# Chapter 7B: RECOVER Activities Update

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## SUMMARY

In past South Florida Environmental Reports, we have provided highlights on Restoration Coordination and Verification (RECOVER) activities and products. These activities and products are reviewed biennially by the Committee on Independent Scientific Review of Everglades Restoration Progress (CISRERP), an independent review panel convened by the National Academy of Sciences to review all aspects of the Comprehensive Everglades Restoration Plan (CERP) and its implementation. The second biennial report by CISRERP was recently released (NRC, 2008). This report states that much good science has been developed and RECOVER has now produced nearly all of the elements needed to implement a decision making framework using adaptive management. Adaptive management is an iterative and deliberate process of applying principles of scientific investigation to design and implementation in order to better understand the ecosystem to reduce key uncertainties and as a basis for continuously refining program/project design and operation.

System status reports are the cornerstone of the CERP Adaptive Management Program. In Chapter 7B of the *2008 South Florida Environmental Report – Volume I*, highlights from the 2007 System Status Report (RECOVER, 2007a) were provided. The 2007 System Status Report contains an analysis of monitoring data from the CERP Monitoring and Assessment Plan (MAP) and other sources, and a preliminary assessment of ecological condition and status of the South Florida ecosystem. Monitoring and data collection and assessment activities cost-shared by the South Florida Water Management District and the U.S. Army Corps of Engineers continued this year and will be reported in the next System Status Report scheduled to be completed in 2009. In addition to the MAP and system status reports, the CERP Adaptive Management Program has many other components, several of which are RECOVER's responsibility to implement. This year's chapter provides a summary of work recently or currently under way on RECOVER's components of the CERP Adaptive Management Program. In addition to implementing the MAP and producing system status reports, these components include the following:

- Preparing periodic updates on CERP
- Evaluating the expected systemwide effects of CERP updates
- Developing and updating conceptual ecological models
- Developing and updating systemwide performance measures
- Assisting CERP projects in developing their performance measures

- Conducting consistency reviews comparing project performance measures to the systemwide performance measures
- Working with modelers to refine models and model output
- Evaluating the final array of project alternatives for systemwide effects using the systemwide performance measures
- Managing and utilizing the large amount of data generated by the MAP
- Developing and refining interim goals and targets
- Determining whether interim goals and interim targets can be or are being met
- Updating the MAP

Although the significant delays in the implementation of CERP projects that have resulted from a lack of federal funding have altered the way in which RECOVER is proceeding with its mandated responsibilities, many RECOVER activities continue to be important and relevant to the eventual success of the restoration of the South Florida ecosystem.

# COMMITTEE ON INDEPENDENT SCIENTIFIC REVIEW OF EVERGLADES RESTORATION PROGRESS 2008 REPORT

Section 601(j) of the Water Resources Development Act of 2000 (Public Law 106-541) requires the establishment of an independent scientific review panel to review Comprehensive Everglades Restoration Plan's (CERP) progress toward achieving its natural system restoration goals. To provide this review, a branch of the National Academy of Sciences, the National Research Council (NRC), routinely convenes the Committee on Independent Scientific Review of Everglades Restoration Progress (CISRERP). This committee has recently released their second biennial review (NRC, 2008). The committee commented on RECOVER products and also provided detailed recommendations to further improve RECOVER's processes and tools.

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> The RECOVER team has now produced nearly all of the elements needed to implement a decision-making framework using adaptive management to assess scientific uncertainty. Documents describing the adaptive management process, and all aspects of performance assessment (i.e., the monitoring plan, an assessment plan, performance, and quality assurance requirements) are completed. Conceptual ecological models that are the foundation of the monitoring and assessment documents have been peer reviewed and published. The information management and data management system and the Interagency Modeling Center are actively developing tools to support the assessment and planning aspects of decision making and assisted in production of the 2007 System Status Report, the first in a series of assessment reports that documents the ecosystem response to implementation of CERP projects. The System Status reports are a critical component of the adaptive management strategy; they are the vehicle used to transmit new scientific information to restoration managers. (NRC, 2008)

The committee found that the CERP Adaptive Management Strategy document (RECOVER, 2006b) provides a strong basis for adaptive management within CERP. It stressed the importance of the Monitoring and Assessment Plan (MAP) and the system status reports. According to CISRERP, the 2007 System Status Report (RECOVER, 2007a) achieved the stated goals; they deemed it a success. It "reports on the initial condition of the ecosystem and can be used to gauge

system response as CERP projects are implemented. For this reason, the first System Status Report is an extremely valuable document" (NRC, 2008). The committee also states that: "The lessons learned from completing the first system status report will be invaluable to refinement of the monitoring plan, the conceptual ecological models, and existing models and further prioritization of future monitoring and assessment efforts."

The committee also reviewed RECOVER performance measures. The Development and Application of Comprehensive Everglades Restoration Plan System-wide Performance Measures (RECOVER, 2007b) document "provides an excellent discussion of challenges associated with developing and applying performance measures" and, along with the associated performance measure documentation sheets, "serves as a valuable resource for scientists and managers" (NRC, 2008).

# MONITORING AND ASSESSMENT PLAN UPDATE

It was recognized during development of both Parts 1 and 2 of the CERP MAP (also known as MAP 1 and 2, respectively) (RECOVER, 2004; 2006a), and as MAP monitoring and research has proceeded, that new insights, programs, and changing priorities would require periodic updates to the program. For example, the initial MAP assumed that funding for complementary monitoring programs already in place by other agencies would remain intact and could be leveraged, but many of these programs are no longer being funded by other agencies. With the (1) recommendations of the National Research Council (NRC, 2006), the completion of the 2006 Pilot System Status Report (RECOVER, 2007d), and 2007 System Status Report (RECOVER, 2007a), (2) proposed linkages between CERP project-level monitoring and MAP monitoring, and (3) uncertainties regarding project implementation timelines, schedules, and funding (for MAP and complementary programs), it is clear that refinement of the plan is needed.

RECOVER has developed a strategic approach to update the MAP. The strategy is being used as guidance to evaluate the hypotheses, performance measures, and monitoring and assessment programs comprising the MAP. When the refinement process is completed, the results will be incorporated into an updated MAP document referred to within this chapter as MAP 2008. The intent of MAP 2008 is to focus on and sustain the monitoring activities necessary to address the hypotheses and ecological assumptions and premises that are at the foundation of Everglades restoration, as well as ensure appropriate linkages to interim goals and interim targets (RECOVER, 2005a), adaptive management (RECOVER, 2006b), and project-level monitoring.

The full suite of monitoring and research needs identified by the plan has always been larger than the available funding and in-kind support provided by non-RECOVER monitoring programs. Various attempts at prioritization have been employed to maintain the most critical components of the plan as annual budgets and non-RECOVER efforts have changed. In MAP 2008, a number of low priority projects have been removed from the total projects list. In addition, an attempt was made to formalize the prioritization process by developing a series of rational guidelines for evaluating monitoring programs to ensure that the highest-priority monitoring continues.

Based on the results from the 2007 System Status Report, the structure of the assessment process laid out in MAP 2 – the use of conceptual ecological models, the establishment of pre-CERP conditions, the ability to detect change, and the need to address both "what" (ecosystem status) and "why" (ecological cause and effect) questions via monitoring and assessment – will be retained in MAP 2008. Additionally, the 2007 report substantiates the systemwide perspective to monitoring and assessment design and interpretation.

The system status reports have provided invaluable information that will facilitate refinement of hypotheses, improving their specificity and applicability in the real-world setting of restoration. Periodic systemwide assessments provide a continuing basis upon which to evaluate monitoring components. These repetitive cycles of evaluation will identify those monitoring elements that are the most useful, and help optimize monitoring by revealing those that may be over represented or less directly valuable for the assessment process. As an additional safeguard to the quality and focus of science, the NRC provides ongoing guidance to RECOVER.

The NRC has recommended pursuing a top-down approach. Accordingly, RECOVER is updating the MAP using a suite of systemwide physical, chemical, and ecological attributes derived from the Total System Conceptual Ecological Model (Ogden et al., 2005). The Total System Conceptual Ecological Model gives an overall representation of the systemwide perspective and the stressors and key attributes of the ecosystem. From this model and the regional conceptual ecological models (Barnes, 2005; Browder et al., 2005; Crigger et al., 2005; Davis et al., 2005a, 2005b; Duever, 2005; Havens and Gawlik, 2005; Ogden, 2005; Rudnick et al., 2005; Sime, 2005; VanArman et al., 2005), a subset of conceptual ecological models along with hypothesis clusters were developed that include all of the components of the stressor-attribute interactions at a level of detail that allows for the design and cost of each monitoring component. The hypothesis clusters and related conceptual ecological models also illustrate how monitoring efforts may be interdependent, which may affect the sustainability of related monitoring.

These ecological attributes will also be used as the basis for revising the interim goals (see the *Interim Goals Update* section of this chapter; RECOVER, 2005a), which are intended to provide measures of restoration success. As such, they must be closely coupled with what is monitored, assessed, and implemented by the MAP both currently and in the future. The MAP 2008 update process is being closely coordinated with the selection of interim goal metrics such that MAP monitoring will provide the information needed to adequately assess and report on the status of these goals in the future.

For each of the MAP modules, MAP hypotheses were ranked. The ranking is being accomplished using a process that (1) carefully reviews the underlying science of the MAP including the hypotheses and performance measures to ensure that what is being monitored is "essential" to the assessment of restoration; and (2) examines the current monitoring and assessment components to ensure that they are providing the data, methods, and models necessary to evaluate status and detect change within key attributes used to assess restoration progress. This will require clearly defined linkages to the management measures (i.e., potential remedial actions) that will keep restoration on track toward achieving the targets laid out in the performance measures and interim goals.

The first step in the process of ranking the underlying monitoring elements that comprise a given hypotheses will be to determine the adequacy of their utility to applied adaptive management. It is essential that hypotheses and their associated performance measures and monitoring components have a demonstrable link to adaptive management. A major criterion for the integration of project-level monitoring into the MAP is adaptive management value. The CERP Adaptive Management Strategy and how the MAP relates to it is discussed in the *Adaptive Management* section of this chapter.

To the greatest extent as possible, the MAP 2008 update will consider the timing and location of restoration project implementation. However, given the current uncertainties associated with the financing of project implementation, Integrated Delivery Schedule formulation, construction of the expedited Everglades projects, and opportunities presented by the potential acquisition of

land and assets of the U.S. Sugar Corporation on overall restoration plan formulation, it is likely that this goal will be achieved in a subsequent revision of the MAP after key implementation uncertainties have been resolved. Nevertheless, if sufficient information on implementation schedules is available, it may be appropriate to adjust monitoring in some cases such that (1) the MAP creates exit and reentry strategies when an adequate baseline has been obtained and construction in a particular area is still years away; and (2) the plan determines how to stage uncertainty-related research such that priority areas or uncertainties take precedence and the costs are stretched out over multiple years.

# INTERIM GOALS UPDATE

Interim goals are used for two major purposes in CERP, as outlined in Section 385.3 of the CERP Programmatic Regulations (DOD, 2003). First, interim goals are used in CERP planning as a guide for project design, as a criterion for development of CERP project scheduling, and to assist in comprehensive plan updates and modification (see the *CERP Planning* section of this chapter). Second, they are used as benchmarks when comparing field information during the implementation and operation of restoration projects to assess whether CERP expected restoration goals are being achieved. In this context, interim goals are expected to play a significant role in driving adaptive management. Interim goals may also be used to report restoration progress to the U.S. Congress.

RECOVER finalized a set of initial technical recommendations for interim goals in February 2005 (RECOVER, 2005a). The initial recommendations described the interim goals as steps along the pathway to achieving the hydrologic, biologic, and water quality goals of CERP. Since that time, work has progressed at the policy level in formulation of the Interim Goals Agreement between the U.S. Army, the U.S. Department of the Interior, and the State of Florida (U.S. Army et al., 2007). The progression of the policy-level work has highlighted the strengths and weaknesses of the methods used to create the initial recommendations. Therefore, this original set of interim goals is in the process of being revised with the intent of addressing several emergent weaknesses of the previous method, and allowing for better communication of technical results between scientists and policy makers.

The NRC, through CISRERP, has recommended that total system metrics be incorporated into the planning process (NRC, 2006). Currently, RECOVER is linking existing performance measure and interim goal metrics, where appropriate, to develop whole system performance measures and interim goals. Whole system metrics are one means by which detailed responses across the entire CERP domain can be conveyed in a simplified, reduced manner. Additionally, whole-system metrics help to convey potential trade-offs or interplay between diverse regions (e.g., Northern and Greater Everglades) and habitat types (e.g., estuaries, Lake Okeechobee, and ridge-and-slough and marl prairie landscapes) under various alternative scenarios. The publication of the Total System Conceptual Ecological Model (Ogden et al., 2005) is facilitating the development of these total system performance measures and interim goals.

The Total System Vegetation Mosaic interim goal is an excellent example of this new approach to developing interim goals. The current draft uses a landscape-scale metric to evaluate the relative distribution and abundance of habitat types across the entire system. Rather than focusing on single habitat types, such as wet prairie or ridge-and-slough, it integrates these areas into a broader approach for a total system perspective.

The Science Coordination Group of the South Florida Ecosystem Restoration Task Force also develops indicators to measure restoration success in South Florida. Since the efforts of the Science Coordination Group in many areas overlap with RECOVER's efforts, RECOVER is developing a formal integration strategy with the group to minimize duplication in the development of interim goals.

## DESIRED RESTORATION, HISTORIC AND INDICATOR CONDITIONS

In assessing CERP success from monitoring data and in planning CERP projects using modeling tools, RECOVER uses three conditions: historic condition, desired restoration condition, and indicator condition over time. Historic condition is the pre-drainage and pre-development condition for an indicator. Indicators such as oysters, wading bird nesting, aquatic faunal populations, sheetflow, etc. are used in interim goals and performance measures. For each indicator used as an interim goal, a "desired restoration condition" must be developed. This condition is not confined to the restoration success expected by the original authorized plan (USACE and SFWMD, 1999). The Programmatic Regulations (DOD, 2003) require that a higher level of performance be strived for during implementation. Therefore, the desired restoration condition (bright green line in **Figure 7B-1**) reflects optimal characteristics of the indicator given that some irrevocable changes have occurred in the South Florida ecosystem preventing a full return to its historical condition (dark green line in **Figure 7B-1**).

Some examples of irrevocable change include loss of spatial extent to urban and agricultural development, the necessity of maintaining the eastern levee system and the Herbert Hoover dike for flood protection, anticipated demands on water supply, and the effects of navigational access in estuaries such as the St. Lucie. Other changes in the system, such as soil subsidence, are not necessarily irrevocable but are significant in consideration of desired restoration condition because of the time needed to attain the restored condition. Additional factors, such as recreational and agricultural land use, are influenced by policy and are important considerations in the development of desired restoration conditions. Such policy considerations may affect the degree to which an area may be restored toward the historic ecosystem. In effect, development of desired restoration conditions will highlight the extent to which the human system and policy considerations will allow full ecosystem restoration or improvements in ecosystem health to occur.

**Figure 7B-1** is a conceptual diagram and does not show the historical, desired, or expected condition of any specific indicator. Individual and specific figure will eventually be developed for each indicator. Each indicator needs to be analyzed to produce both an estimate of predicted plan performance at a point in CERP implementation (yellow/light green boxes) and at full CERP implementation (green boxes) as well as an estimate of the desired restoration condition (bright green line) to allow for improvement to the plan.

A desired restoration condition for an indicator provides a reference point for improving CERP performance, for evaluating CERP restoration success, and for communicating science in an effective manner. In several cases, monitoring datasets are limited for a metric, and predictive models are not yet available. If a predictive model is already available for the metric, desired conditions allow for a more robust description of the restoration condition by recognizing model uncertainty and taking into account issues and parameters potentially not addressed in model formulation. Currently, desired restoration conditions are being developed using expert opinion and will be adjusted as data on the indicator becomes available through the MAP program.

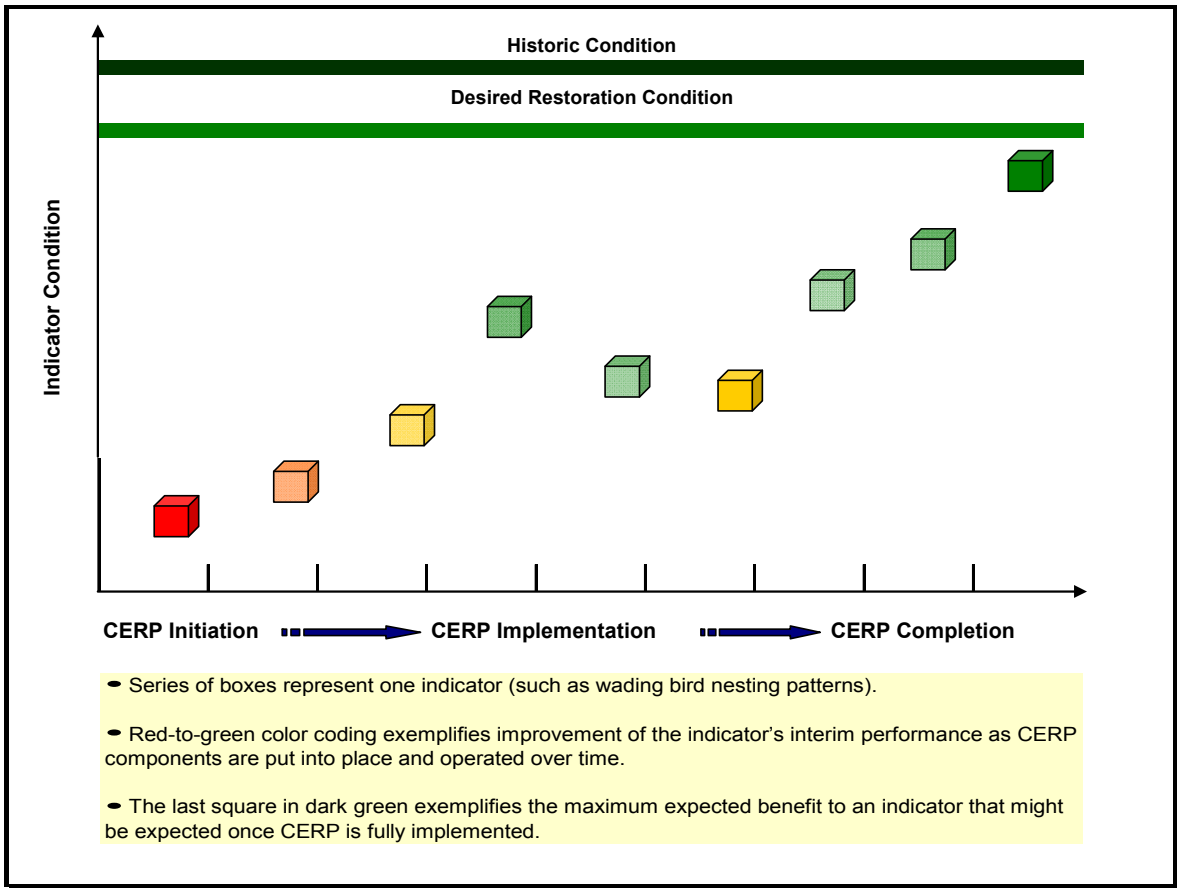


**Figure 7B-1.** Conceptual diagram of desired restoration condition compared to historical condition and expected performance of an indicator as CERP implementation proceeds.

When evaluating plan performance, model output for an indicator will be compared to both the predicted performance of the plan at that point in CERP implementation and the desired restoration condition (bright green line) (**Figure 7B-1**). An indicator's actual response to CERP implementation will also be measured against the desired restoration condition using data collected from the field as part of the MAP. The metrics used to measure these two facets of the indicator – its predicted performance and its actual performance – may be the same or they may be different. Not all ecological functions have indicators that can be modeled with currently available tools, so surrogate predictive metrics must be used. Generally, predictive measures are based on hydrology and the specific hydrologic needs of a given habitat type, community, or system, while assessment occurs at the attribute level, such as a plant community or species. If the metrics are different, then they must be linked to one another in some logical (physical or biological) fashion usually identified within conceptual ecological models (RECOVER, 2006a). The RECOVER systemwide performance measures will be used as guidelines in determining predictive metrics, and the MAP will be used as a guideline for the desired restoration condition. The documentation sheets for these measures are available on RECOVER's web site at www.evergladesplan.org/pm/recover/eval_team_perf_measures.aspx.

An example of the same metric used for predictive modeling and assessment is hydropattern. Hydropattern is standard output of the South Florida Water Management Model (SFWMM), including ponding duration and related statistics. As such, the modeled output for hydropattern can be used as a way of evaluating alternative plans. Hydropattern (i.e., ponding duration) can also be measured using data gathered from the field. These field data can be compared to modeled output to determine the accuracy of the model and can also be compared to a desired restoration goal for hydropattern as long as the data and models are appropriately converted to the same spatial and temporal distributions. RECOVER is currently working on resolving spatial and temporal distribution issues between field data and model requirements to enable metrics to be used for both planning and assessment purposes.

In contrast, the interim goal metrics for Everglades tree islands are tree island habitat suitability indices (HSIs) for drought and for flooding. These indices are hydrologic metrics (percent of time at a particular water depth) and are appropriate for the evaluation of different modeled scenarios. However, the index values are inappropriate to use as a desired restoration condition, or goal, for comparison to data collected in the field. Nevertheless, the field metrics (i.e., tree stress data or areal extent data) can be related to the HSI by determining the empirical and/or physiological links between water depth and duration and the physiological characteristics of the species that make up the diverse and sustainable tree island community. This is an example of using evolving assessment data and knowledge to extend the reach of model predictions.

In closing this section, it should be noted that the usefulness of interim goals and the concept of a desired restoration condition extends beyond the confines of CERP. Both the goals and the methodologies used to develop them are equally applicable to non-CERP restoration activities and may be equally suited for use in evaluating proposed or actual changes in water management operational strategies.

# SYSTEMWIDE PERFORMANCE MEASURES UPDATE

Performance measures are tools that allow the evaluation of restoration plans and assessment of restoration implementation. RECOVER has continued its development and refinement of methodologies needed to utilize these performance measures. A summary of work completed during the last year and ongoing efforts is summarized below.

## OYSTER HABITAT SUITABILITY INDEX

A Habitat Suitability Index Model has been developed for the Eastern oyster (*Crassostrea virginica*) for the Caloosahatchee Estuary (Volety et al., 2005; Mazzotti et al., 2005) and is currently being updated based on recent monitoring data. It is a modification of the original model developed by Cake (1983) and modified by Soniat and Brody (1988) for Texas estuaries. The model was generated based on District flow data and oyster response data from the Caloosahatchee Estuary collected through MAP-funded monitoring activities. Refinement of the oyster HSI will help identify exact locations or areas that have the greatest potential to develop as reefs, extent of reef coverage assuming certain growth rates, and reasonable predictive capability of oyster reef survival should conditions change in the future. When baseline values of ecological responses (condition index, disease intensity of the oyster parasite *Perkinsus marinus*, spat recruitment, time of reproduction) of oysters become available in the future, these aspects will be used to optimize the model. The model will be strengthened to better predict oyster responses with the ongoing input of monitoring data. Also, it can likely be exported and used in other

estuaries with minor modifications. RECOVER is currently modifying this model for use in the St. Lucie Estuary and other east coast estuaries.

Various other species-specific HSIs are currently being vetted for use by RECOVER. Once the Interagency Modeling Center is able to run the high-resolution Across Trophic Level System Simulation (ATLSS) model, these HSIs will be used for assessment and evaluation.

## SHEETFLOW

CERP proposes to restore more natural sheetflow patterns by eliminating unnatural barriers to flow. The Water Conservation Area 3 Decompartmentalization and Sheet Flow Enhancement Project, referred to simply as Decomp, involves reconnecting significant portions of the Everglades ridge-and-slough landscape to restore sheetflow. Resumption of sheetflow and related patterns of hydroperiod and water depth may significantly help to restore and sustain the micro-topography, directionality, and spatial extent of ridges and sloughs and improve the health of tree islands without significantly infringing on adjacent wet prairies where short hydroperiod, tussock growth habitats will persist.

A performance measure has been developed for sheetflow in the Everglades ridge-and-slough landscape. The sheetflow measure has three components: timing, distribution, and continuity. A flow-volume metric is also planned. All components of this performance measure were developed based on a flexible transect design. Currently, this performance measure is being applied at three geographically distinct locations: (1) a northern set of transects that cross Water Conservation Areas 3A and 2A, (2) a set of transects near Tamiami Trail, and (3) a southern set of transects within Everglades National Park that include central Shark River Slough and Taylor Slough. The general locations of the first two sets of transects are shown in **Figure 7B-2**. The exact location for these transects and the location for the third transect have not yet been identified. Additional transects can be added as needed to measure timing and distribution in almost any location for which we have a target. Continuity measurement, which uses paired transects, should be limited to areas where we believe Natural System Model (NSM) directionality is still more or less intact or achievable and in areas that respond to the operation of structures. The sheetflow component is currently applied at paired transects at Tamiami Trail. Additional paired transects may also be applied at the L-38, L-39, Miami, and L-67 canals. Coding of these transects is flexible allowing easy movement of transects to address specific project needs.

Output from the SFWMM is used to evaluate the effectiveness of proposed restoration plans in reestablishing sheetflow. Flow and depth data gathered by the Everglades Depth Estimation Network (EDEN) will be used to compare this performance measure to field assessments and to calibrate the model. EDEN can be applied further in order to help understand future refinement of this measure by potentially adding a directionality component, if needed.

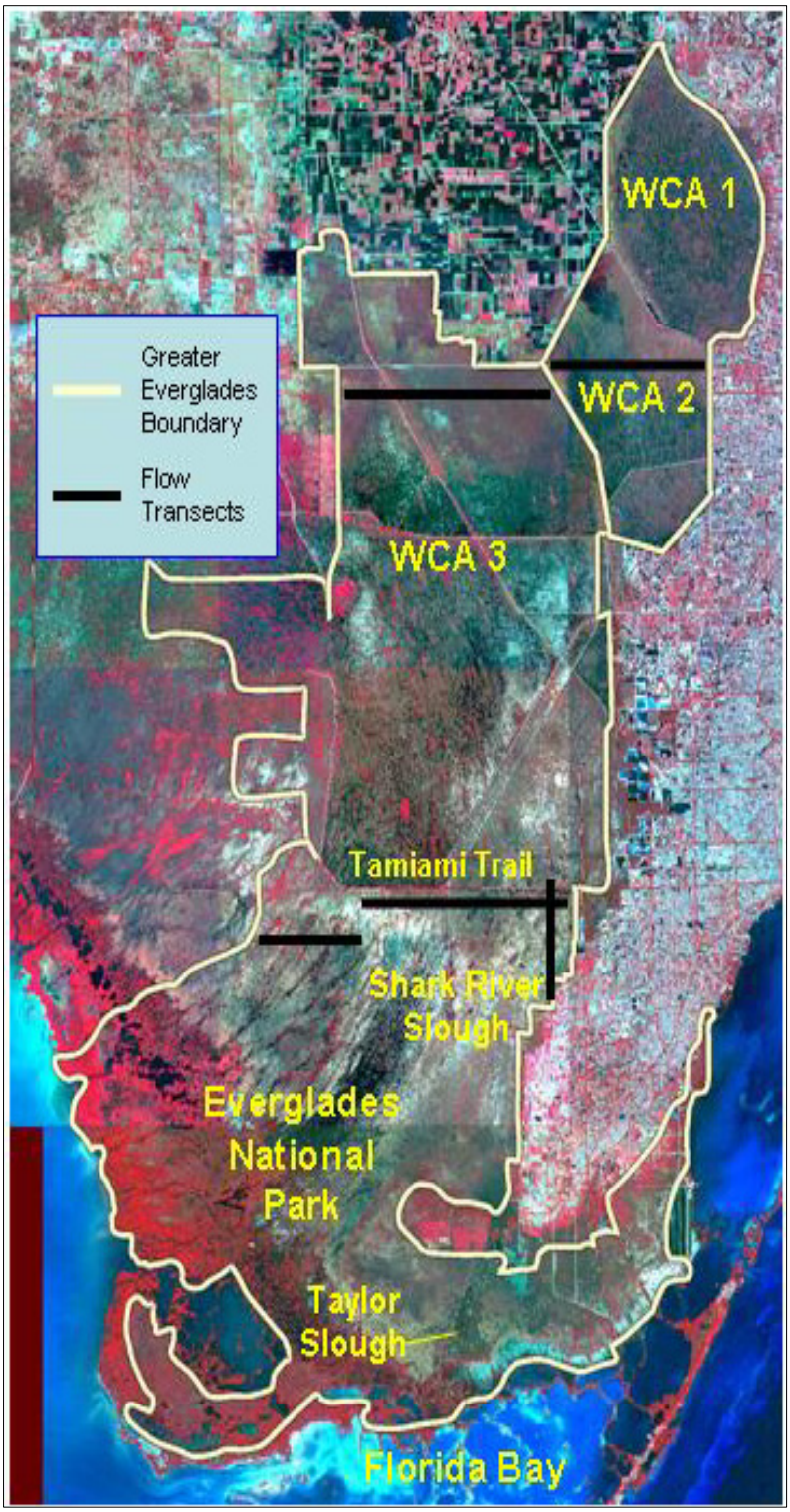


**Figure 7B-2.** General location of transects that will be used to evaluate sheetflow performance in the Everglades ridge-and-slough landscape.

## WET PRAIRIE VEGETATION

As CERP is implemented and sheetflow is restored to the ridge-and-slough landscape, wet prairies, which occur in broad transitional wetlands between sloughs and uplands, must be maintained. Wet prairies have hydroperiods intermediate between sloughs and uplands. They support a high diversity of plant species, provide habitats for a variety of native invertebrate and vertebrate species, including the endangered Cape Sable seaside sparrow (*Ammodramus maritimus mirabilis*), and provide seasonal aquatic habitats that are an important prey base for wading birds and other predators (Davis et al., 2005b). Most wet prairies in the Everglades occur on both sides of Shark River Slough and Taylor Slough, the main natural flow-ways within Everglades National Park (**Figure 7B-3**).

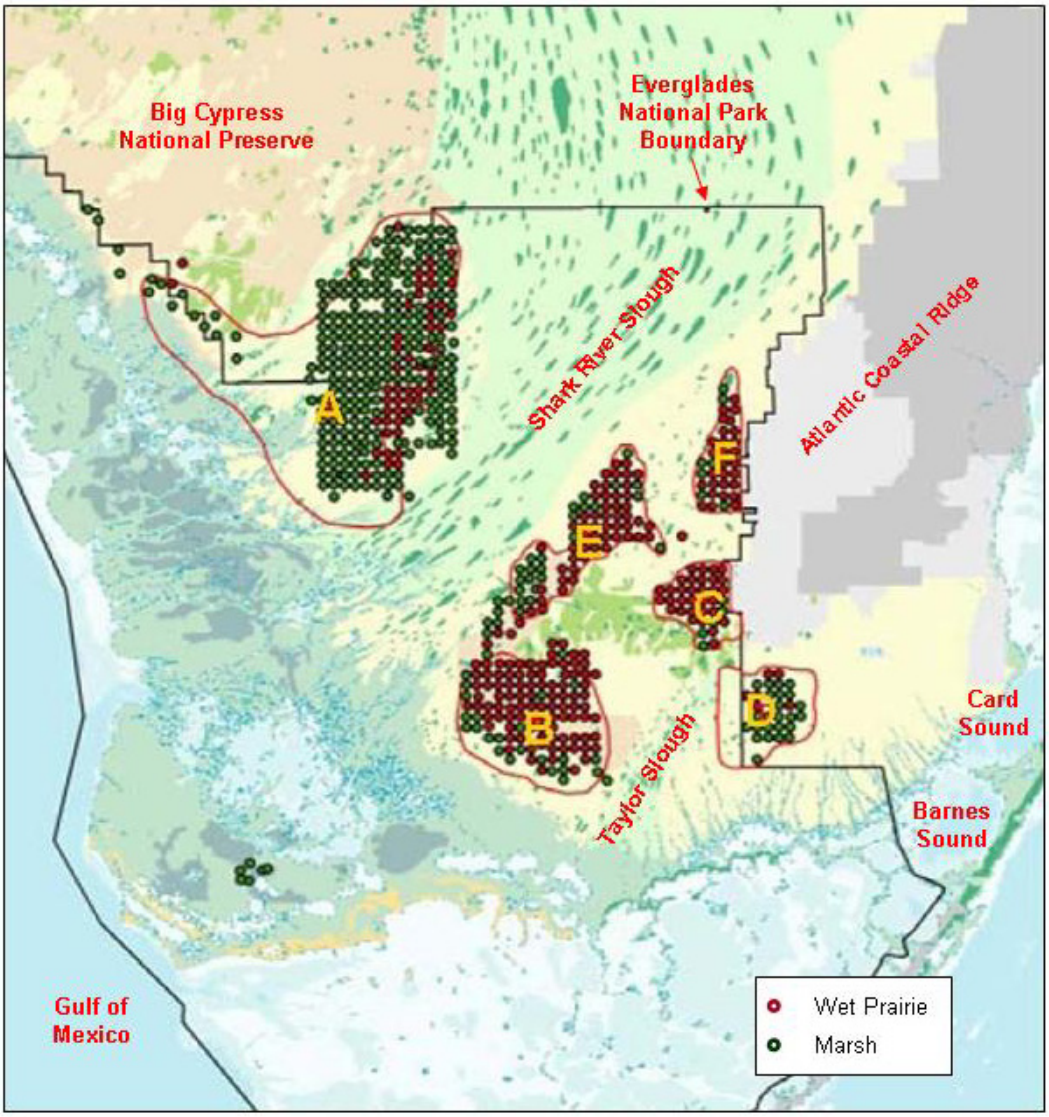


**Figure 7B-3.** Distribution of major wet prairie (red dots) and marsh (green dots) habitats in the Greater Everglades.

The goal of this performance measure is no net loss or minimal loss of wet prairie vegetation, while at the same time meeting the hydrologic needs of the ridge-and-slough landscape. The evaluation component of this performance measure (wet prairie stage distribution) is directly tied to the MAP vegetation transects that cover both ridge-and-slough and marl habitats. The corresponding assessment metric for this performance measure is based on vegetation community structure in marl prairie landscapes and associated stages. The wet prairie vegetation performance measure (in combination with the hydrology performance measures and the draft slough vegetation performance measure) helps illustrate the dynamic interplay between ridge and slough, and marl prairie habitats in wet and dry years and under varying alternative scenarios.

## MIGRATION TO REGIONAL SIMULATION MODEL

The SFWMM is a regional-scale computer model that simulates the hydrology and the management of South Florida water resources from Lake Okeechobee to Florida Bay. It was used to develop the initial CERP plan (USACE and SFWMD, 1999) and is still used by RECOVER when it conducts evaluations of CERP refinements and regional evaluations of the performance of alternative plans for projects. While it is an effective tool when used for evaluating refinements of the full CERP, it is generally not effective at a small enough scale to see regional responses caused by individual project alternatives.

The complexity of the South Florida ecosystem requires a comprehensive modeling tool with greater flexibility for simulating various planning and management options, and the ability to integrate multiple disciplines into one model (e.g., hydrology, hydraulics, ecology, and water quality). Therefore, the District has developed the Regional Simulation Model (RSM). The RSM accounts for interactions among surface water and groundwater hydrology, structure and canal hydraulics, and management of these hydraulic components. The RSM simulates the coupled movement and distribution of groundwater and surface water in conjunction with the coordinated operation of canals and structures in South Florida. Future RSM versions will also have water quality and system ecology components. In addition, the RSM operates at a smaller scale than the SFWMM, which should enable it to simulate regional effects of individual projects.

RECOVER has been assisting with the migration of Greater Everglades performance measures from the SFWMM to the RSM in support of Decomp. In the future, as more of the RSM components come online, RECOVER will modify its systemwide performance measures for use with this model.

## ECOLOGICAL MODELS

Ecological models are needed to accurately predict interim goals, evaluate alternative plans, and assess the success of CERP implementation on the ecosystem. In an effort initiated by Everglades National Park, RECOVER is currently developing a slough-vegetation metric based on hydrologic optima and tolerance of slough species. RECOVER is developing a high-resolution water depth method using SFWMM output combined with High Accuracy Elevation Data that can be applied to ecological models, such as habitat suitability and spatially explicit species indices. Conversion to this scale will allow evaluators to better understand spatial variability within model cells and indicator regions, allowing a picture of a cumulative distribution of performance rather than the overall mean values that are currently used. RECOVER is also in the process of vetting the Across Trophic Level System Simulation high-resolution topography and associated high-resolution water depth methods. Once an accepted high-resolution water depth method is available, RECOVER will review existing ecological models, including those for alligators, wading birds, fishes, and periphyton, for application on the high-resolution platform(s).

## REFINEMENTS OF EXISTING PERFORMANCE MEASURES

Additional refinements are being made to the existing systemwide performance measures. Targets and calculation methods for the Extreme High and Low Water Levels in the Greater Everglades Wetlands performance measure are being updated to address topography issues and increase sensitivity of the extreme low water level metric. Additional stations were added to stage-to-salinity regression equations used in the Southern Estuaries Salinity performance measure. Additional regionally significant Everglades marsh gauges were added to the Everglades Water Levels performance measure used to simulate freshwater inflow into Florida Bay and southwestern estuaries.

# DATA MANAGEMENT

Appropriate management of MAP and other data is vital to RECOVER's assessment and evaluation activities and for providing the data needed to adaptively manage restoration activities. The multiagency structure of CERP has presented unique data management challenges. These challenges have been successfully addressed through an information technology infrastructure known as the CERPZone. This infrastructure consists of a stand-alone network and servers hosting various applications that are accessible via a web interface or CITRIX® server. The CERPZone is financed and managed collaboratively by the District and the U.S. Army Corps of Engineers. The following applications and services are currently available within the CERPZone:

- **CERP Calendar** – a tool for viewing a list of both public and internal events.
- **CERP Directory** – a searchable directory containing user and agency information.
- **CERP Information Technology Initiation Form (CITIF)** – a mechanism for requesting IT support.
- **Data Access, Storage and Retrieval (DASR)** – an application for archiving and managing RECOVER, CERP Project, Geographic Information System (GIS), and modeling data.
- **Documentum** – a document management application.
- **Electronic Data Catalog (EdCat)** – a tool that currently provides full text search capability for Documentum.
- **Everglades Depth Estimation Network (EDEN)** – an integrated network of real-time water level monitoring, ground elevation modeling, and water surface modeling from gauging stations operated by the Big Cypress National Preserve, Everglades National Park, the District, and the U.S. Geological Survey.
- **Interactive Web Meeting** – an application allowing effective sharing of presentations, video, and multi-user text chat that can support up to 25 simultaneous connections.
- **Policy Digest** – a tool providing a searchable repository of policies.
- **San Space Request (SAN SR)** – a storage system for RECOVER, CERP Project, GIS, Documentum, and modeling data.
- **www.evergladesplan.org** – official web site of the Comprehensive Everglades Restoration Plan.

- **CERP GIS Data Catalog** – a catalog of available GIS layers.
- **CERP GIS Access Point** – an access interface to RECOVER and CERP GIS data and software.
- **CERP GIS Request Form** – a GIS services request mechanism.
- **CERP Model Management System** – an application allowing users to navigate, browse, and query a variety of modeling information via a web browser.
- **Model Reader** – an application summarizing model output for analysis.
- **CERP Benchmark Locator** – an application for displaying locations of CERP Geodetic Network benchmarks.
- **Gazetteer Database** – an enhanced place name repository allowing integration with mapping applications that allows users to select a map location and return related documents and map files.

In addition, the following applications are currently under development and implementation:

- **Morpho** – the existing metadata creation, query, and maintenance tool originally developed by the National Center for Ecological Analysis and Synthesis (NCEAS), and based on Ecological Metadata Language (EML) is undergoing enhancement to provide a web-based RECOVER and CERP project metadata creation and maintenance tool.
- **EndNote** – the off-the-shelf reference/bibliography tool is currently being implemented within CERPZone to support the collaborative production of critical RECOVER reports and documents, such as the system status reports.
- **Oyster HSI** – this tool was originally developed under the Southwest Florida Feasibility Study and is undergoing enhancement and technology migration for implementation in CERPZone.
- **Assessment App** – an application is under development to integrate GIS and relational database technology in order to support and facilitate integrated multi-agency data assessment and data analysis for inclusion in the next system status report.
- **Monitoring Locator** – an application under development to provide spatial search capabilities for metadata describing monitoring efforts supporting RECOVER and CERP program implementation.
- **MAPTRACK** – an application under enhancement to manage project financial and budget information and periodically produce a MAP implementation status report.
- **Electronic Data Catalog (EdCat)** – a textual search application under enhancement to provide spatial search capabilities for program/project GIS data, model output, and other related data.

All these tools and applications create and support the collaborative environment necessary to support the multiagency RECOVER and CERP project teams. Several applications developed for CERPZone have been positively received by the Florida Department of Environmental Protection and The Oceans Council as they develop a data management standard for the State of Florida. RECOVER is currently collaborating with these groups to help guide the creation of a similar statewide system.

# ADAPTIVE MANAGEMENT

CERP is being planned, implemented, assessed, and refined using the principles of adaptive management, and all RECOVER's mandates and activities are ultimately united by this process. Adaptive management, as it has been defined for CERP, is an iterative and deliberate process of applying principles of scientific investigation to design and implementation to better understand the ecosystem, to reduce key uncertainties, and as a basis for continuously refining program/project design and operation. The overarching goal of adaptive management as a restoration tool is to aid in defining restoration strategies that recognize present-day solutions may be deficient for future conditions and that the future will be influenced by unanticipated internal and external events, particularly at the large scale of the South Florida ecosystem.

RECOVER has produced an Adaptive Management Strategy document (RECOVER, 2004) that explains the principles of adaptive management and when adaptive management should be used, and provides an overall strategy for integrating adaptive management into CERP. This strategy encompasses all of CERP, not just the systemwide aspects for which RECOVER is responsible. The Adaptive Management Strategy document is available on RECOVER's web site at www.evergladesplan.org/pm/recover/recover_docs/am/rec_am_stategy_brochure.pdf. Some key examples how adaptive management is incorporated into RECOVER activities are summarized below. RECOVER is also producing an adaptive management guidance manual, a draft of which is currently undergoing review by CERP staff and management (RECOVER, 2007c).

## CERP PLANNING

### Systemwide Planning

RECOVER conducts periodic systemwide CERP updates, as mandated by the Programmatic Regulations (DOD, 2003). These updates occur at least every five years and include evaluation of the current plan using new and/or updated modeling. Updates also incorporate information regarding CERP and other state and federal projects in South Florida and their latest scientific, technical, and planning information. RECOVER reviews the updated model output and compares it to systemwide performance measures — the updated plan's predicted performance is evaluated to determine whether the plan is still able to meet CERP's goals and objectives. The first update was conducted in 2005 and incorporated recent climatic information, topography, and land use projections. The modeling scenarios considered were the 2000 existing condition, the 2050 future without CERP condition, and the 2050 with CERP condition (termed CERPA). The next update will be in 2010 and will incorporate any additional new information including that gained through the MAP as reported in the system status reports. Documentation of the Initial CERP Update (RECOVER, 2005b) is available at http://www.evergladesplan.org/pm/recover/icu.aspx.

As expected, the hydrologic results of initial CERP update modeling differ from those in the Central and Southern Florida Comprehensive Review Study (Restudy) modeling (USACE and SFWMD, 1999). While there were areas identified in which CERPA performance was improved over Restudy performance, there were also areas with reduced performance. RECOVER recommended that further work be done to improve the modeled performance of CERPA through operational optimization, and management is reviewing this recommendation.

### Project-Level Planning

RECOVER has many responsibilities associated with project-level planning and has recently become significantly more active in supporting Project Development Teams (PDTs) with Project Implementation Report (PIR) development. More specifically, RECOVER (1) guides the development of and reviews project performance measures for consistency with systemwide performance measures; (2) guides and reviews the development of project-level monitoring plans with a focus on assuring their consistency with MAP monitoring efforts and their ability to provide adaptive management support to the project; and (3) performs regional evaluations on the final array of alternatives that are developed during plan formulation. In the past year, RECOVER staff has been actively involved with the PDTs of various regional restoration efforts, including Decomp, Everglades Agricultural Area Reservoir, Biscayne Bay Coastal Wetland, C-111 Spreader Canal, and Picayune Strand projects and the Aquifer Storage and Recovery (ASR) pilot study. Documentation for performance measure consistency reviews and evaluations that have already been conducted are available at www.evergladesplan.org/pm/recover/rap_assist_projects.aspx. RECOVER also maintains the baseline conditions that are used for modeling and provides other assistance to projects as requested. RECOVER also supports planning activities for various restoration programs/projects, such as the Northern Everglades and Estuaries Protection Program and the Southwest Florida Feasibility Study.

## PERFORMANCE ASSESSMENT

An essential element of adaptive management is the development and execution of a scientifically rigorous monitoring and assessment program to analyze and understand system responses to the implementation of restoration activities and to the natural climatologic variability of South Florida, and to understand the synergistic effects of the interaction of these key drivers. Such information will be essential to help optimize project design and operation to maximize restoration benefits. The assessment program relies heavily on MAP (RECOVER, 2004; 2006b), whose first task has been to develop a pre-restoration, systemwide environmental baseline against which to measure the effects of structural and operational restoration of the system. The 2007 System Status Report provides a partial baseline assessment. However, power analysis indicates that additional longer-term data is necessary to formulate a complete baseline assessment. Delays in implementing many CERP projects have given RECOVER the additional time needed to develop a defensible baseline and, in the interim, the environmental data being acquired and assessed by RECOVER provides a comprehensive and dynamic picture of ecosystem health. The scientific and technical information generated from MAP implementation is organized and assessed biennially and reported in system status reports. Development of each system status report also provides the opportunity to revisit the MAP and revise it in response to new information.

In accordance with the Programmatic Regulations, RECOVER is required to prepare a technical report at least once every five years. This report presents a systemwide assessment of whether CERP's goals and purposes are being met, including whether interim goals (RECOVER, 2005a) are being achieved or are likely to be achieved. This technical report is used in the CERP reports to the U.S. Congress, the next of which is due in 2010.

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