success is not dependent on whether the larger goal itself was necessarily achieved.

Recommendations

This investigation leads to a list of recommendations for increasing the likelihood that adaptive management will be integrated and relevant for large-scale ecosystem restoration. These recommendations are not only applicable to restoration programs but are appropriate for any large-scale programmatic application of adaptive management.

Learning as a goal – The basic goal of adaptive management is to capture learning to reduce uncertainties and improve future decision-making. However, learning is rarely, if at all, an explicit goal of the restoration programs or the implementing agencies in any of the three cases. Learning often occurs but is not recognized as a success because the larger goals and objectives were not achieved. Instead, programs and projects are often not funded when too much uncertainty is expressed. Programs need to find a balance between identifying what they do know that will enable them to achieve goals but also identify what is still unknown. Programs need to take as a central tenet that learning is a valuable and necessary goal for something as complicated as large-scale ecosystem restoration.

Research and Education – All three programs expressed concern that if adaptive management is required, many program participants will react negatively, either assuming they are already achieving an AM approach or feeling turned off by being told to do something different. Programs should recognize the term ‘adaptive management’ has become jargon that means different things to different people. Programs should evaluate the current level of understanding of the implementing agencies to identify how much education is needed to inform managers how AM is different from trial-and-error management. Programs should develop training in advance of implementation so managers and other stakeholders have ample time to learn about the adaptive management approach before being asked to conduct adaptive

management itself. This training should recognize and advertise that the learning curve will be an investment in time now that will have a significant long term return in saving time and money for future decisions.

Accountability & Authority – Common to all three programs is the lack of accountability of any one group or individual for ensuring that adaptive management is executed across the program. The science bodies are given responsibility in programmatic documents but lack the authority or the resources to carry out this responsibility in its necessary details. If science bodies are held accountable for adaptive management they need to be given the resources and authority to do the job they are tasked with doing. Whether it falls on the science body, an interagency workgroup, or the implementing agencies themselves, programs should recognize that some entity needs to be held accountable for the implementation of adaptive management. Furthermore, groups that are held accountable need the associated level of authority so that adaptive management proceeds.

Measurement – None of the programs showed evidence of how the program intends to measure the effectiveness of their programmatic adaptive management approach. It is hard to imagine how programs will implement adaptive management and recognize when actions were taken as a result of an adaptive management approach without some method to measure or track the programmatic adaptive management process itself. The lack of being able to measure adaptive management has resulted in inconsistent attention to the process. Programs should develop a means for tracking the decision-making processes to enable identification of how decisions are made and how much of a role adaptive management plays in the decision-making process.

Leadership – Both the CERP and CALFED had lead scientists who were successful in gaining the respect of non-scientists which ensured that the idea

of adaptive management was well received. However, the turn-over of these adaptive management champions resulted in unfavorable outcomes for AM. Leadership is a must for adaptive management to be successful at the program level. However it should not necessarily be the responsibility of the lead scientists. Senior managers from implementing agencies are just as likely candidates for being successful adaptive management champions. Furthermore, commitment to adaptive management leadership needs to be considered as successions in positions arise.

Resources – The three programs differed in the amount of resources that were dedicated to developing the adaptive management process, but none seemed to allocate sufficient resources to ensure adaptive management would remain relevant. Adaptive management is unlikely to proceed in an unstable funding environment. Fluctuations in resources often result in necessary components for adaptive management, such as monitoring, being the first to be eliminated. Because monitoring requires substantial resources, especially staff and time, investment in modeling resources, especially at the program scale should be considered. Adaptive management needs a sustained budget and staff structure that is resilient to changes in the broader program.

Bottom-up Process – Large-scale ecosystem restoration programs are enormously complex to begin with and the application of adaptive management creates an added layer of complexity. The difficulties involved with developing system-wide modeling and monitoring are two strong examples of how the absence of certain programmatic pieces can limit programmatic adaptive management. Additionally, unsuccessful attempts at implementing adaptive management across an entire program can cause irreversible damage to AM's reputation among proponents and implementing managers who may likely not try AM again out of fear of failure. Programmatic adaptive management should build their modeling and

monitoring from the bottom up in addition to top-down approaches. This bottom-up approach can demonstrate how AM can be accomplished, thereby decreasing the magnitude of any perceived failures, increasing buy-in from skeptics and proponents alike, and increasing the likelihood of success.

Consider a different name – The term adaptive management is often interpreted to mean the very thing it was designed to distinguish itself from, trial-and-error. In places where adaptive management is perceived a failure, the very mention of the term can be a turn-off to those being asked to try again. The original thinkers behind the term adaptive management considered the name ‘experimental management’ to be a synonymous term. However, experimental design can often be quite difficult to integrate and the name ‘experimental management’ might be as problematic as the name ‘adaptive management.’ Other names that may work in place of adaptive management could include ‘effectiveness evaluation management,’ ‘systematic learning management,’ or ‘monitoring and adjustment management.’

Monitoring – Monitoring across large-scales is one of the biggest challenges for programmatic adaptive management, but it is a necessary component for any adaptive management process. Monitoring designed for needs that fall outside the adaptive management scope is not adequate to meet the monitoring needs of AM itself. Monitoring must provide results that inform the decision-making processes of adaptive management. Developments in monitoring have not reached the sophistication necessary to accomplish effectiveness monitoring at the program level, however there are numerous examples of effectiveness monitoring at the project scale. Programs are advised to pursue effectiveness monitoring at the project level, pursue status and trends monitoring at the system level and create links between the two levels of monitoring.

Bibliography

Boesch, D. (2006). Scientific requirements for ecosystem-based management in the restoration of Chesapeake Bay and Coastal Louisiana. *Ecological Engineering*, 26, 6-26

Booher, D.E. and Innes, J.E. (2006). *Complexity and Adaptive Policy Systems: CALFED as an Emergent Form of Governance for Sustainable Management of Contested Resources*. Retrieved February 8, 2008
http://www.csus.edu/ccp/publications/ISSS_Complexity_and_adaptive_policy_systems.pdf

CALFED Bay-Delta Program. (2000a). *Programmatic Record of Decision*. CALFED Bay-Delta Program.

CALFED Bay-Delta Program. (2000b). *Multi-Species Conservation Strategy*. CALFED Bay-Delta Program.

CALFED Bay-Delta Program. (2000c). *Attachment 3 Implementation Memorandum of Understanding*. CALFED Bay-Delta Program.

CALFED Bay-Delta Program. (2000d). *Ecosystem Restoration Program Plan Strategic Plan for Ecosystem Restoration*. CALFED Bay-Delta Program.

CALFED Bay-Delta Program. (2000e). *Ecosystem Restoration Program Plan Volume 1: Ecological Attributes of the San Francisco Bay-Delta Watershed*. CALFED Bay-Delta Program.

CALFED Bay-Delta Program. (2004). *Reinitiation of Consultation: Assessing Progress Towards Milestones and the Efficacy of the Environmental Water Account*. CALFED Bay-Delta Program

CALFED Bay-Delta Program. (2006). *DRAFT 1/5/06 Framework for indicators for science, management and adaptive management in the CALFED Bay-Delta Program*. CALFED Bay-Delta Program.

Central and Southern Florida Project. (2000). *Master Program Management Plan Volume 1 – Management Processes*. U.S. Army Corps of Engineers and South Florida Water Management District.

Central and Southern Florida Project. (2003). *A Vision Statement for the Comprehensive Everglades Restoration Plan*. U.S. Army Corps of Engineers and South Florida Water Management District.

Central and Southern Florida Project. (2004). *Comprehensive Everglades Restoration Plan Annual Report*. South Florida Water Management District and Florida Department of Environmental Protection.

Dexter, L. A. (1970). *Elite and specialized interviewing*. Evanston, Ill.: Northwestern University Press.

Drinker Briggs, P. (2008). *Planning and Management for Invasive Species in Three Large-scale Coastal Ecosystem Restoration Programs*. Master's Thesis, University of Washington.

Gregory, R., Ohlson, D., and Arvai, J. (2006). Deconstructing Adaptive Management; Criteria for Applications to Environmental Management. *Ecological Applications*, 16(6), 2411-2425.

Gunderson, L., and C. S. Holling, editors. (2002). *Panarchy: understanding transformations in human and natural systems*. Washington D.C.: Island Press.

Healey, M. (2007). *The Hitchhiker's Guide to Adaptive Management*. Retrieved August 17, 2007
http://calwater.ca.gov/science/pdf/CSP_LS_brown_bag_Adapt_Management_112007.pdf

Holling, C. S., editor. (1978). *Adaptive environmental assessment and management*. New York, New York: John Wiley.

Innes, J. E., Connick, S., Kaplan, L., & Booher, D. E. (2006). *Collaborative Governance in the CALFED Program: Adaptive Policy Making for California Water*. Berkeley CA: Institute of Urban and Regional Development.

Kvale, S. (1996). *Interviews: an introduction to qualitative research interviewing*. Thousand Oaks, CA: Sage Publications.

Lee, Kai N. (1993). *Compass and Gyroscope: Integrating Science and Politics for the Environment*. Washington D.C.: Island Press.

Louisiana Coastal Area. (2004a). *Ecosystem Restoration Study Volume 1: LCA Study – Main Report*. U.S. Army Corps of Engineers and State of Louisiana.

Louisiana Coastal Area. (2004b). *Ecosystem Restoration Study Volume 2: Science and Technology Program*. U.S. Army Corps of Engineers and State of Louisiana.

Louisiana Coastal Area. (2004c). *Ecosystem Restoration Study Volume 3: Hydrodynamic and Ecological Modeling*. U.S. Army Corps of Engineers and State of Louisiana.

Murray, C. and Marmorek, D. (2003). Adaptive Management and Ecological Restoration, Chapter 24, in: Freiderici, P. (ed.). *Ecological Restoration of Southwestern Ponderosa Pine Forests*. Washington: Island Press.

National Research Council. (2004). *Adaptive Management for Water Resources Project Planning*. Washington D.C.: National Academies Press.

National Research Council. (2006). *Drawing Louisiana's New Map: Addressing Land Loss in Coastal Louisiana*. Washington D.C.: National Academies Press.

Nyberg, B. (1999). Implementing adaptive management of British Columbia's forests –Where have we gone wrong and right? In: McDonald, Fraser and Gray (eds). *Adaptive Management Forum: Linking Management and Science to Achieve Ecological Sustainability*. Ontario Ministry of Natural Resources.

Raynie, R.C. and Visser, J.M. (2002). *CWPPRA Adaptive Management Review Final Report*. Retrieved January 31, 2008
http://lacoast.gov/reports/amrfr/FINAL_REPORT_12-20-02.pdf

RECOVER (2003). *Draft CERP Monitoring and Assessment Plan*. Retrieved May 2, 2007
http://www.evergladesplan.org/pm/recover/recover_map_2003.aspx

RECOVER. (2004a). *Review of Project-Level Performance Measures Standard Operating Procedure (SOP)*. Retrieved 4/21/08 from
http://www.evergladesplan.org/pm/recover/recover_docs/et/et_reviews/et_rev_pm_rev_st_op_proc.pdf

RECOVER. (2004b). *CERP Monitoring and Assessment Plan*. Comprehensive Everglades Restoration Plan Central and Southern Florida Project.

RECOVER. (2005) *Draft- RECOVER Regional Evaluation and Report Process*. Retrieved 4/21/08 from
http://www.evergladesplan.org/pm/recover/recover_docs/et/rec_sop_reg_eval_current.pdf

RECOVER. (2006a). *Comprehensive Everglades Restoration Plan Adaptive Management Strategy*. Retrieved June 20, 2007 from http://www.evergladesplan.org/pm/recover/recover_docs/am/rec_am_strategy_brochure.pdf

RECOVER. (2006b). *Monitoring and Assessment Plan (MAP), Part 2 2006 Assessment Strategy for the MAP*. RECOVER Integrative Assessment Sub-team.

RECOVER. (2007a). *RECOVER Fact Sheet*. Retrieved March 7, 2008 from http://www.evergladesplan.org/docs/fs_recover_2007.pdf

RECOVER. (2007b). *RECOVER Teams and Chair Contact Information Updated May 2007*. Retrieved June 2, 2007 from http://www.evergladesplan.org/pm/recover/recover_docs/rap/rap_teams_contact_list_current.pdf

RECOVER. (2007c). *RECOVER Teams and Chair Contact Information Updated December 2007*. Retrieved December 12, 2007 from http://www.evergladesplan.org/pm/recover/recover_docs/rap/rap_teams_contact_list_current.pdf

RECOVER (2007d). *DRAFT Adaptive Management Implementation Guidance Manual* (Version 1.2). RECOVER.

RECOVER. (2008a). *RECOVER Teams and Chair Contact Information Updated February 2008*. Retrieved March 10, 2008 from http://www.evergladesplan.org/pm/recover/recover_docs/rap/rap_teams_contact_list_current.pdf

RECOVER. (2008b). *RECOVER Teams and Chair Contact Information Updated July 2008*. Retrieved July 24, 2008 from http://www.evergladesplan.org/pm/recover/recover_docs/rap/rap_teams_contact_list_current.pdf

Science Board of the Louisiana Coastal Area Ecosystem Restoration Program. (2007). *Comments on the Proposed Adaptive Management Implementation Framework for LACPR*. Retrieved November 11, 2007 from <http://www.umces.edu/~boesch/LCASBonAMimplementation.pdf>

South Florida Water Management District. (2004). *2004 Everglades Consolidated Report*. Retrieved Jan 8, 2008 from https://my.sfwmd.gov/pls/portal/docs/PAGE/PG_GRP_SFWMD_SFER/PORTLET_PREVREPORT/FINAL/chapters/ch7.pdf

South Florida Water Management District. (2005). *Documentation of the South Florida Water Management Model Version 5.5*. South Florida Water Management District.

U.S. Army Corps of Engineers. (2008). *DRAFT Louisiana Coastal Protection and Restoration Technical Report*. U.S. Army Corps of Engineers.

Van Cleve, F.B., Leschine, T. and Klinger, T. (2006). An Evaluation of the Influence of Natural Science in Regional Scale Restoration Projects. *Environmental Management*, (37)3, 367-379.

Walters, Carl (1986). *Adaptive Management of Renewable Resources*. New York: Macmillan.

Walters, C. (1997). Challenges in adaptive management of riparian and coastal ecosystems. *Conservation Ecology* [online]1(2):1.

Yin, R.K. (2003). *Case Study Research Design & Methods Third Edition*. Thousand Oaks, CA: Sage Publications.

Appendix A: Multi-Case Study Methodology

This thesis was based on case study methodology defined by Robert K. Yin's Case Study Research: Design and Methods (2003). The use of the case study methodology allows researchers to retain meaningful characteristics of the research subject and is particularly useful for research involving “organizational and managerial processes.” Understanding organizational and managerial processes is at the heart of understanding programmatic adaptive management, thus case study methodology is appropriate to this research question. Yin also recommends a multiple-case study approach over a singular case study approach for several reasons. The most salient reason is that if replication is identified under different contexts, it adds significant credibility to the experiment's findings. The following details the multi-case study methodology:

Definition

Technical Definition Scope: Case study research is an appropriate methodology for investigating subjects that are not clearly separable from their context (Yin 2003). The essence of the case study design is to understand the relationship between the context and the research subject. The context-research subject relationship can't be separated in case study research and the context is fundamental to understanding the research subject. Programmatic adaptive management is a research subject that would be difficult to study independent of the different program contexts for which it is being applied.

A multiple-case study design is not the same as the more common scientific approach of testing multiple samples within the same experiment. Instead, each case is an experiment in its own right (Yin 2003). The ability to make comparisons across multiple case studies is dependent on the similarity in context among the cases. The results are not based on frequency and statistical significance. The result is preferably an identification of trends across the case

studies investigated with some predictive ability. However, there is no expectation on being able to calculate probability for future experiments. The results are based on analytical and not scientific generalizations, and the generalizations are applied to theories and not populations (Yin 2003).

Explanatory Case Study- Yin identifies three types of strategies for case studies: descriptive, exploratory, and explanatory. These three strategies are not inclusive and the overlap is not always clear. However, focusing on one strategy keeps the research approach manageable. This thesis is based on the explanatory strategy which is used to answer “how” and “why” questions (Yin 2003). The explanatory strategy identifies causal relationships mostly from the history of the contemporary research subject under investigation, and the relationship findings are “intended to be generalizable” (Yin 2003). The results from the explanatory strategy can be framed as lessons learned and applied to similar cases in the future, or in the true spirit of adaptive management be applied to the very cases studied in this research.

Experimental Design (Background Research, Components & Protocol)

Background Research – According to Yin (2003), good case study research is dependent on understanding all relevant background before conducting substantive case study research. Researchers are more informed and can understand appropriate flexibility with greater understanding of the research subject. As such, I conducted a literature review on the broad subject of adaptive management with additional consideration given to AM literature that discusses the complexity of AM for large-scale applications. The seminal literature on AM at large scales is Kai Lee’s Compass and Gyroscope (1993) which provided great insight into how to understand and investigate programmatic adaptive management.

Design Components – Yin (2003) emphasizes five components that should be identified prior to case study research: 1) questions; 2) propositions (if any); 3) units of analysis, 4) logic linking data to propositions; and 5) criteria for interpreting findings. Questions refer primarily to the research questions (see Methodology & Appendix II) and the posed questions (see Appendix II) to a lesser extent that act as reminders during the research. Propositions are similar to theories that are explored but not necessarily equivalent to testable hypotheses. The unit of analysis is defined by the nature of the research and the context of the case. For this study, the unit of analysis is programmatic adaptive management. Identifying trends and patterns is the logic which links the data to propositions. These components and the overall criteria are inherently flexible in structure and can be used to compare or contrast results (Yin, 2003).

Case Study Selection - Selecting appropriate case studies occurs after the researcher has some evidence that the case in question is relevant to the research questions and will provide insight into the investigation. A common set of criteria provides rationale for the cases used in a multi-case study design. The multi-case study criteria in this study are: 1) restoration program is focused on restoring ecosystems rather than select species or habitats; 2) spatial scale is regional in size encompassing multiple counties or multiple states; 3) the program organization is complex and includes state and federal participation as well as a collection of projects designed to achieve larger system-wide goals; and 4) program documentation explicitly uses the term ‘adaptive management’ as part of the espoused programmatic approach to restoration.

Research Protocol – Research protocol increases the reliability of the research and helps to identify potential problem areas in advance (Yin 2003). This study

uses multi-case study research protocol which is a sequential process detailing the “overview” of the research subject, “procedures” that are adhered to in the collection and analysis of evidence, “questions” that will be asked of each research subject, and organization of the results for a final report (Yin 2003). This thesis uses a combination of the Thesis Prospectus and Interviewing Protocol as the design for the overall Research Protocol. Of note for a multi-case study research design is ideally to complete one case study before moving on to subsequent case studies (Yin, 2003). This multi-case study investigated the three case studies simultaneously in the collection of evidence (document and artifact review, conducting interviews) as this was a more manageable approach but analyzed the evidence and completed the case study analysis in the order of the CERP, the LCA Study and CALFED.

Criteria

Ecosystem-based Restoration – An underlying purpose of this study is to identify lessons learned for applying AM to ecosystem restoration therefore it is fundamental that each case selected is focused on restoration of the respective ecosystem. Restoration cases that only target at the species or habitat levels were not considered. Ecosystem restoration has also been described as process-based restoration in which restoration is focused on re-establishing ecosystem processes at a scale that encompasses traditional species and habitat-based restoration.

Spatial Scale – Scale is a fundamental element to the programmatic component of programmatic adaptive management and cases need to be large enough to encompass the ecosystem that is the target of restoration. AM is suggested to become less feasible as scale increases (Lee, 1993). Comparisons across multiple case studies with a large variance in scale (hundreds of square miles compared to thousands of square miles) would lessen the ability to make generalizations across multiple case studies. For purposes of this study, spatial

scale can be conceptualized with political jurisdiction, and the regional scale includes multiple counties within a single state or across multiple states.

Organizational Complexity – Multiple organizations and multiple projects are inherent to ecosystem restoration programs at large scales. Large scale ecosystems encompass multiple jurisdictions for governance and resource management. It follows that appropriate case studies include programs that include both state and federal participation working together to achieve restoration. Furthermore, the programmatic component necessarily is comprised of several different projects that are designed to achieve both project-level goals as well as being designed as smaller pieces to achieve larger system-wide goals.

Explicit Program-level Adaptive Management Approach – Being able to compare results across case studies is dependent on each case explicitly referencing adaptive management at the program level, usually identified in official program documents. Case studies were selected by using the term ‘adaptive management’ or ‘adaptive environmental assessment and management’ and further defining what the term(s) means in the context of their program and how the programs approached AM programmatically. Case studies that infer an adaptive management approach either through an ecosystem-based management approach or other approaches but do not use the exact term ‘adaptive management’ in program documents are not eligible as case studies for this thesis.

Potential Biases and Methodology Challenges

The multi-case study method calls for treating each case the same. However, due to the large variance in available evidence for each case it was highly challenging to treat each case the same. The CERP case study had more evidence that was easier to find across all three forms of evidence I used. The

number of documents, artifacts, and appropriate interviewees were in greater supply in the CERP than the LCA and CALFED programs. This was most critical in identification of interviewees. Although I asked each interviewee in all three programs whom I should interview, I was able to find almost all the names for CERP in advance of this question. However, in both the LCA and CALFED programs I was only able to identify one or two individuals and relied on them to provide me with the rest of the necessary names. This reliance on one interviewee recommending other interviewees was most problematic in CALFED as I was unable to identify anyone from the federal agencies involved to interview and I did not get the same level of representation of interviews as in the other two programs.

The major methodological challenge I faced was avoiding the case study trap of not studying the unit of analysis I intended to study, i.e. programmatic adaptive management rather than project-level adaptive management. I was conscious of this trap throughout this investigation and only collected evidence that addressed adaptive management across the program. I asked all interviewees to provide their answers in the context of the program as a whole and not speak to individual projects. However, the projects of a restoration program are intertwined with the overall program and it is neither possible nor advisable to try to completely separate the project component from the program component. I paid special attention throughout this study to annotate any form of evidence that was not primarily a form of programmatic evidence.

Appendix B: Interview Methodology

Interviews are one of six forms of evidence used in multi-case study methodology as defined by Yin (2003). This thesis used interviews with program participants familiar with adaptive management for the purpose of collecting unpublished and unreported information describing the experiences and opinions of the interviewees. An interview protocol of elite, semi-structured interviews was developed based on the work of Dexter (1970) and Kvale (1996), respectively (see below). This combined interview method is not a strict, formal process where each interviewee is asked the exact same questions in the exact same sequence. Rather, the interviews are discussions based on the relevant knowledge of the interviewee that allows for: in-depth explanations; follow-up clarifying questions; identification of points not previously considered by the interviewer; and verification of evidence communicated by the interviewee (Kvale, 1996).

Elite Interview – An elite interview gives the interviewee “specialized, non-standard” treatment because of their unique knowledge of the research subject. The elite interview allows the interviewee limited control of the interview by helping guide the discussion and interpretation of the facts. It is the elite interviewee’s intimate knowledge of the research subject that allows this limited control (Dexter 1970). For this thesis, interview candidates were considered elite if they were participants of AM-specific groups, lead authors or co-authors of AM documentation and/or senior level scientists and managers of science bodies and implementing agencies respectively.

Semi-structured Interview – A semi-structured interview is “an interview whose purpose is to obtain descriptions of the life world of the interviewee with respect to interpreting the described phenomena” (Kvale 1996). The interview involves a pre-planned structure but has flexibility resulting in an interview that more resembles a conversation in its execution. The evidence

collected through the semi-structured interview is influenced by the experiences and opinions of the interviewee and is formulated with a post-interview analysis.

Logistics

Selection of Interviewees – There were multiple methods used to identify appropriate individuals who can speak to programmatic adaptive management for each case study. When available, lead authors and co-authors of documents specifically developed for programmatic AM were identified. Authors of larger documents that included chapters or sections on AM were also considered. Program websites as well as PowerPoint presentations available on the public domain Internet also provided names of appropriate program representatives. Finally, the interviews themselves revealed suitable program representatives either through the course of the interview or when I asked them directly whom else I should contact. For all of the interviewees that were ultimately contacted, it was mandatory that they could all speak to AM at the program-level and were not limited in their experience to only project-level understanding of AM.

I did not set a minimum number of interviewees to contact for each program although I did aim to get a broad representation across each program (see Figure 3). It was important to get interviewees at both the state and federal level, members of implementing agencies and non-implementing agencies and senior level scientists and managers. In total I identified and contacted sixteen representatives from the CERP with twelve who participated, ten representatives from the LCA of which seven participated, and twelve from CALFED of which seven participated. At the end of the interviews I asked each person who else I should contact within the program that can speak to programmatic adaptive management. At the end of the interview process, it was evident that the same sets of names were mentioned collectively among all participants and I feel confident that I identified the best representatives on

AM from each program. Of note, the most important individual to interview about AM in CERP, as identified from both program documentation and from interviewee recommendations, a former chief scientist and top advocate for AM in the program did not respond to multiple requests for an interview.

Data Collection – All interviews were conducted by telephone as time and resources did not allow travel to visit interviewees on-site. Interviews were not tape recorded. Reasoning for not recording the interviews was based primarily on increasing the candidness of the responses from the interviews. Although the interviewees were assured anonymity, I felt that tape recorded evidence would hinder the nature of the responses interviewees would provide. Some of my questions could potentially reveal criticism of co-workers, supervisors and the organizations interviewees work for or with and thus information was recorded through typed notes.

Briefing the interviewee – As a courtesy to the interviewees as well as providing necessary context to the interview, interviewees were briefed on the nature of my research and the intended purpose for the research results. The main purpose of the briefing was to ask respondents to answer all questions in the context of programmatic decisions and not project-level decisions, although these two levels are intertwined in reality. I was conscious of not trying to introduce bias in the interview during the briefing by keeping the introduction part of the interview short and focused on the nature of the interview and then allowing the interviewee to ask any questions they might have after I have completed the interview and to describe the intended purpose of the research results.

Interview Procedure

1. Made interview request by email or phone providing a synopsis of my research purpose.

2. Confirmed interview time to take place on the phone for a minimum of 30-60 minutes. Interviews were allowed to extend longer if interviewees time and interest allowed.
3. Executed phone call and introduced interviewee to myself, and briefly described my multi-case study research purpose.
4. Informed interview subject that all responses would remain anonymous and would only be associated with the program.
5. Asked interviewee if they had any questions before beginning.
6. Asked background questions of interviewee's involvement in the program and familiarity with adaptive management at the program level.
7. Asked posed questions; modified and/or added questions where necessary.
8. Concluded interview by asking the interviewee if they had any other comments or questions.
9. Described to interview subject how the information collected was going to be used and restated that all information is anonymous.
10. Allowed 60 minutes of time immediately following the interview to review notes and fill-in any incomplete information.
11. Analyzed notes after each interview and at the end of all interviews to place data in categories according to my seven criteria and other categories as necessary.

Interview Protocol

Two key terms need explanation to understand the reasoning and format of the interviews.

Research Questions – Research questions are a short list of questions that address the overall purpose of the investigation but are not directly asked to the

interviewees. Interviewees are not asked research questions because the questions are either too broad or too vague resulting in different interpretations by various interviewees as to the exact question at hand. Of note, interview research questions are not the exact same questions as the thesis research questions, but they are specifically aimed at informing the larger thesis research questions.

Posed Questions – Posed questions are the specific questions asked of the interviewee, also called interview questions (Kvale, 1996). A small group of posed questions are derived to inform each of the research questions and are designed to eliminate multiple interpretations of the question among the interviewees. The short and simple posed questions can be modified during individual interviews as elite, semi-structured interview methodology allows.

Research Questions and Associated Posed Questions: Question Set #1

P1: What is your role in the restoration program?

P2: What is your familiarity with adaptive management in your restoration program?

RQ-1a: What is the institutional support for programmatic adaptive management?

PQ: How do you define adaptive management for your program?

- a) How clear are the restoration goals and objectives for adaptive management?
- b) How is adaptive management organized at the program level?
- c) How does the program measure success of its AM approach?
- d) How influential are those in charge of adaptive management in the overall structure of the program?

RQ-1b: How is the program implementing adaptive management?

PQ: How is adaptive management being implemented?

- a) If not, why isn't adaptive management being implemented?
- b) How much do the AM planning documents influence implementation?
- c) How influential are AM policies on actual implementation?

RQ-2: What role does AM play in program-level decision-making?

PQ: How is AM used for decision-making?

- a) How important is the adaptive management approach to program decision-makers?
- b) How is evaluation from adaptive management being used to adjust program actions?
- c) How does system-wide monitoring influence program decisions?
- d) How is performance from projects integrated into program learning?
- e) How are stakeholders involved in the adaptive management process?
- f) What influences program-level decisions the most?

RQ-3: How does the program identify learning from AM?

PQ: Is the program testing uncertainties based on a single hypothesis or model or is the program testing uncertainties based on multiple hypotheses or models?

- a) How is AM used to test for uncertainties at the program level?
- b) How is adaptive management used to accommodate for surprises and failures?
- c) How is AM used to address surprises or failures?
- d) What recommendations do you have for organizing adaptive management to be most effective for ecosystem restoration?
- e) Is there anything else you would like to tell me about AM in your program?
- f) Who else do you think I should talk to about AM in your program?

Appendix C: Program Results Explanations

CERP Results Explanations

Formal Institutionalization - RECOVER has evolved in its organization since its inception in 2003 and is currently made up of four entities: the RECOVER Leadership Group (RLG), the Assessment Team, the Evaluation Team and the Planning Team. The RLG is the overarching group within RECOVER that oversees the other three teams. Historically, RECOVER included an Adaptive Assessment Team that was tasked with contributing to the “preparation of an adaptive management strategy” (RECOVER 2004, p.1-13). However, the 2007 fact sheet for RECOVER

(http://www.evergladesplan.org/docs/fs_recover_2007.pdf) ascribes the role of developing and implementing the CERP AM Program to the RECOVER Leadership Group.

CERP AM Flow Charts start in 2000 with the Adaptive Assessment Flow Chart (Fig. C-1). The 2000 flow chart is a generic process for an AM strategy at the program level (although not referred to as AM until 2003). The CERP 2000 Adaptive Assessment Flow Chart resembles Nyberg’s AM process clearly in five out of six elements. The design stage of AM is included in the box for ‘Comprehensive Everglades Restoration Plan.’ The implementation stage of AM is included in the “Implementation of next Scheduled Project” box. The monitoring component of AM is addressed with the box labeled “System-wide Monitoring Program.” The evaluate step of Nyberg’s AM process is included in the box “Interpret System-wide Responses.” The Adjust stage is represented by the boxes “Revise Design or Operation of CERP” and “Revise Conceptual Models.”

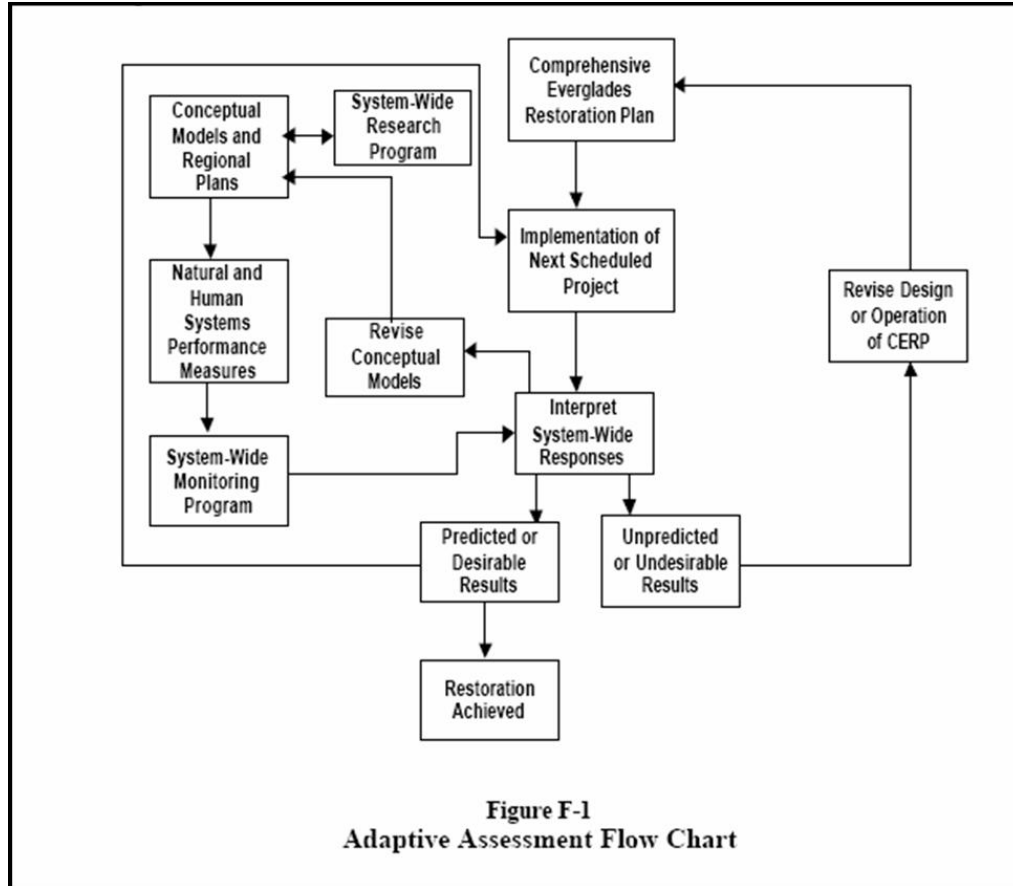


Figure: C-1 CERP Adaptive Assessment Flow Chart (Central and Southern Florida Project 2000)

In 2004, as part of an official program document ‘CERP Monitoring and Assessment Plan: Part 1 Monitoring and Supporting Research’ CERP developed an Adaptive Management Program conceptual map that replaced the 2000 Adaptive Assessment flow chart (Fig. C-2). Figure C-2 is confusing because the title refers to an “AM program,” but the figure is referenced as an “AM process” in the Monitoring and Assessment Plan. Figure C-2 includes AM process steps of monitoring (“CERP System-wide Monitoring and Assessment Plan”), evaluate (“AAT Synthesis and Interpretation Report”) and adjust (“Revisions to Conceptual Ecological Models, Performance Measures, & Monitoring Plan”).

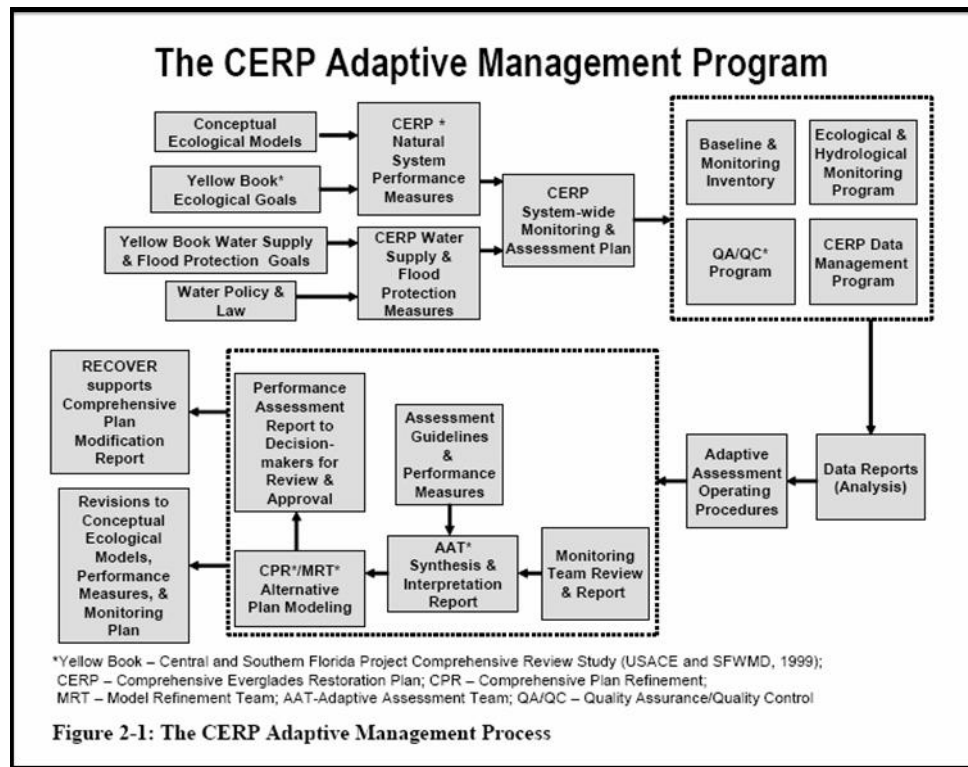


Figure: C-2 CERP's 2004 Adaptive Management Process (RECOVER 2004b)

In 2006, the AM Steering Committee and RECOVER released the first document solely dedicated to programmatic AM; the “Comprehensive Everglades Restoration Plan Adaptive Management Strategy.” This document is one of two documents that defines the CERP AM program (RECOVER 2006). The CERP AM strategy is based on a four-box framework overview (Fig. D-3) that replaces the 2004 CERP AM Process. The four boxes of the AM overview are: 1) Project Development; 2) Performance Assessment; 3) Management and Science Integration; and 4) CERP Update Process. Each box unfolds into another flow chart with additional details on how the individual process of each box works and where in the four-box framework the individual boxes link to each other. Box 1 includes the AM steps of design and implementation; Box 2 includes the AM steps of monitoring and evaluation;

Boxes 3 and 4 focuses on the AM step of adjusting and assessment. Note: within each of the four boxes includes several overlapping phases of AM

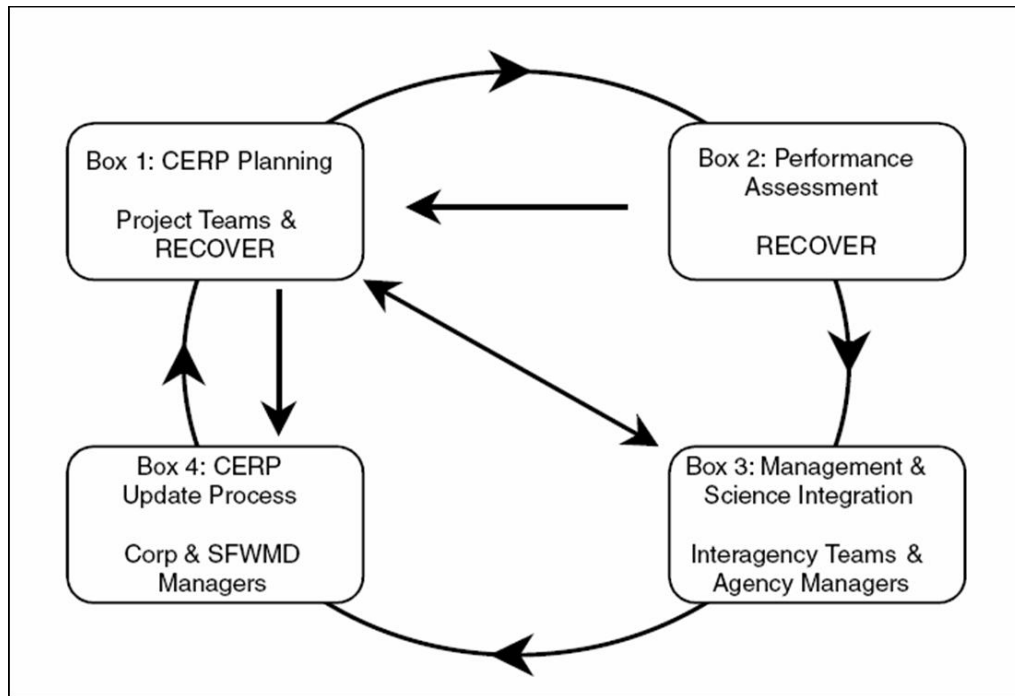


Figure: C-3 CERP's 2006 AM Strategy Overview (RECOVER, 2006)

The second document defining the CERP AM program is the AM Implementation Guidance Manual which was scheduled to be released in spring of 2006 (RECOVER, 2006), but the final version is still unavailable to the public as of July 2008 (CERP Interviews, May 9th through June 5th, 2008).

Formal institutional structures for programmatic AM are evident starting in 2002 with the formulation of a multi-agency Adaptive Management Steering Committee (NRC, 2007). CERP executed workshops dedicated to understanding and applying adaptive management programmatically on June 18-19 and October 22-23, 2003. These workshops focused exclusively on developing a robust AM strategy (RECOVER, 2004). In 2006 CERP and

RECOVER staff participated in the 2006 Greater Everglades Ecosystem Restoration Conference which included a plenary session dedicated to AM as it pertains to the Comprehensive Plan and a full day of concurrent workshops for AM (<http://www.conference.ifas.ufl.edu/geer2006/#agenda>). CERP also has a webpage summarizing the AM process it intends to use:

http://www.evergladesplan.org/pm/program_docs/adaptive_mgmt.aspx (Fig. C-4).

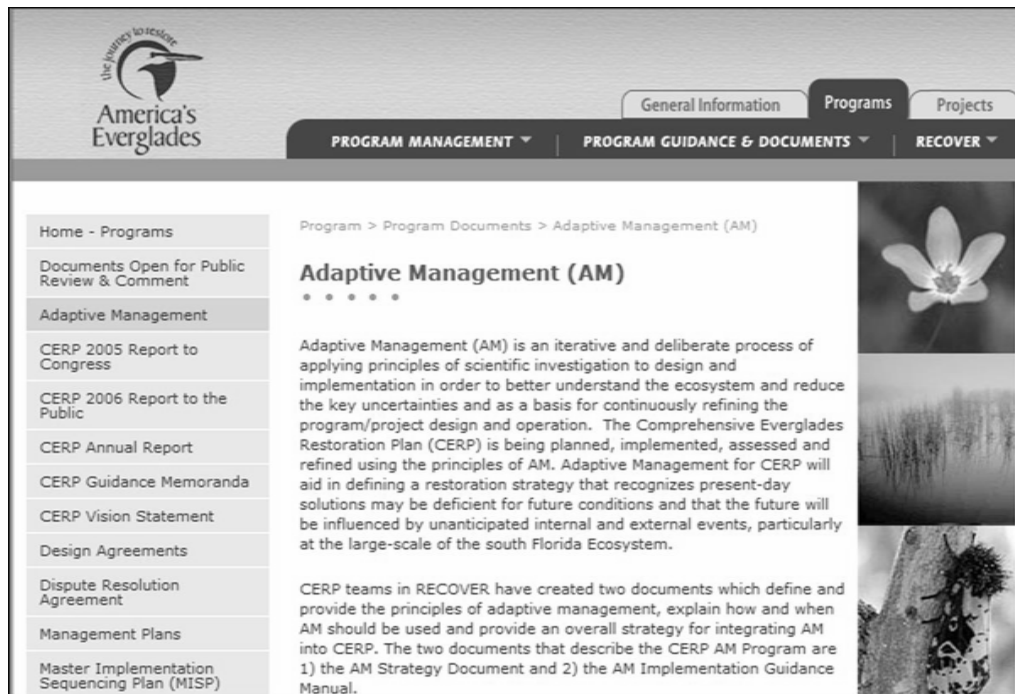


Figure: C-4 CERP's AM Webpage

System-wide Models - CERP's commitment to system-wide modeling is demonstrated with Figure C-5 that indicates the boundaries of the system-wide model and pages on program websites such as:

<http://modeling.cerpzone.org/pmviewer/index.jsp> and

http://www.evergladesplan.org/pm/recover/system_wide_modeling.aspx

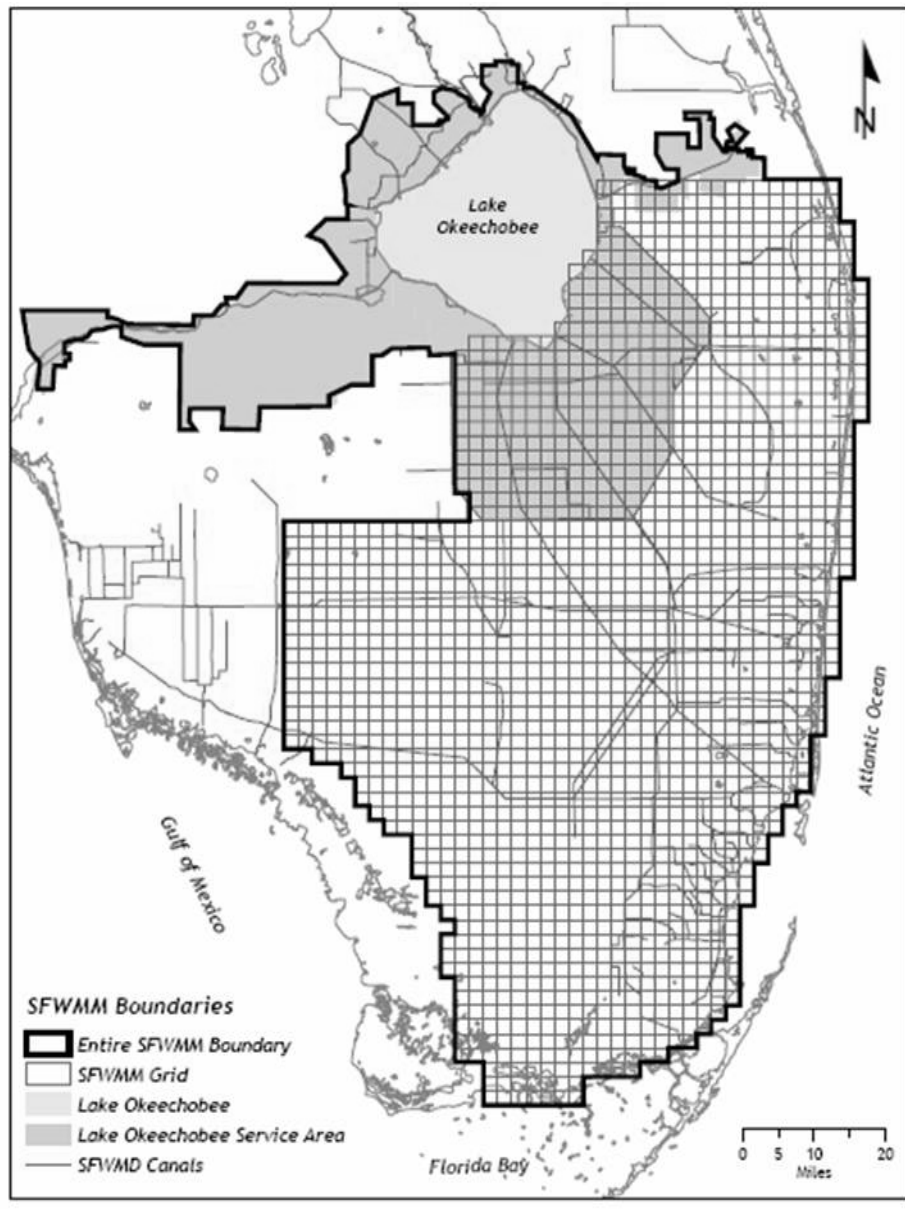


Figure: C-5 Boundaries of the SFWMM system-wide model for CERP

System-wide Monitoring - The MAP Part 1 Chapter 2 ‘Development of the CERP Monitoring Plan and Adaptive Management Program’ asserts that the MAP is a “key component” of the CERP AM Program (RECOVER 2004b, p.2-6). The MAP Part 2 Chapter 7 ‘System-wide Performance Assessment’ includes subsection 7.3 ‘Linkages to Adaptive Management’ (CERP 2006).

The MAP Part 2 conceptually links system-wide monitoring to the CERP AM four-box strategy in Box 2 (Fig. C-6) .

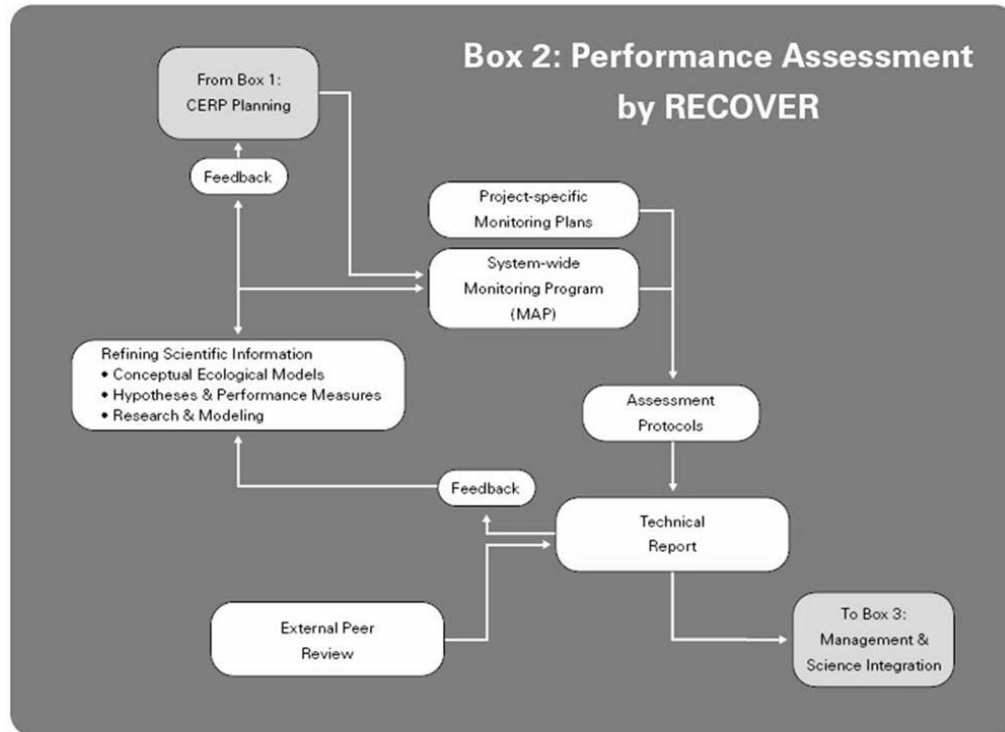


Figure: C-6 Linkage of MAP with Box 2 of CERP AM Strategy (RECOVER 2006a)

Collaborative Structure for Stakeholders - The ‘CERP Master Program Management Plan’ indicates that the plan’s formulation was developed through “an inclusive and open process that included all stakeholders” (Central and South Florida Project 2000, p.6) The Master Plan states that stakeholder group activities will be conducted for those groups that are “most interested in and directly affected by restoration efforts”(p. F-14) such as such as local government agencies, tribes and non-profits as well as involving the general public. A draft version of the MAP (RECOVER 2003) provides a figure of how stakeholders, science and policy & management will be integrated for the maximum opportunity for the success of CERP (Fig. C-7). However, this figure is not included in the final version of the MAP Part 1 (RECOVER

2004b), nor does the MAP Part 1 include any dedicated sections for stakeholders. The only inclusion of stakeholders in the MAP Part 2 identifies how monitoring results will be used to develop reports that will be provided to stakeholders, but does not indicate that stakeholders will be involved in any other way.

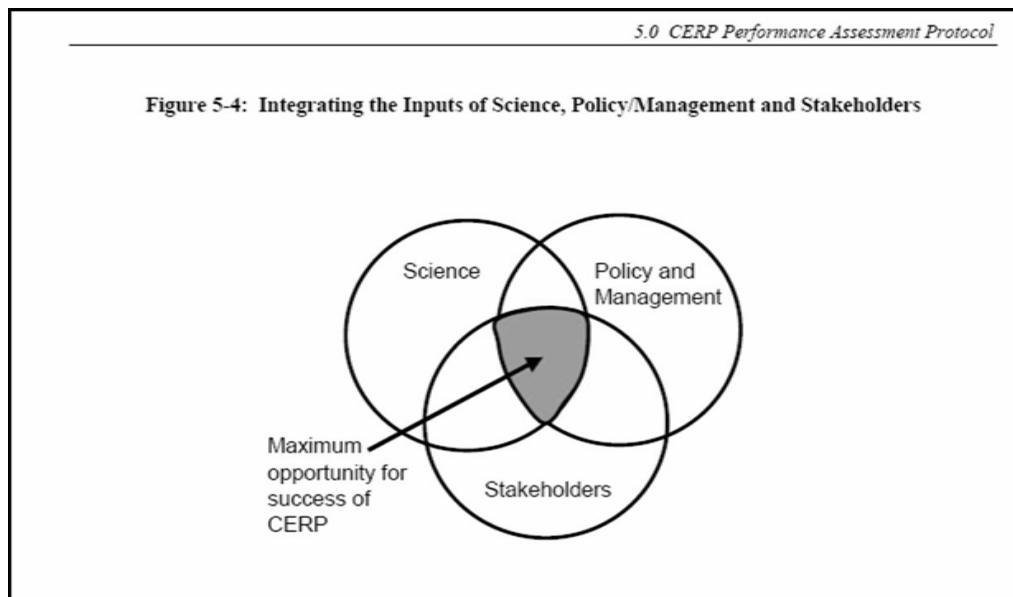


Figure: C-7 The Integration of Stakeholders for Maximum Opportunity of CERP's Success (RECOVER 2003)

Stakeholder involvement in CERP's programmatic AM program is first documented in the 2006 CERP AM Strategy. The CERP AM Strategy asserts that the integration of AM into the restoration plan is beneficial to stakeholders by providing an additional opportunity to be a part of the decision-making process and to provide a formal forum for expressing changing societal values (RECOVER 2006). CERP's AM strategy claims that collaboration takes place in all four components of the AM strategy, but stakeholders will be most involved in the processes of boxes 3 and 4 of the AM framework. However, a review of the individual pieces of box 3 (Fig. C-8) and box 4 (Fig. C-9) does not include a box specifically designated for stakeholders.

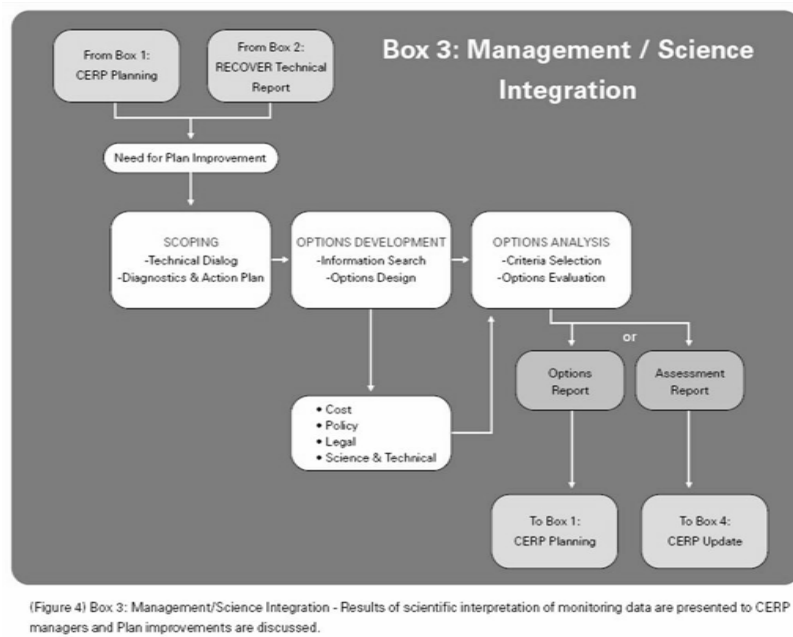


Figure: C-8 Box 3 of CERP's AM Strategy (RECOVER 2006a)

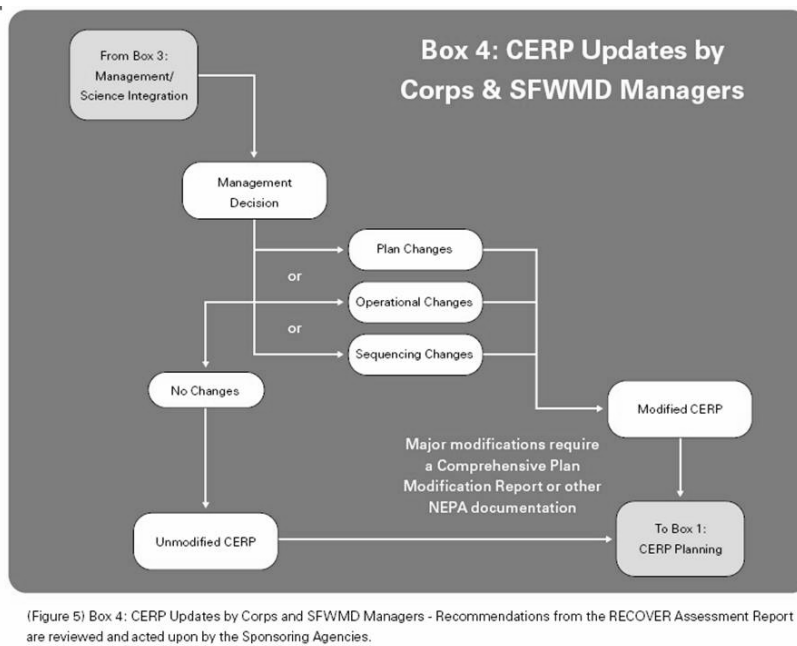


Figure: C-9 Box 4 of CERP's AM Strategy (RECOVER 2006a)

The draft version 1.2 of the AM Implementation Guidance Manual (AMIGM) provides greater detail on how stakeholders are involved in programmatic AM

for CERP. The draft AMIGM V1.2 states that stakeholders must be actively engaged in decision-making at the program level to ensure success of the restoration programs (RECOVER 2007d). CERP defines four categories of stakeholder participation in decision-making: “Inform, Consult, Involve and Collaborate” (RECOVER 2007d, p. 3-2) with the level of participation ranging from least to most, respectively. Inform is described as a one-way conversation of providing comments. Consult includes sharing of information but lacks accountability for detailing how feedback influences a decision. Involve seeks feedback, details how feedback influences decisions and increases buy-in. Collaborate is a partnership with stakeholders which includes development of alternatives, formulation of preferences and selection of preferred alternative. CERP admits that traditional stakeholder involvement exists in the ‘inform’ and ‘consult’ categories during public comment periods. Documentation of these comments exists, but there is an absence of documentation of how public comment and stakeholder feedback is used for specific decisions. Although this thesis study is only concerned with AM at the program-level, the CERP AMIGM outlines twelve steps of applying AM at the project level and Step 1 is ‘Stakeholder Engagement and Collaboration.’

Interagency Cooperation - The CERP Master Program Management Plan states that the implementation of CERP requires a higher level of partnering between the USACE and SFWMD and for the first time in the Central and South Florida Project history, the USACE and SFWMD will be sharing responsibility for designing and constructing projects (Central and South Florida Project 2000). This partnership resulted in the USACE locating its own staff at the SFWMD Headquarters to facilitate implementation. Section 3.1 of the 2000 Master Program Management Plan describes the shared responsibility between the USACE and SFWMD to jointly develop each program-level activity and in the case where other agencies are part of the program-level

activity; representatives from those agencies will be included (Central and South Florida Project 2000).

Leadership Commitment

The RECOVER AM Strategy (RECOVER 2006a) lists participants (numbers in parentheses) of the CERP AM Steering Committee and Writing Team: the USACE (5); the SFWMD (3); the USFWS (3); the NPS (3); and private consultants (6). From these 20 participants, two are listed as primary contacts (one from the USACE and one from the SFWMD) and both have since retired (CERP Interviews May 9 through June 5, 2008). The AM Implementation Guidance Manual Draft V1.2 lists six primary authors and eleven contributors: the USACE (4); the SFWMD (1); the USFWS (1); and private consultants (11). There are five individuals that are listed on both the AM Strategy and AMIGM documents, including the two individuals who retired.

Louisiana Coastal Area Ecosystem Restoration Study Results Explanations

Formal Institutionalization - Chapter 2 of Appendix A of the Ecosystem Restoration Study details how the LCA Study plans to formally institutionalize AEAM. Chapter 2 asserts that “All organizations within the LCA Management Structure have a role in implementing AEAM... (Fig. C-10) Specifically, the Program Manager is responsible for the overall program and issuing programmatic guidance to make necessary adjustments to better meet program objectives” (Louisiana Coastal Area 2004a, p.4-73). The LCA Plan also includes a schematic detailing the S&T Program approach for how AEAM and other program components will work together to develop comprehensive plans for restoration (Fig. C-11).

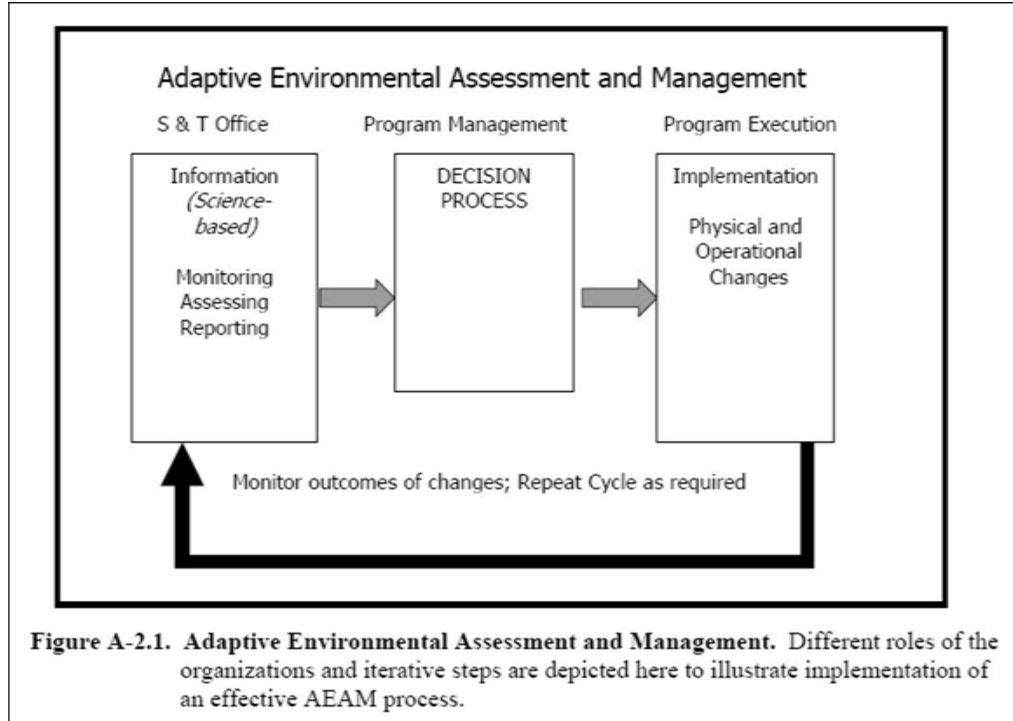


Figure C-10. Organizational Roles in the LCA AEAM Process (Louisiana Coastal Area 2004a)

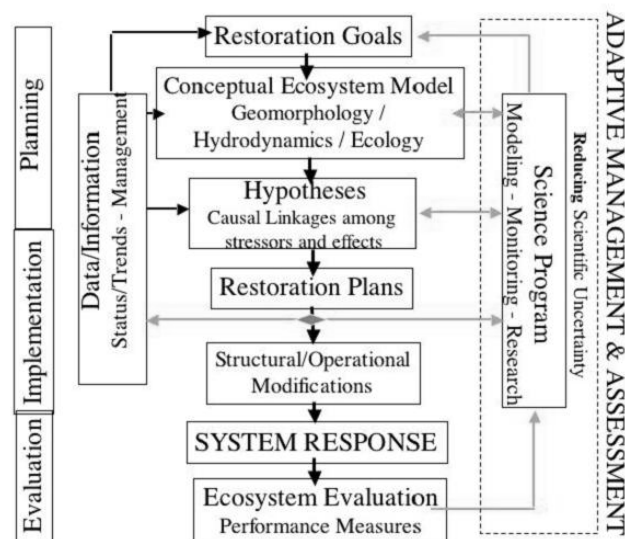


Figure: C-11 S&T Program Approach Using AEAM for Restoration Planning (Louisiana Coastal Area 2004a)

The LACPR Draft Technical Report (U.S. Army Corps of Engineers 2008) outlines a clear institutionalization of programmatic AM by proposing an Adaptive Management Program (Fig. C-12). The proposed AM Program includes a dedicated Adaptive Management Office as the center of the AM Program. The LACPR AM Program design includes four teams: Science and Technology, Adaptive Assessment, Adaptive Evaluation, and Adaptive Planning. The Science & Technology Team proposed within the AM Program is the same Science & Technology Program developed under the LCA Study. The design of the LACPR Adaptive Management Office includes a director, staff and funds to address programmatic adaptive management needs.

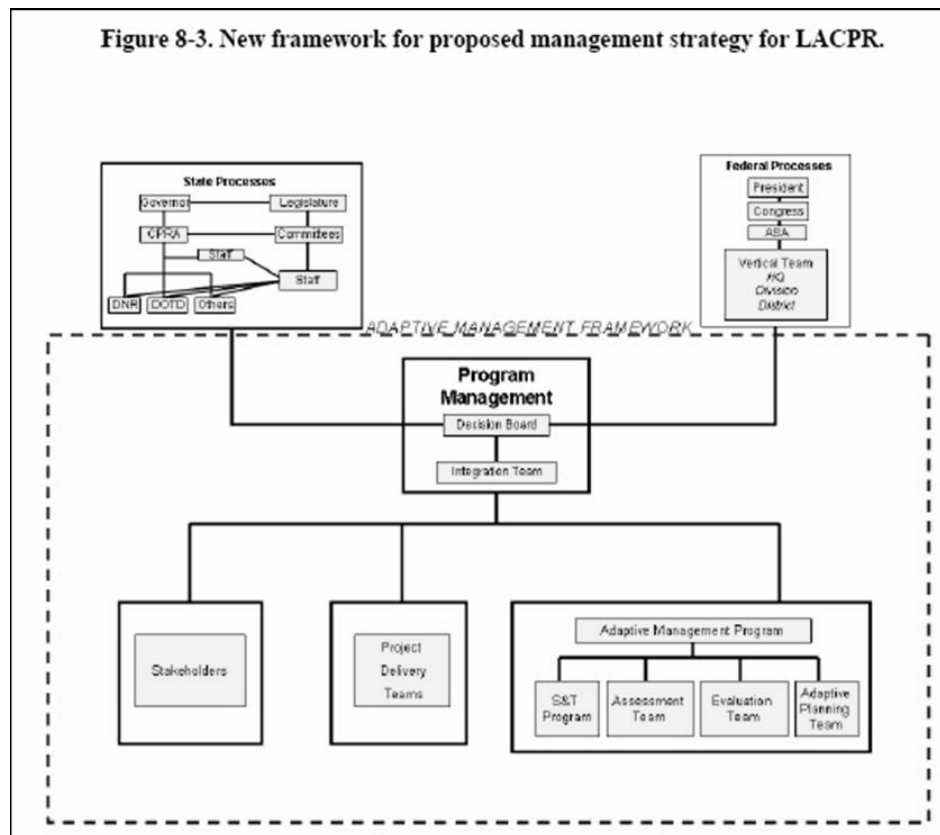


Figure: C-12 Proposed AM Program in the LACPR Management Strategy (U.S. Army Corps of Engineers 2008)

System-wide Models - The Coastal Louisiana Ecosystem and Restoration (CLEAR) model was developed to support decision-making in the LCA Study (http://www.clear.lsu.edu/clear/web-content/iPages_web/02AboutCLEAR.html) (Fig.C-13)

Chapter 2 ‘Formulation of the LCA Ecosystem Model’ asserts that “modeling plays a crucial role in AEAM to modify or adjust restoration programs or actions, and to provide analysis and guidelines as to the efficiency of different rehabilitation strategies (Figure C-14)” (Louisiana Coastal Area 2004b, p.A-13).

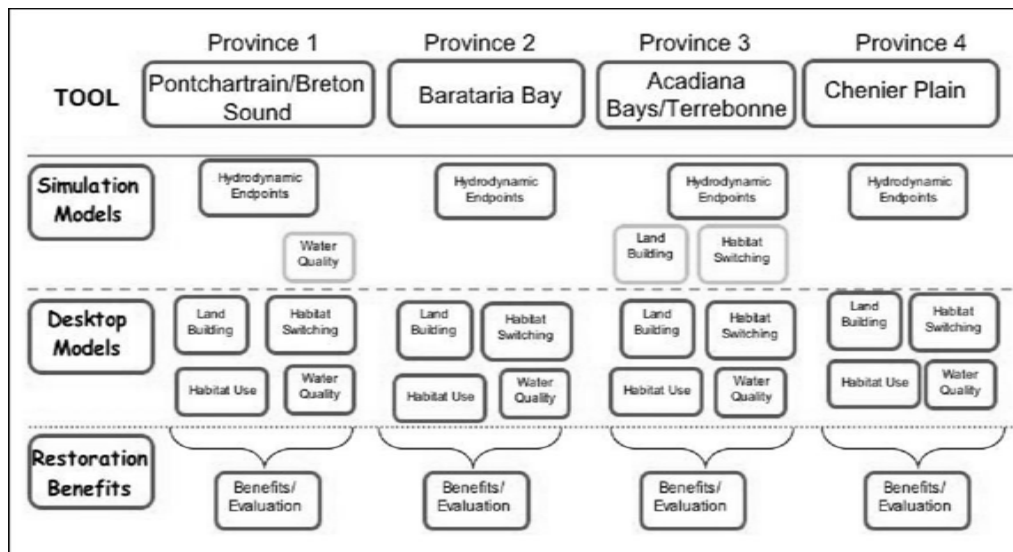


Figure: C-13 LCA CLEAR Ecosystem Model (Louisiana Coastal Area 2004c)

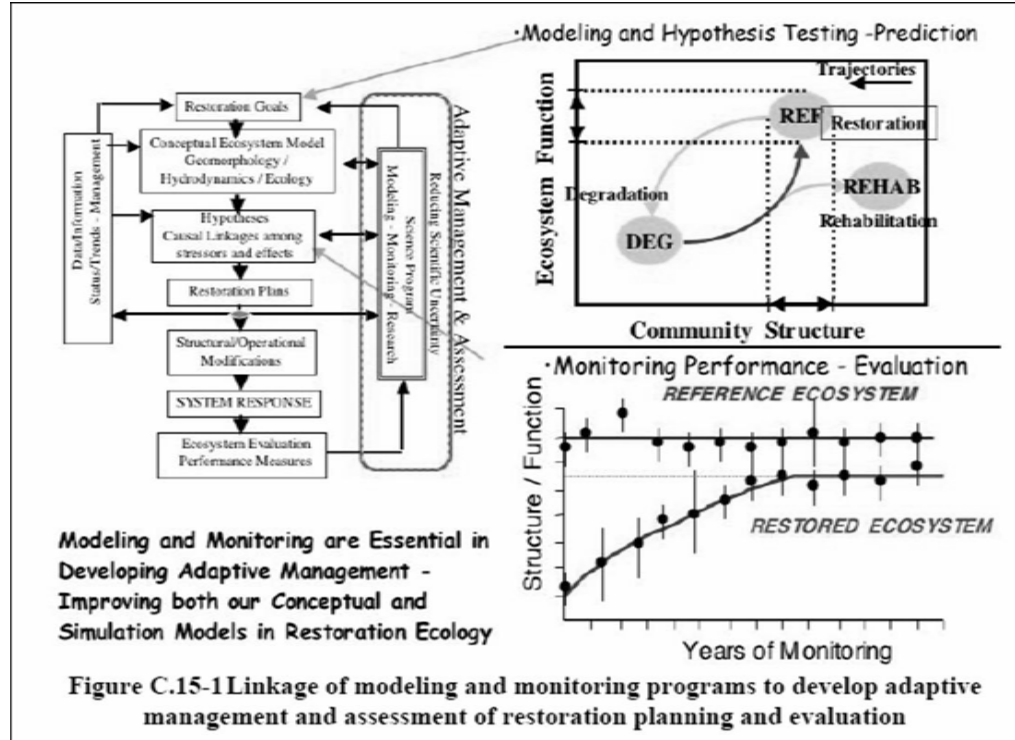


Figure: C-14 Conceptual Linkage of Modeling and Monitoring to AM (Louisiana Coastal Area 2004c)

System-wide Monitoring - The Coastwide Reference Monitoring System includes a webpage (Fig. C-15) (<http://www.lacoast.gov/projects/overview.asp?statenumber=CRMS>).

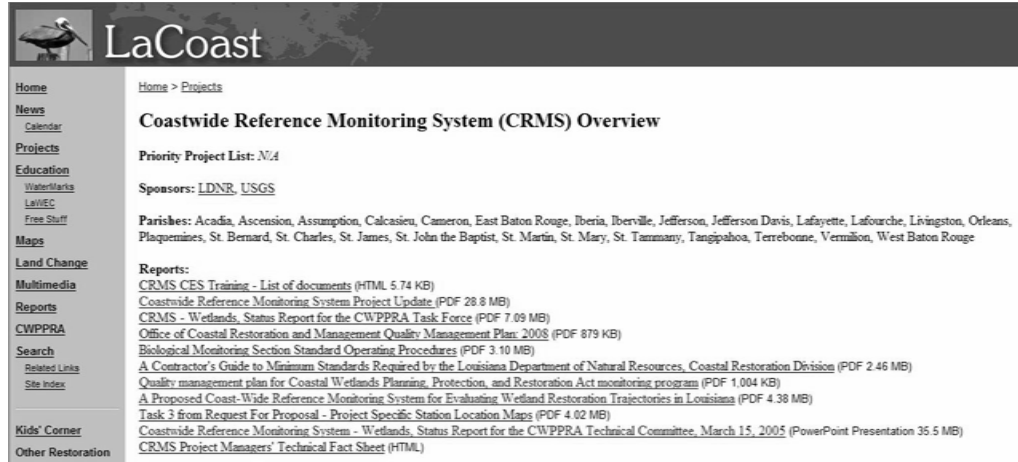


Figure: C-15 Screenshot of the CWPPRA Coast-wide Reference Monitoring System (lacoast.gov)

Collaborative Structure for Stakeholders - Documentation of stakeholder involvement in the LCA Study includes Section 5 of the Final Report 'Public Involvement' (Fig. C-16) (<http://www.lca.gov/lcafactsheet.pdf>). The methods for participation included traditional public comments and some instances of small group breakout sessions allowing individuals to interact and collaborate with study team members (Louisiana Coastal Area 2004a). The LCA Plan includes an example of incorporating feedback from stakeholder involvement with the inclusion of freshwater management and allocation in a sub-region of the LCA plan (Louisiana Coastal Area 2004a).

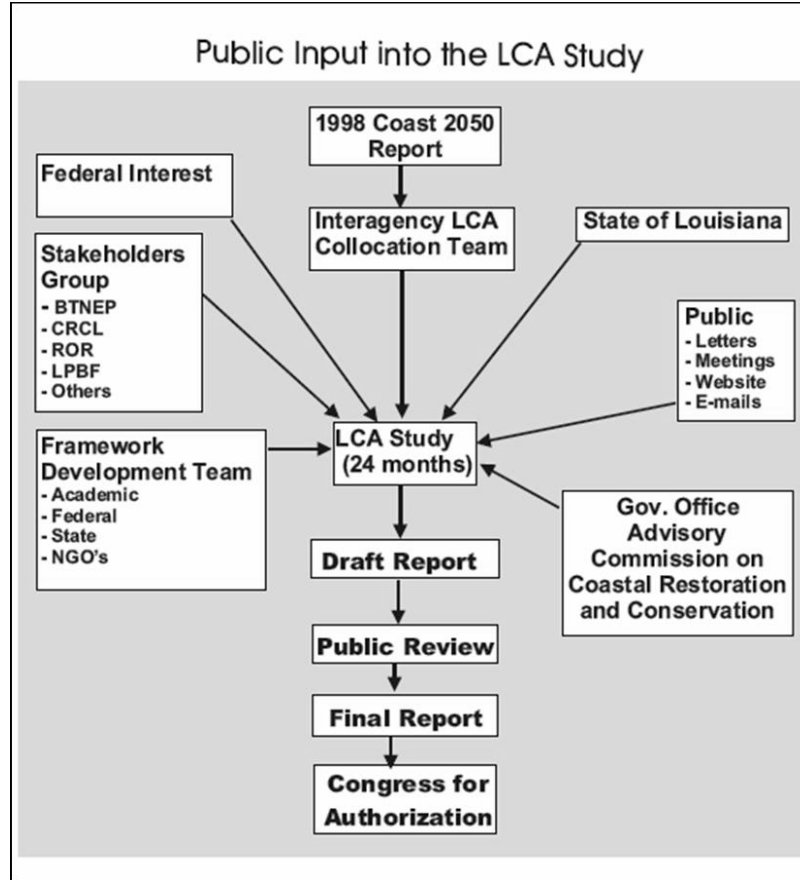
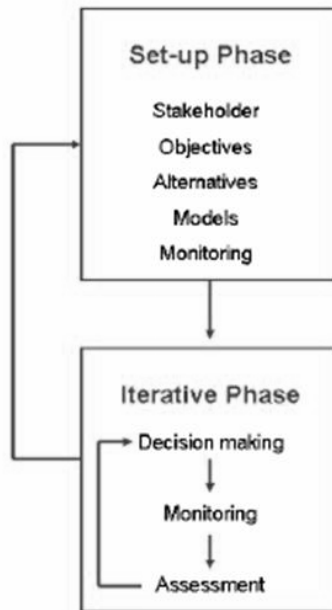


Figure: C-16 Public Input into the LCA Study

(<http://www.lca.gov/lcafactsheet.pdf>)

The LACPR report also proposes a strong link between stakeholders and programmatic AM. In addition to stakeholders being included in the AM Framework (Fig. D-13), the report proposes that development of a programmatic AM strategy for LACPR would be executed in consultation with stakeholders. This proposal outlines a two-phase approach where stakeholders are involved in the set-up phase (Fig. C-17)

Figure 8-4. Two-phase learning in adaptive management.



Source: Williams, B.K., R.C. Szaro, and C.D. Shapiro. 2007.

Figure: C-17 Inclusion of Stakeholders in 2-phase Learning in AM (U.S. Army Corps of Engineers 2008)

Interagency Cooperation - Appendix A of the LCA Study Main Report is dedicated to the Science and Technology Program and includes a diagram of how the S&T Program works with the LCA Program Execution Team (PET) using an adaptive management context to facilitate communication (Fig. C-18).

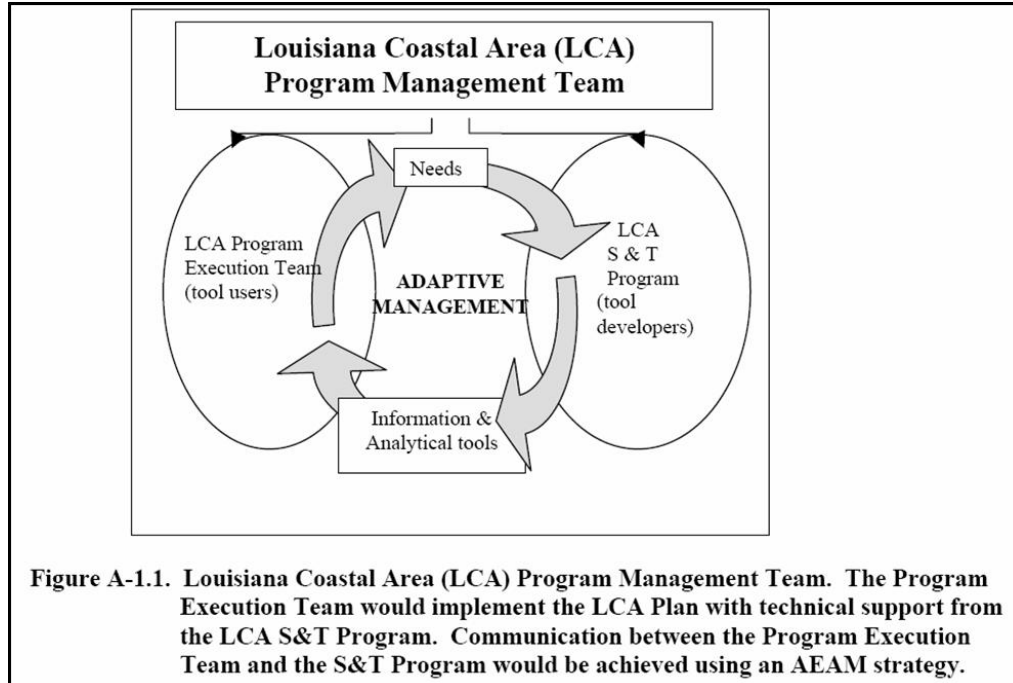


Figure: C-18. AEAM as the communication tool between the LCA PET and the LCA S&T Program (Louisiana Coastal Area 2004a)

LACPR documentation explicitly addressed interagency communication as part of the AM process and developed a flow chart of the traditional communication channels to demonstrate the challenge of interagency communication and cooperation (Fig. C-19).

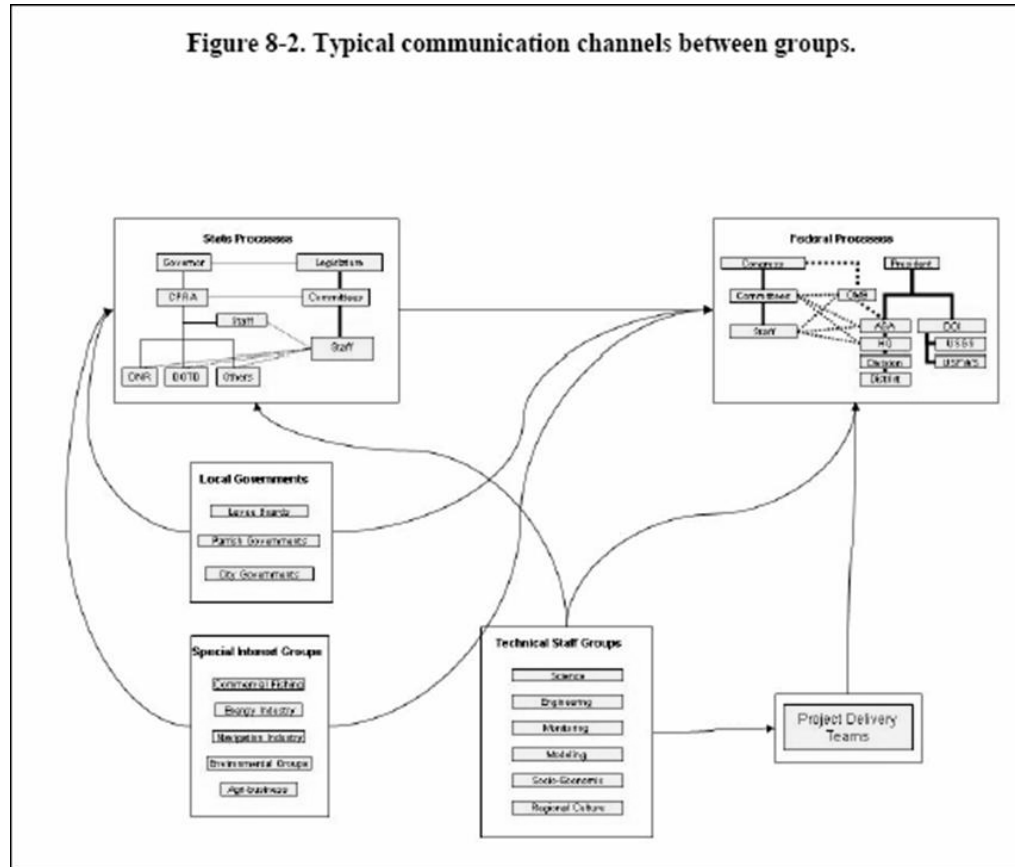


Figure: C-19 Typical Interagency Communication between Participants in Louisiana Restoration (U.S. Army Corps of Engineers 2008)

CALFED Results Explanations

Formal Institutionalization - The Ecosystem Restoration Program objective under CALFED is the most visible example of attention for using AM programmatically. Volume 3 of the ERP Strategic Plan dedicates Chapter 3 to the 'Adaptive Management Process' (Fig. C-20).

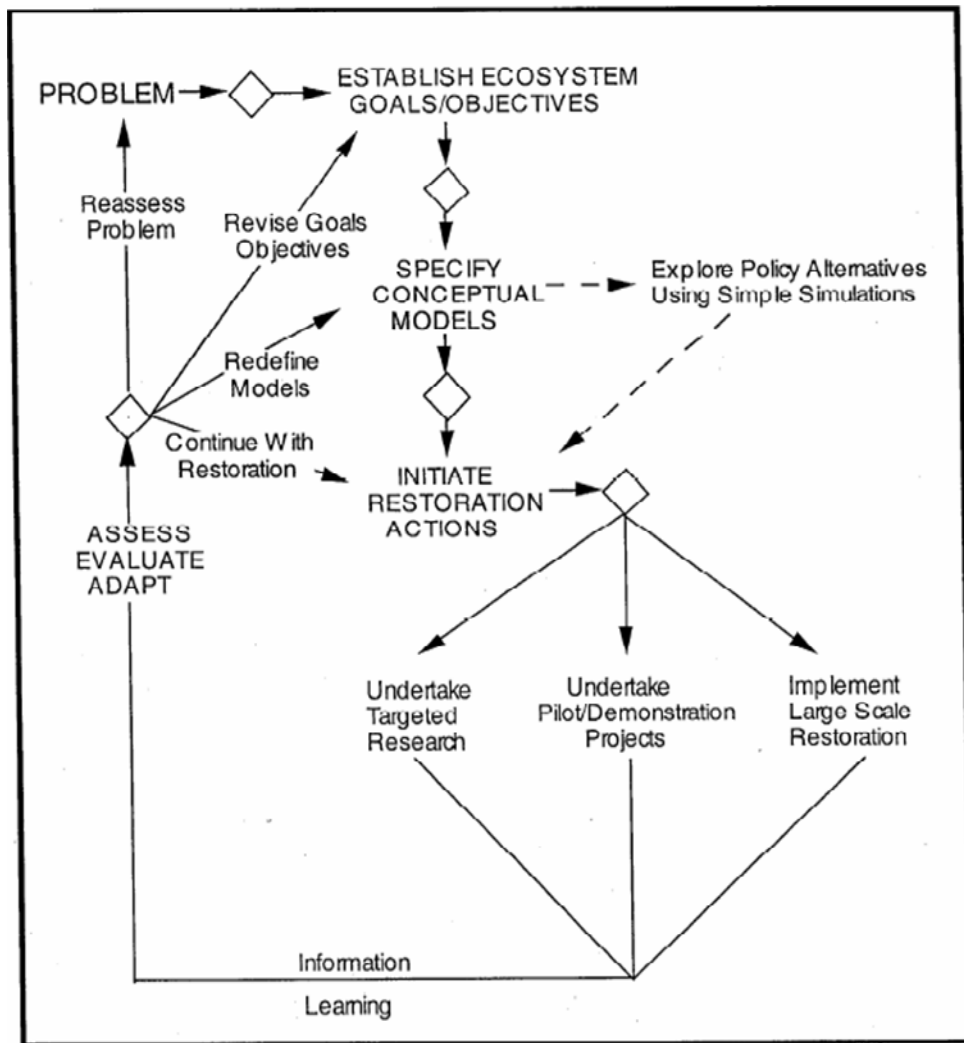


Figure: C-20 CALFED Diagram of the AM Process (CALFED Bay Delta Program 2000d)

On July 10-11, 2001, CALFED hosted an Adaptive Management Symposium with the Adaptive Management Practitioners Network (<http://www.adaptivemanagement.net/CALFEDagenda.htm>) “to share practitioners’ experiences with large regional ecosystem restoration and implementation of adaptive management” with the AMPN, CALFED staff and others. Proceedings of this symposium are available through the AMPN (<http://www.adaptivemanagement.net/Proceedings/AMinBayDelta.pdf>) and explain that one of the goals for hosting the symposium is to help move CALFED’s programmatic approach more towards an AM approach.

System-wide Monitoring - The ‘Framework for indicators for science, management and adaptive management in the CALFED Bay-Delta Program’ Draft 1/5/06 asserts that indicators can be used to facilitate adaptive management and link science, management and adaptive management (CALFED Bay-Delta Program 2006) (Fig. C-21).

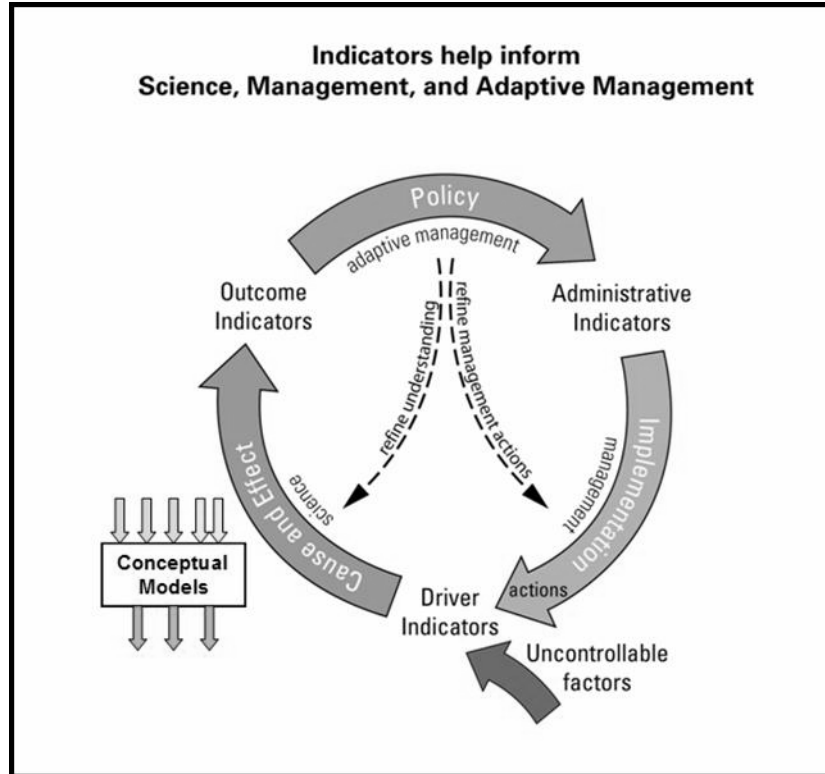


Figure: C-21 Indicators Linking Science, Management and Adaptive Management (CALFED Bay-Delta Program 2006)

Interagency Cooperation - Figure C-22 is from the Booher and Innes publication summarizing the differences between governance learning before and after CALFED.

Table 3: Comparison of Governance Before CALFED and After²¹	
Before CALFED	After CALFED
Gridlock and litigation driven process	Collaborative process
Project-by-project decisions	Comprehensive framework with linkages and balancing requirements
Single agency, single purpose projects	Multiple purpose, interagency projects
Centralized decision making	Emphasis on local and regional solutions
Limited public involvement	Extensive public involvement and leadership
Internal agency science; no peer review	Independent science reviews
Limited or no accountability or transparency	Public governing body and planning and tracking systems
Mechanistic decision-making based upon assumptions and mandates	Flexible, adaptive management and learning

Figure C-22: Summary of Changes in Governance Learning from CALFED's New Organization (Innes 2006)