

# **An Adaptive Assessment Strategy for the Comprehensive Everglades Restoration Plan**

## **RECOVER Adaptive Assessment Team**

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### **Introduction**

Large, complex regional restoration programs must include a means for measuring how well they meet their goals. For the Comprehensive Everglades Restoration Plan (CERP), scientists have developed a process known as the Adaptive Assessment. Adaptive Assessment will measure responses of natural and human systems as the CERP is implemented, and quantify how well the restoration plan is meeting its desired objectives. Adaptive Assessment also will provide a scientific basis for making improvements to the plan, if and when the need or opportunities for such improvements are identified. The primary role of Adaptive Assessment is to have an on-going process for increasing the probability that the plan will be successful.

The terms “Adaptive Assessment” and “Adaptive Management” are currently used interchangeably by many managers and resource professionals. Because Adaptive Management in its original meaning described a designed process for testing hypotheses, the term Adaptive Assessment is used here to describe a protocol for collecting and interpreting new information specifically for the purpose of improving the design of the Comprehensive Plan.

Adaptive Assessment provides an organized process for confronting and reducing uncertainties that exist about how the natural and human systems in south Florida will respond to a long-term restoration program. Some uncertainties are inevitable, in that we are dealing with systems that are highly complex, not thoroughly understood, and difficult to predict. The systems are complex in their detail (i.e., in the number of different components that they include) and their dynamics (i.e., the number and scales of relationships that drive responses). The current level of uncertainty has prompted a range of professional opinions regarding the comparative importance of different ecosystem variables and of the linkages among them. Although these debates are essential steps for focusing and prioritizing future research and modeling and for refining our measures of success, they reveal that our current understandings are inadequate (primarily at medium to large scales) to predict with certainty the ecological responses to specific hydrological patterns. Adaptive Assessment provides a means for continually reducing these levels of uncertainty, by refining the design of the restoration program in response to improving information and scientific understanding.

Because of the inevitable uncertainties, natural and human systems will at times respond in ways that are not anticipated or predicted by any existing hypotheses and assumptions. It is these unexpected responses, when they result in negative changes, which often are the stimuli for “crises” at political and management levels. Adaptive

Assessment moderates the crisis response by providing an in-place process for early detection and interpretation of the unexpected, and for maximizing the learning opportunities associated with these events.

Adaptive Assessment provides a process for learning and incorporating new information into the planning and evaluation phases of the restoration program. Adaptive Assessment is valuable in that it treats all responses, expected or not, as learning opportunities. An unexpected response does not represent a failure for the program if it can be used to improve our understanding of a complex system so that corrective actions can be taken in the restoration program in order to move the system towards improved environmental health. Much of the design of the restoration program, including the selection of performance measures and targets, is based on a set of causal assumptions derived from a set of conceptual ecological models for the major landscapes of south Florida. These conceptual models are based on a large body of existing scientific information and on best professional judgements. Implementation of the restoration program provides opportunities for testing these assumptions by comparing actual system responses to those that are predicted. Actual responses, in combination with information obtained from applied research and modeling, can lead to refinements in the conceptual models and assumptions, and to reduced levels of uncertainty regarding future iterations of the restoration program.

Overall, Adaptive Assessment provides a framework for: (1) strengthening coordination across agency and disciplinary lines by establishing a commonly accepted assessment process and set of performance targets; (2) validating the performance of CERP components as they are put in place; and (3) encouraging agencies to be flexible about the design and implementation of the restoration program. The bottom line is that Adaptive Assessment substantially improves the probability that a complex, regional restoration program will be successful, by providing a structured, well-focused process for assessing and refining the program on a continuing basis throughout its implementation.

## **Key Components of Adaptive Assessment**

### *Conceptual Ecological Models and Performance Measures*

The basis for Adaptive Assessment is a set of conceptual ecological models. These models provide a tool for converting broad policy-level objectives established for the CERP into specific, measurable indicators of the health of the natural and human systems, and develop a suite of testable hypotheses that predict major ecological responses to the restoration program. These assumptions become the basis for the design of the CERP by identifying the structural and operational modifications of the system that are necessary to achieve the restoration objectives. The rationale is that a restoration plan should focus on correcting the stressors identified in the conceptual models, because these models represent a consensus opinion of scientists regarding the most important ecological attributes and causal links in stressed natural and human systems in south

Florida. A set of conceptual ecological models for south Florida is described in Ogden and Davis (1999).

The conceptual models identify the major stressors and ecological attributes (indicators) that provide the most useful measures of how the system is expected to respond to changes made by the Comprehensive Plan. The models identify a relatively small number of biological, chemical and physical elements that collectively are representative indicators of the system-wide responses to restoration at a range of spatial and temporal scales. The model elements are the basis for application of a regional science strategy during the implementation of the CERP. Performance measures are developed for each of the elements (ideally for both stressors and indicators) and are used as the standards for evaluating restoration program success. The full set of measures and targets are used to design a regional monitoring, research and modeling program for the Comprehensive Plan.

#### *Comprehensive Assessment Program*

Adaptive Assessment requires that a program be in place that integrates (1) comprehensive monitoring of a set of spatially, temporally and hierarchially appropriate performance targets (a.k.a., indicators or endpoints), in combination with (2) scientific information derived from applied research and predictive modeling. In terms of successfully designing and implementing a regional restoration program, the monitoring focuses on elements of the natural and human systems that have been specifically identified to be the most appropriate measures of the desired restoration targets. The science focuses on reducing major uncertainties in linkages between stressors and ecological attributes in the conceptual models. This overall approach provides a rigorous program that is highly relevant to the overall goal of successfully restoring or enhancing the natural and human systems of south Florida.

The monitoring component of Adaptive Assessment is defined as one which: (1) uses a regionally standardized set of monitoring and data management protocols; and (2) is designed at spatial scales and over time periods that are consistent with the scales of the implementation schedule for the restoration plan and the expected system responses. Further, (3) such a monitoring program only becomes comprehensive when it measures responses by the full set of physical, chemical and ecological performance measures that are established for the restoration program. The specific objectives of the monitoring should be to: (1) measure the status and trends among the select set of environmental indicators; (2) establish base-line variability for each of the indicators; and (3) detect unexpected responses for elements of the systems that have not been specifically earmarked by the performance measures as key indicators.

The monitoring should address several other considerations. The design of this program provides an opportunity to review existing monitoring programs for their extent, protocols, data management processes, and funding bases relative to the needs of Adaptive Assessment. CERP monitoring should build on existing monitoring programs to achieve the objectives of Adaptive Assessment, while still meeting individual agency

needs. The monitoring should be initiated at the earliest opportunity, so that new base lines (where none currently exist) can be established prior to implementation of the restoration program. Adaptive Assessment will require annual reports of monitoring results, as a basis for interpreting system responses relative to the predicted responses from each phase of the restoration program.

Monitoring alone is not sufficient for a program of Adaptive Assessment because many of the links between stressors and values in the existing ecosystem conceptual models are uncertain. These uncertainties must be addressed because the models are the foundation of Adaptive Assessment. A long-term program of applied research and modeling, which is well-focused on improved understandings of fundamental cause and effect relationships in the greater Everglades ecosystem, is therefore considered to be an essential component of the overall comprehensive program.

In order for Adaptive Assessment to benefit the design and assessment of the CERP, it must include the following elements: (1) a long-term data collection program (physical, chemical, and biological) designed to monitor ecosystem status and trends throughout the implementation of the plan; (2) cause-and-effect scientific investigations designed to increase ecosystem understanding, particularly if restoration implementation yields unanticipated results; (3) hydrological and ecological modeling to gain a better predictive understanding of ecosystem responses to restoration; and (4) peer review at the individual project design, implementation, and dissemination levels to ensure scientific quality and rigor.

### **The Adaptive Assessment Process**

Adaptive Assessment measures responses in natural and human systems to determine how well the restoration plan achieves its desired objectives, and uses these assessments as a basis for making improvements in the plan. To be successful, an Adaptive Assessment strategy requires that certain conditions and processes be in place. These are: (1) that a restoration program be implemented iteratively; (2) that key indicators of conditions (environmental health) in the natural and human systems be identified and appropriately monitored; (3) that it be possible to make changes in the design, sequencing, and operation of the plan in response to information gained from the integrated program of monitoring, applied research and modeling; and (4) that a specific protocol for conducting Adaptive Assessment be in place throughout the life of the restoration program.

A schematic representation of the overall Adaptive Assessment process is shown in Figure 1, next page. This schematic shows several places where assessments can “feed-back” to alter the design, sequencing and operation of a plan, and the design and assumptions contained in the conceptual models. The components and links shown are new in that no agency or multi-agency process has previously been in place for the purpose of implementing regional Adaptive Assessment. The CERP team has created a multidisciplinary Adaptive Assessment team within its system-wide RECOVER process, and this team will review and interpret annual monitoring results in the context of the

performance measure targets, and use the annual assessments as a basis for recommending any needed revisions in future phases of the restoration plan.

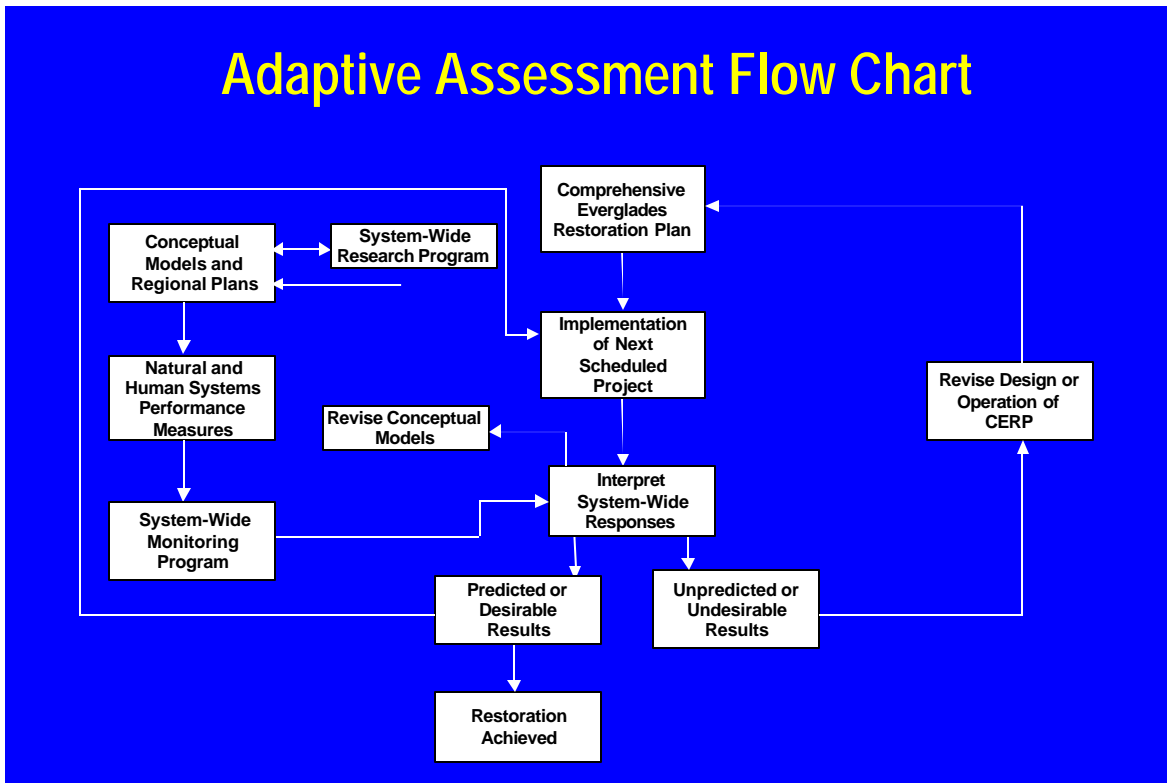


Figure 1

To fully evaluate the success of a restoration program, Adaptive Assessment must consider responses over a wide range of scales, including broad temporal scales. For a number of reasons, some significant system responses may not become apparent until several years following the time when the project specifically responsible for these ecological changes has been completed. The time required for these responses to be detected may be longer than the intervals between plan iterations. Even where system responses seem to be occurring on shorter time scales, relative to the implementation of discrete components, it still may be difficult to determine specific cause and effect relationships.

These complications in the Adaptive Assessment process, a consequence of the necessary pace of the overall restoration program and the remaining uncertainties in causal relationships, are being substantially moderated in two ways. First, by ensuring that applied research and modeling are integral parts of the process, the baseline of information needed for predicting and interpreting system responses is constantly being strengthened. Secondly, by creating a strong science presence on the RECOVER assessment team, the best understandings of the south Florida systems can be incorporated into Adaptive Assessment. The Adaptive Assessment team is responsible

for reviewing and interpreting system responses, integrating new science into the assessment process, and revising the conceptual models and working hypotheses.

## **Sources**

The ideas presented in this Adaptive Assessment strategy document have come from a number of sources including, (a) S.S. Light, L. Gunderson, and C.S. Holling. 1994. On ecological policy design and adaptive environmental management. Draft report. SFWMD, (b) minutes of an adaptive environmental management workshop, 27 Feb.-01 March 1995, Gainesville FL., (c) minutes of an adaptive assessment scoping workshop, 27-28 March 1996, Gainesville FL., (d) minutes of a multi-agency adaptive management workshop, 02 July 1996, Jacksonville FL, (e) the “Integrated Science Plan.” 18 December 1997. Science Coordination Team. South Florida Ecosystem Restoration Working Group, and (f) R. Margoluis and N. Salafsky. 1998. Measures of Success. Island Press, Washington, D.C. This Adaptive Assessment document has been reviewed and approved by the Adaptive Assessment Team of RECOVER.

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