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FINAL DRAFT
2006 SYSTEM STATUS REPORT

PILOT ASSESSMENT
SYSTEM-WIDE REPORT

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EXECUTIVE SUMMARY

The 2006 Assessment Team (AT) System Status Report (SSR)–Pilot Assessment represents the initial application of the *Monitoring and Assessment Plan (MAP)–Part 2: 2006 Assessment Strategy for the MAP* developed by REstoration COordination and VERification (RECOVER) team for analyzing monitoring data from the MAP, Part 1: Monitoring and Supporting Research. As such, it represents a proof concept for applying the assessment strategy outlined in the MAP, Part 2, which will be used for assessing the success of the Comprehensive Everglades Restoration Plan (CERP or Plan). However, this assessment is not intended to provide a comprehensive assessment of the ecological condition nor the status of either the MAP modules (Southern Estuaries [SE], Northern Estuaries [NE], Greater Everglades [GE], and Lake Okeechobee [LO]) or the South Florida ecosystem as a whole.

The SSR plays an important role within CERP; it is designed to assess and document progress towards meeting performance measure (PM) targets and interim and long-term goals. On a biennial basis, the MAP module reports will be summarized and multiple years of data compiled to create an annual SSR that will address the overall status of the system relative to system level hypotheses, PMs, and restoration goals. The SSR provides the interface between the science of the restoration (e.g., MAP principal investigators (PI) and MAP modules) and information to the National Research Council (NRC), Interim Goals and Targets Report (IG/IT), CERP Report Card, and constitutes a major component of the RECOVER Technical Report mandated by the Programmatic Regulations.

The hydrological characteristics for the 2006 Water Year (WY2006) (May 1, 2005—April 30, 2006) can be summarized as being a wetter than average year with two peaks in rainfall and surface water flows-June and October 24, 2005. Even though WY rainfall was higher than average, there were significantly dry months-January and March 2006 in most areas, and December 2005 and April 2006 in some areas. Drier winter and spring months dampened out the hydrologic impact of the high summer and fall rainfall. The combined impact of the 2004 and 2005 hurricane season on LO was significant. Details of the WY 2005/2006 hydrology are available in the *2006 South Florida Environmental Report–Volume I* including a discussion on the active 2005 hurricane season (Chapter 1B). A PDF version of this report can be found at the following address: *http://www.sfwmd.gov/sfer*.

The assessment process developed and formalized in the MAP, Part 2 was successfully applied for selected hypotheses in the SE, NE, GE, and LO MAP modules. The focus of each module's test of concept addressed estimating trends in baseline/reference condition and assessing the ability to detect change. Based on these initial assessments, the conceptual ecological models (CEMs) and associated hypotheses adequately captured the driver-stressor-response relationships and do not have to be modified at this time. As would be expected, the module-specific lessons learned vary depending on the specific hypotheses examined. For example, while the pilot assessment for oysters in the NE MAP module was an overall success, the following lessons learned are module specific: (1) the sampling protocol should be adjusted to better capture spatial variation; (2) the

extent of oyster reef coverage needs to be mapped every five years in order to evaluate the IGs; (3) genetic and hydrodynamic information is needed to both understand the linkages controlling the exchange of larval sources among the various reefs and to understand which oyster reefs act as larval sources and are therefore fundamental to the long-term survival of oyster populations.

The SE module used hypotheses describing submerged aquatic vegetation (SAV) as their test of concept for the assessment process. The results indicate that the pilot assessment was an overall success and that there is no indication that the present CEM and hypotheses for SAV need to be changed since statistically significant trends in SAV were associated with statistically significant trends in water quality. However, long-term, spatially and temporally extensive water quality and hydrologic monitoring are critical to the successful interpretation of MAP data.

The hypotheses cluster selected for the test of concept for the GE focuses on understanding the collapse of wading bird nesting colonies in the southern Everglades. Initial data for the 2005 nesting season indicated only 1,990 wading bird nests were initiated in the mainland of Everglades National Park (ENP), compared to 24,249 in the Water Conservation Areas (WCAs). A possible explanation for the low initiation of nesting in ENP in 2005, despite water recession rates conducive to prey concentration early in the nesting season, is that low wet season prey biomass of marsh fishes and other prey species was insufficient to produce dry season prey concentrations adequate to support nesting. This explanation indicates that the component of the predator-prey hypothesis for wading birds does not need to be modified at this time.

The initial test of concept for LO indicates it should be possible to perform assessments on SAV, phytoplankton, and littoral zone emergent vegetation hypotheses clusters. However, it was noted that given the effort required to conduct an assessment on a single hypothesis cluster, it was recommended that hypotheses clusters be assessed on a rotating basis at five-year intervals.

In addition to module-specific recommendations, the 2006 SSR-Pilot Assessment highlighted the following lessons and challenges that transcend the individual modules and are important to the success of CERP:

- Sustainability is a primary issue for CERP and key to the successful implementation of the MAP. Given the long timeframe for restoration and the data used by CERP is acquired from a variety of sources, the sustainability of this program is dependent upon the commitments of many federal, state, and academic institutions. Consequently, there is a need to assure that the necessary agreements are in place to ensure sustainability of CERP and its adaptive assessment and monitoring program.

- A comprehensive data management (DM) program is fundamental to the success of CERP. The development of RECOVER's DM program will require a hierarchical integrated strategy that accesses and integrates a wide array of biological, chemical, and physical data collected by a wide range of organizations and scientists. This data

will then be used to establish a baseline from which future assessments of CERP will be performed. As data is collected and analyzed and assessments are being made, the principles of the CERP Adaptive Management (AM) Strategy will be used to recommend and institute changes in programs and projects as needed.

- There is a critical need to review the number of PMs currently being used in CERP and their relationship and relevancy to assessing progress to achieving IGs. The development and assessment of module hypotheses clusters indicates that many PMs may no longer be needed or relevant to the restoration and decision-making process. In addition, these pilot assessments have identified a clear disconnect between the current list of IGs and the hypotheses and the PMs currently being used by the MAP modules to assess CERP.

- While the topic of exotic species was not explicitly addressed in the pilot assessments, it remains an important issue with potentially broad implications for the success of CERP. The South Florida Ecosystem Restoration Science Coordination Group (Science Coordination Group) has reported on assessing and managing invasive species and has identified it as a key system-wide indicator of restoration success. Similarly, in the 2006 *South Florida Environmental Report* (Chapter 9) the South Florida Water Management District (SFWMD) discusses the importance of exotic species in south Florida and its potential impact on the restoration.

- As with hydrology, water quality is a persistent theme throughout much of the 2006 SSR–Pilot Assessment. For example, water quality characterization in local or regional areas has been an important component for examining hypotheses relating to SAV dynamics in the SE and LO. Consequently, a comprehensive system-wide assessment of water quality trends remains a critical information gap that requires attention.

In summary, the primary goal of the 2006 SSR–Pilot Assessment was to conduct a test of concept of the assessment process for detecting and assessing changes resulting from the implementation of CERP as outlined in the MAP, Part 2. The conclusions of this exercise indicate that the test of concept was successfully implemented for the SE, NE, GE, and LO MAP modules and the CEMs and supporting hypotheses are sufficient and do not require modification at this time. It is important to recognize that the 2006 SSR does *not* provide a comprehensive assessment of the status and condition of the individual MAP modules or the south Florida ecosystem nor does it provide conclusions or recommendations regarding the "success" in achieving CERP restoration goals. However, the 2006 SSR–Pilot Assessment has already resulted in recommendations for improving the MAP Parts 1 and 2.

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1.0 INTRODUCTION

The 2006 Assessment Team (AT) System Status Report (SSR)–Pilot Assessment represents the initial application of the Comprehensive Everglades Restoration Plan (CERP or Plan) *Monitoring and Assessment Plan (MAP), Part 2: 2006 Assessment Strategy for the MAP* developed by REstoration COordination and VERification (RECOVER) for analyzing monitoring data from the *MAP, Part 1: Monitoring and Supporting Research*. As such, it represents a "test of concept" of the guidance concepts and strategy that will be used for assessing the success of the Plan. The "test of concept" involves each MAP module completing a detailed analysis of one hypothesis cluster. The remaining analyses of all other MAP module activities can be found in the 2006 AT SSR–Module Report. This assessment is not intended to provide a comprehensive assessment of the ecological condition nor status of the MAP modules or the south Florida ecosystem as a whole.

This initial assessment focuses on the following objectives:

- Conducting a test of concept of the assessment process outlined in the MAP, Part 2 and coordination using example hypothesis clusters (see below) for the Southern Estuaries (SE), Northern Estuaries (NE), Greater Everglades (GE), and Lake Okeechobee (LO).
- Assess the ability to detect change by evaluating sampling design, data quality objectives (DQOs), variability, power analysis, and relevant spatiotemporal patterns.
- Establish reference conditions by evaluating MAP and non-MAP databases (e.g. experimental data).
- Characterize the status of monitoring and data availability and sharing for the MAP modules as a whole.
- Evaluate and provide recommendations on data acquisition, dissemination, and management.
- Provide recommendations on the assessment process and coordination among principal investigators (PIs), participating agencies, members of the RECOVER AT and RECOVER Leadership Group, and the National Research Council (NRC).

It is important to recognize the limitations of this 2006 AT SSR-Pilot Assessment. It is not intended to provide a comprehensive assessment of the status and condition of the individual MAP modules or the south Florida ecosystem. Because many of the data sets are limited to a few years, estimates of baseline or reference condition for many hypotheses and associated performance measures (PMs) remain uncertain. Consequently, this report will not make conclusions or recommendations regarding "success" in achieving CERP restoration goals until more data becomes available for conducting trend and uncertainty analyses. Nevertheless, the analyses that comprise this assessment have resulted in recommendations for improving the MAP, Part 1 and 2.

1.1 Context for the Pilot System-Wide Status Report

CERP is the largest environmental restoration effort ever pursued and documenting the success of the Plan relies on the MAP as the basis of assessing performance. The MAP includes specific PMs developed to quantify ecological responses to restoration efforts, and thereby measure the effectiveness of individual projects in meeting established restoration targets or goals. The combined response from the full set of PMs will be used to evaluate the overall success of the CERP.

The MAP, Part 2 also provides for the assessment guidance process to be employed by the PIs and Module Groups to assess CERP performance. The principal audience for this document includes RECOVER, the AT, the Integrative Assessment Sub-team (IAT), the MAP module groups, and PIs who have responsibility for interpreting data collected as part of the MAP and preparing annual reports on their findings.

RECOVER will use the assessment process outlined in the MAP, Part 2 to assess CERP progress and satisfy CERP reporting requirements. RECOVER technical reports will also provide an analysis of measured and anticipated ecosystem responses and whether the responses are due to internal structural or operational components, or are external to the Plan. These technical reports will be used and referenced by the United States Army Corps of Engineers (Corps) and the South Florida Water Management District (SFWMD) when preparing assessment reports pursuant to the Programmatic Regulations set forth in the Water Resources Development Act of 2000 (Section 601(h)(3)) (WRDA 2000). The technical reports and key indicators assessments will be the source of information in preparing a proposed CERP "Report Card" to be issued to the public, agencies, legislature, and other stakeholders.

The SSR plays an important role within CERP; it is designed to assess and document progress towards meeting PM targets and interim and long-term goals. On a biennial basis, the MAP module reports will be summarized and multiple years of data compiled to create an annual SSR that will address the overall status of the system relative to system level hypotheses, PMs, and restoration goals. The SSR provides the interface between the science of the restoration (e.g., MAP PIs and MAP modules) and provides information to theNRC, Interim Goals and Targets (IG/IT) Report, CERP Report Card, and constitutes a major component of the RECOVER Technical Report mandated by the Programmatic Regulations.

The SSR represents the accumulation of multiple years of data on the status and trends of PMs critical to the restoration, and will be used to provide information to the NRC, IG/IGs reports, CERP Report Cards to the public, and a major component of the RECOVER Technical Report mandated by the Programmatic Regulations. The System Status Report will provide the following: 1) a synthesis of findings across modules and across years to provide a holistic description of the status of the system; 2) an evaluation of the results in relationship to supporting system-level hypotheses and achieving system-wide IGs; 3) a summary of those changes that are consistent with goals and hypotheses and those that are not; 4) a discussion of why the goals and hypotheses are not being achieved; 5) the identification of major unanticipated findings that may need attention

and correction, and 6) identify issues relevant to the Adaptive Management (AM) Program in CERP.

When identifying issues relevant to AM, the Annual SSR must address two factors–a clear description of the problem, and an analysis and interpretation that indicates the potential causes of the problem. This information will be provided to the AM Team responsible for formulating options to address unforeseen problems that arise during implementation. The reporting of this information could require the PIs and Module Leaders to re-evaluate the Conceptual Ecological Models (CEMs_, the driver–stressor–effects pathways, and associated PMs in order to provide a plausible explanation for the observed results.

1.2 Environmental Characteristics of the 2005-2006 Water Year

Recognizing hydrology's significance to the entire South Florida ecosystem, the following is a brief summary of the hydrologic data and analysis for Water Year 2006 (WY2006) (May 1, 2005—April 30, 2006). Details of WY 2006 hydrology is available in the 2006 *South Florida Environmental Report–Volume I* including a discussion on the active 2005 hurricane season (Section 9). The website for a PDF version of this report is: *http://www.sfwmd.gov/sfer*.

The hydrology of South Florida in WY2006 can be summarized as a wetter than average year with two peaks in rainfall and surface water flows in many areas, June and October 24 2005. Even though WY rainfall was higher than average, there were significantly dry months, January and March 2006 in most areas, and December 2005 and April 2006 in some areas. Drier winter and spring months dampened out the hydrologic impact of the high summer and fall rainfall. The combined impact of the 2004 and 2005 hurricane season on LO was significant. LO annual inflow of 3,707,764 acre-feet (ac-ft) and outflow of 4,034,447 ac-ft were the maximum on record since 1972. The high stage and volume of LO resulted in high discharge through the St. Lucie Canal (907,187 ac-ft) and the Caloosahatchee River (2,175,467 ac-ft). Inflows into and outflows from Water Conservation Area (WCA) 3 were higher than average. Everglades National Park (ENP) inflows were more than two times those of WY2005.

	WY2006	WY2005	Historical Average	WY2006 PET
Upper Kissimmee	52.91*	64.19*	50.09	52.43
Lower Kissimmee	48.50*	50.12*	44.45	53.79
Lake Okeechobee	47.33*	45.51	45.97	54.91
East EAA	48.24	46.16	53.48	50.72
West EAA	58.29*	52.20	54.95	52.18
WCA-1 and WCA-2	47.96	43.72	51.96	51.47
WCA-3	53.39*	40.27	51.37	51.42
Martin-St. Lucie	61.70*	56.99*	54.14	52.43
Palm Beach	57.80	50.44	61.54	51.73
Broward	56.67	42.80	58.13	51.42
Miami-Dade	57.44	43.05	57.11	52.91
East Caloosahatchee	56.91*	54.10*	50.68	54.00
Big Cypress Preserve (BCP)	58.75*	50.39	53.98	52.30
Southwest (SW) Coast	60.56*	55.05*	54.12	52.36
ENP	57.27*	40.15	55.22	52.91
District	54.72*	50.67	52.75	52.47

Table 1. Spatial comparison of WY2006, WY2005, historical average annual rainfall (inches) and WY2006 potential evapotranspiration (PET). (* = above average rainfall). The examples of data in Table 1 and Figures 1-3 in Appendix A, illustrate the spatial and temporal patterns of rainfall for WY2005 and WY2006 compared to historical averages. Clearly, WY2006 was above average for precipitation reflecting the very active hurricane season in South Florida. South Florida received rainfall from four hurricanes in WY2006: Hurricane Dennis in July, Hurricane Katrina in August, Hurricane Rita in September, and Hurricane Wilma in October. The hydrologic impact of these hurricanes on the SFWMD during the WY2005 hurricane season is discussed in the 2006 South Florida Ecosystem Restoration (SFER) report.

1.3 System-Wide Connectivity

Connectivity is a system-wide property that is fundamental to the functionality of the South Florida ecosystem. The role and importance of connectivity between the diverse geographic and/or habitat components comprising the modules in MAP can be appreciated when one examines the working hypotheses that form the scientific foundation for assessing the success of the restoration. Changes in land and water management practices, resulting from the implementation of CERP, will have an important affect on system-wide connectivity from three perspectives: 1) freshwater wetland hydrologic connectivity provided by sheet flow; 2) connectivity between freshwater and estuarine systems; and 3) habitat connectivity lacking physical barriers between various landscape types and their associated animal population.

Freshwater wetland hydrologic connectivity is a core feature of the Everglades - the slow movement of water across the vast, low gradient, wetland landscape. Drainage and compartmentalization efforts during the 20th century for flood control and water supply purposes interrupted this flow, as well as altering water levels, distribution, and seasonal timing. Water flows are closely linked to water levels, and their alterations have caused environmental damage. Efforts to restore the Everglades have focused on re-establishing

more natural hydropatterns–the appropriate water levels, and the location, timing, and duration of these water levels.

Habitat connectivity is necessary for many animal species and allows dispersal of juveniles away from their places of birth, for movement of animals within home ranges, and for long distance range shifts. As development has progressed, remaining habitat patches have become smaller in size and increasingly isolated from one another. Fragmentation of once expansive habitats caused by land development has caused discontinuities in dispersals and foraging ranges and reduced viability of isolated species and populations of upland vertebrates such as the Florida panther and red-cockaded woodpecker.

Freshwater and estuarine connectivity has been disrupted by water-management practices, land-use practices, and the reduced spatial extent of natural wetlands. Moreover, billions of liters of freshwater are discharged annually through canals or re-engineered natural waterways directly that would otherwise have gone into estuaries through coastal wetlands. These unnaturally large releases of water to estuaries during the wet season, primarily for flood control, and the reduction of total freshwater flow to estuaries during the dry season, primarily for water supply, results in unnaturally abrupt changes in salinity levels in the estuaries. The loss of freshwater wetland/estuarine connectivity has resulted in estuarine systems being un-buffered from seasonal rainfall cycles, which accentuates inter-annual and intra-annual variability in salinity and water quality.

2.0 SOUTHERN ESTUARIES

2.1 Summary[1] of Module Assessments

The SE influenced by the CERP include Florida Bay, the coastal lakes inland from Florida Bay, Biscayne Bay, and estuaries within southwest Florida's mangrove zone from Whitewater Bay to Lostmans River (Figure 2-1). Altered freshwater inflows have affected circulation, water quality and salinity patterns of theSE, in turn altering the structure and function of these ecosystems. Changes in SAV habitat structure and distribution have been of particular concern because of their effects upon animal populations

Seagrass beds are an important component in many coastal marine environments; however, there are few locations in the world where seagrasses are as dominant in the hydroscape as in south Florida (Fourqurean et al., 2002). Because most seagrasses are benthic-perennial plants, they are continuously subject to stresses and disturbances that are associated with changes in water quality along the land/sea interface. Seagrass abundance to a large extent determines public perception regarding the "health" of the coastal waters of Florida (Goerte 1994; Boesch et al., 1995). Thus, recent changes in the distribution and abundance of seagrasses within Florida Bay have been perceived as an especially significant change in the overall health of the Bay. For these reasons, seagrasses have been deemed "one of the best indicators of change" in the SE ecosystem (Fourqurean et al, 1992.) and an important assessment hypotheses for the SE Module.

The basic SAV sampling approach used in the MAP, uses randomly sited 0.5 meter square quadrats within basins/subregions. When data from this sampling design was analyzed it was found to be repeatable to within 1 Blaun-Blanquet (BB) unit. Analysis of the baseline data by this approach yielded 95% confidence intervals which is generally less than 1 BB unit. Specifically as the statistical approach taken here not only permits examination of two different and equally meaningful statistics but reduces variance with respect to the mean which should enhance the ability to detect departures from long term trends.

The proof of concept for SAV assessment in the SE was successfully implemented.

In Biscayne Bay, SAV data (and water quality data) is sparse or lacking in the very nearshore where CERP effects are expected to be the most intense. A test of a video-based sampling approach shows promise and will be continued this year with MAP support if funds are available. This may resolve some of the SAV spatial data deficiencies in that region.

Biscayne Bay models are needed to interpret SAV monitoring data.

[1] *Specific details and appropriate references for information presented in module summaries are provided in the module-specific assessments.*

BB data are ordinal, with a non-uniform scale. As a result, the means calculated in this assessment (and in the most recent overall SAV summary based on Fish Habitat Assessment Program [FHAP] data) are not strictly correct or readily interpretable. The lower three BB values (0.1, 0.5, 1.0) are measures of abundance but the upper BB values (2, 3, 4 and 5) are measures of cover. Not surprisingly, regressions of BB estimates against biomass measurements obtained by coring (a time-consuming destructive removal method) break down at higher BB values. Model studies will have to rely upon the ancillary SAV data (e.g., shoot density, leaf area and above-below ground biomass) now being obtained by both sampling groups at a limited number of sites as well as by other MAP projects (i.e., Juvenile Seatrout Sampling in Florida Bay). These data will also be essential to address the biological mechanism(s) regulating observed changes in abundance and distribution and will be invaluable in establishing the factors controlling an observed change. Another important source of data perhaps most useful to distinguish changes on very short time scales (episodic events) that might bias particular samples will be the pulse amplitude modulated (PAM) fluorometry data being taken by the FHAP group as part of its MAP project.

Efforts to understand causality of observed changes in Biscayne Bay will be more difficult in that with respect to water quality in particular the interagency modeling program in Biscayne Bay is considerably less advanced than for Florida Bay (and the southwest Florida shelf). While the SAV sampling will be able to determine if changes have occurred and if these exceed pre-CERP trends (or variability), assignment of cause and effect and inputs to the management decision process will be compromised.

There is no indication that the present SAV hypotheses need to be changed.

The problem of systematic differences between sampling field groups needs to be more fully resolved. It may simply result from a systematic difference in actual sample location or timing amongst the groups. On the other hand, there seems to be differences in sampling practice. That is, some investigators look down upon the canopy from above (and taller plants will of course shield shorter ones below) while others push the canopy aside and look beneath it. Until these differences are well understood and resolved (and attempts are already underway) the BB data should not be merged across sampling groups. If it should prove to be the case that methods are changed (or have already changed with personnel changes) over time within groups efforts to establish baselines will be compromised. Fortunately, the analysis to date provides no indication this has occurred. One thing that is already clear is that a decade or more of SAV data may be needed to observe trends in even the simple summary statistics employed herein. The five years of data available for Biscayne Bay were generally insufficient to establish a baseline. The extreme variability in the water quality data (and the limited predictive value of even the "statistically significant" regressions derived) also argues that a long-term consistent water quality data set is an absolute requirement and must continue to be maintained in future years. Despite these reservations and the simplicity of the analysis performed, it

Tropical storms can reset the biological clock with respect to long duration biological sequences of seagrass species replacement.

is felt that where trends were noted they were generally consistent with changes in water quality and in the direction predicted by the CERP hypotheses.

In addition, the affects of episodic events such as tropical storms and hurricanes must be considered in the dynamics between stressors and drivers for this area. The SE (indeed all of Florida) are increasingly affected by tropical storms that make landfall (or nearly so) in this region.

2.2 Relationships of Southern Estuaries Module Assessment to Interim Goals

There is a relatively close relationship between the SAV monitoring (and assessment) and the present IGs for the SE but it is far from perfect. In fact the current MAP work plans will not in themselves be sufficient (unless modified and supplemented) to address some of the refined spatial goals discussed above. Explicit targeted transect sampling will be required and to some degree this has already been initiated outside of the MAP.

Long-term, spatially and temporally extensive water quality and hydrologic monitoring are critical to the successful interpretation of MAP data.

The recommended method for predicting Florida Bay SAV for IG purposes is to eventually depend upon statistical and mechanistic seagrass models. Modeling parameters for predicting this indicator include: percent cover and relative abundance of seagrass (*Thalassia*, *Halodule*, and *Ruppia*) and macro algal species; biomass and relative abundance of *Thalassia*, *Halodule*, and *Ruppia*; spatial distribution and extent (coverage) of seagrass community types (based on percent cover and biomass data); and seasonal variation (end of dry and wet seasons) in these measures.

There is a relatively close relationship between the SAV monitoring (and assessment) and the present IGs for the SE but it is far from perfect.

An important and potentially troubling concern may be the need, for modeling purposes, to accurately assess biomass (rather than estimating it indirectly from regression relationships based on limited data). Depending upon model sensitivity this might require additional data, effort and expense. Unfortunately given systematic differences in BB estimates it will not be possible at this time to pool FHAP and Miami-Dade County Department of Environmental Resources Management (DERM) (and likely National Oceanic and Atmospheric Administration [NOAA]/Beaufort) data to increase the number of observations and perhaps improve regression reliability. In any case such regressions tend to breakdown over the full BB range and are most reliable only at the lower end of the overall range. Since it is probable that the IGs for SAV in Florida Bay will change in its next iteration and MAP sampling will be updated at two year contract renewal intervals the opportunity will arise to improve the match between the processes of model prediction and assessment.

2.3 Lessons Learned–Southern Estuaries Module Assessment

The pilot or proof of concept of the assessment process for SAV in the SE was an overall success. BB estimates being taken as part of MAP should be sufficient to distinguish CERP implementation-related changes from background trends. Further there is no indication that the present conceptual model and hypotheses for SAV need to be changed since statistically significant trends in SAV were associated with statistically significant trends in water quality. The following observations and recommendations have emerged based on this initial assessment. The five years of data available for Biscayne Bay SAV were insufficient to establish a baseline and suggests that a decade or more of SAV data may be needed to see trends in even the simple summary statistics employed herein. This problem is confounded because Biscayne Bay SAV and water quality data are sparse or lacking in the very nearshore where CERP effects are expected to be most intense. While the SAV sampling will determine if changes have occurred and if these exceed pre-CERP trends (or variability), assignment of cause and effect and inputs to the management decision process will be compromised because the interagency water quality modeling program in Biscayne Bay is considerably less advanced than for Florida Bay (and the southwest Florida shelf). Further, the extreme variability in the water quality data (and the limited predictive value of even the "statistically significant" regressions derived) also argues that a long-term consistent water quality data set is an absolute requirement and must continue to be maintained in future years. Despite these reservations and the simplicity of the analysis performed, it is felt that it is significant that where SAV trends were noted they were generally consistent with changes in water quality and in the direction predicted by the CERP hypotheses. Finally, it is strongly recommended that future SE assessments be conducted by the experts themselves rather than Module leaders as was done in this case.

3.0 NORTHERN ESTUARIES

3.1 Summary[2] of Module Assessments

Several key indictors have been selected to be used by RECOVER to assess the current condition and monitor changes in ecological health of the NE through time as CERP projects are implemented. Acknowledging the large number of estuarine species and their critical habitats that define a healthy functioning estuary this assessment has focused on a small number of key indicator species with the most direct ties to the water management activities that CERP will be affecting in the area. The oyster MAP was chosen as a pilot of the assessment process. The other key indicators that will be assessed in the NE includeSAV, benthic invertebrates and fisheries.

The pilot assessment process for the oysters in the NE was an overall success. Some refinements in the monitoring program, predictive tools and further knowledge of the major factors effecting the reestablishment, health and long-term survival of the oyster communities are needed. Major conclusions and recommendations are discussed below. There appears to be no need at this time to revise any of the oyster hypotheses, but some gaps in knowledge such as the affect of contaminants on oysters need to be studied.

The pilot assessment process for the oysters in the NE was an overall success.

The existing sample design can adequately assess the magnitude and direction of change in oyster populations in the NE.

While the existing sampling design and sampling frequency can adequately assess the direction and magnitude of change in thePMs, the sampling protocol may be adjusted to better capture the spatial variation of responses. Since the first full year of sampling has only recently been completed for the east coast estuaries, the seasonal trends will be evaluated before any adjustments are made. For example, if the salinity regime in two stations is too close, the location of the stations may be adjusted to capture the range of salinities that would influence the oyster responses.

Analyses of reproduction are currently performed using histological techniques. Such techniques are time-consuming, expensive and require specific expertise limiting the number of samples that can be analyzed. Newer techniques such as enzyme linked immunosorbant assay that use antibodies against egg protein of eastern oysters are now being developed. These techniques will greatly enhance the sample processing and increase the sample size.

Newer, cost effective techniques are needed for determining reproductive health of oysters in the NE.

[2] *Specific details and appropriate references for information presented in module summaries are provided in the module-specific assessments.*

While the water quality (i.e., temperature, salinity, and dissolved oxygen [D.O.]) are being measured at the sampling site during each sampling event (once a month), a more frequent sampling is required to capture the episodic events. While an attempt is being made to assess the predation pressure in the east coast estuaries, this is not being assessed in the Caloosahatchee River. Given that predation pressure is significant in some locations, such information is necessary and will strengthen the habitat suitability index (HSI) models in strengthening their predictability of potential suitable habitat. Since oysters reproduce between March and November, oyster spat recruitment and reproductive activity measurements may be limited to those months. However, such information is not available for oysters from the east coast estuaries. When such information becomes available, the sampling protocol may be adjusted.

Salinity, temperature and D.O. need to be monitored on a real-time basis.

The PM of living oyster densities is being assessed, but the extent of oyster reef development (spatial coverage in acres) is not being mapped. Extent of oyster coverage is described as an interim target, thus oyster reef mapping should be conducted periodically (once every five years).

Mapping of oyster beds in all parts of the NE must become a regular part of the MAP program.

Oyster reefs occupying the various estuaries in southeast Florida are not isolated entities but are instead linked to one another via exchange of larvae. Each reef is linked to other reefs to a greater or lesser degree depending upon distance, hydrodynamics, and environmental factors that promote or defeat the survival and growth of the larvae. Previous studies clearly indicate that, based upon variations in genetic structure among southeast Florida oyster populations, larval exchange is spatially structured. It is probable that temporal variation in larval exchange also characterizes these populations. An understanding of larval exchange is a necessary precursor to the proper management of oyster reefs in southeast Florida, and throughout the state, because that information will reveal those oyster reefs that act as larval sources and therefore fundamental to the long-term survival of oyster populations in Florida waters. At present, the needed genetic and hydrodynamic information to define those reefs in not available.

There is no indication that the present conceptual models and examined hypotheses need to be modified.

3.2 Relationships of Northern Estuaries Module Assessment to Interim Goals

The IGs for oysters were stated simply in terms of acres of suitable habitat under restoration scenarios in the estuaries where full CERP implementation restoration targets exist (all but Lake Worth Lagoon [LWL] and in the SE Biscayne Bay). A baseline for oysters has been established in all NE except LWL where preliminary mapping exists, but area calculations are not finalized. Mapping consists of distribution of reefs/beds, size class distribution and percent alive/dead. During CERP implementation new maps need to be created on five-year time intervals to track changes. The current Master Implementation Schedule for CERP was utilized in the model runs to predict the expected progress over time, in five-year increments, toward achieving that target. See the RECOVER recommendations for IGs for details on each of the four NE. A number of watershed hydrology, hydrodynamic salinity and oyster models were employed. The IG for oysters will be assessed using several other parameters as well as acres in order to determine cause and affect relationships of water management changes due to CERP implementation on the health and distribution of the oyster reefs. The monitoring program which is designed to track the predictions made includes measuring spat abundance and distribution, the spatial extent of oyster beds, juvenile growth and survival and oyster health as indicated by condition index and extent of disease. Future refinement of the IG predictions in all estuaries needs to occur. The oyster HSI model is proving to be a useful tool for this purpose. The model needs to be adapted for use on the east coast and the monitoring data currently being collected will improve calibration of the tool. As modeling scenarios for the preferred restoration plan in LWL become final this information will need to be used to develop the five-year predictions for that estuary as well. As information is gained in these first few years of monitoring, efforts will be made to make sure that temporal and spatial scales and matrix being predicted and assessed are complementary in all cases.

Future refinement of the IG predictions in all estuaries needs to occur. The oyster HSI model is proving to be a useful tool for this purpose.

3.3 Lessons Learned–Northern Estuaries Module Assessment

The pilot or proof of concept of the assessment process for the oysters in the NE was an overall success. However, refinements in the monitoring program, predictive models/tools and factors effecting the re-establishment, health and long-term contaminant effects on oysters, and survival of the oyster communities are needed. Nevertheless, there appears to be no need at this time to revise the oyster conceptual model or hypotheses. Based upon this initial assessment, there are three recommendations: 1) the oyster sampling protocol be adjusted to better capture spatial variation; 2) the extent of oyster reef coverage be mapped every five-years to evaluate meetingIGs; and 3) genetic and hydrodynamic information is needed to understand the linkages controlling the exchange of larval sources among the various reefs and to understand which oyster reefs that act as larval sources and therefore fundamental to the long-term survival of oyster populations.

4.0 GREATER EVERGLADES

4.1 Summary[3] of Module Assessments

Predator-Prey Interactions of Wading Birds and Aquatic Fauna Forage Base
The hypothesis chosen as a proof of concept for the GE wetlands module describes the relationship of wading bird nesting to available aquatic prey populations. The collapse of wading bird nesting colonies in the southern Everglades is attributed to declines in population densities and seasonal concentrations of marsh fishes and other aquatic prey organisms. Monitoring of wading bird/aquatic fauna predator-prey interactions across the GE wetlands is based on the hypothesis that restoration of natural hydrologic conditions will re-establish distributions of prey densities and concentrations across the landscape that in turn will support the return of large, successful wading bird nesting colonies to the SE.

The proof of concept for predator-prey interactions of wading birds in the GE was successful.

The predator-prey hypothesis cluster is used as a proof of concept for the assessment process in the GE wetlands because MAP monitoring of the key components of the hypothesis has been implemented, and a full year of data is available for 2005. Furthermore, this large and complex group of hypotheses for a major restoration goal of GE wetlands has high levels of uncertainty regarding how the biological components relate to each other and to hydrology. The following 2005 monitoring results provide the first system-wide overview of wading bird/aquatic fauna predator-prey interactions, and they are consistent with the current predator-prey hypothesis.

Wet Season Production and Dry Season Concentration of Aquatic Prey Organisms in the Southern Everglades. The abundance of prey populations in the southern Everglades (ENP) during the 2005 wet season were largely due high crayfish biomass in the marl prairies to either side of Shark River Slough, and to low fish biomass in the southern half of the ENP compared to areas to the north. The same marl prairie areas that supported high wet season prey populations also produced the highest prey concentrations of all areas sampled during the 2005 dry season. Prey concentrations in these areas consisted of high densities of the Everglades crayfish compared to other areas.

The marl prairies to either side of Shark River Slough produced the highest prey concentrations of all areas sampled during the 2005 dry season.

Contrasts between the WCAs and the Southern Everglades in the Production and Concentration of Aquatic Prey Organisms. Patterns of abundance and concentration of aquatic fauna prey populations in the WCAs were fundamentally different from those in the southern Everglades during 2005. Crayfish represented a minor component of aquatic fauna biomass throughout the WCAs during the 2005 wet season. Grass shrimp were generally abundant in the WCAs, although they were nearly absent throughout most

[3] *Specific details and appropriate references for information presented in module summaries are provided in the module-specific assessments.*

of ENP. The most notable pattern in the WCAs during the 2005 wet season was the abundance of all major groups of aquatic fauna in WCA 1 compared to other areas.

The WCAs also differed from the southern Everglades in the concentration of aquatic prey during the 2005 dry season. Prey densities in concentration patches in the WCAs were lower than in the ENP and were dominated by fishes rather than crayfish. The only area in the WCAs that came close to having high prey densities comparable to the southern marl prairies was southern WCA 2A.

Prey densities in the WCAs were lower than in the ENP and dominated by fishes rather than crayfish.

Correspondence of Wading Bird Nesting Initiation and Failure to Concentration and Dispersion of Aquatic Prey. Nearly 29,000 wading bird nests were initiated in GE wetlands during 2005. The strong initiation of nesting in 2005 is characteristic of the resurgence in total numbers of nesting birds since about 1999. The strong onset of wading bird nesting during January-February 2005 corresponded to the period of concentration of aquatic prey. Higher than average water levels at the start of the 2005 dry season showed a steady and rapid drying rate from November through February throughout most of the system. The combination of initially high water levels and desirable drying rates concentrated prey in drying slough habitats mostly in short-to-medium hydroperiod landscapes during 2005.

Nearly 29,000 wading bird nests were initiated in GE wetlands during 2005.

The abandonment of wading bird colonies in March 2005 corresponded to the dispersion and reduced concentration of aquatic fauna due to reversals in the receding water pattern. Rainfall events starting in March caused water level reversals throughout most of the system. Patches of drying slough habitat suitable for prey concentration ceased to be formed, and prey concentration sampling was disrupted. When prey concentration patches dispersed, the previously strong initiation of wading bird nesting ended in widespread nest failure by most species. This was true for Great Egrets, White Ibises, Wood Storks and Snowy Egrets, and the trend occurred throughout the GE wetlands and Florida Bay. Successful nesting occurred only in Roseate Spoonbill colonies in northwest and southeast Florida Bay. Had it not been for the reversals in water level recession, 2005 would likely have been a year with a large number of successfully nesting wading birds.

Comparison of the Distributions of Wading Bird Nesting and Aquatic Prey Population. Traditionally, large colonies of nesting wading birds in the Everglades formed along coastal areas of ENP prior to their collapse. During the 2005 nesting season, 1,990 wading bird nests were initiated in the mainland of ENP, compared to 24,249 in the WCAs during the 2005 nesting season.

A possible explanation for the low initiation of nesting in coastal regions of the ENP in 2005, despite water recession rates conducive to prey concentration early in the nesting season, is that low wet season prey biomass was insufficient to produce dry season prey concentrations that were adequate to support nesting. This explanation is consistent with the finding that fish biomass was low in southern areas of the ENP compared to other areas of the Everglades during the 2005 wet season. The low fish biomass there is relevant to the hypothesis that collapse of traditional coastal nesting colonies is related to declines in prey populations along the freshwater/estuarine interface of the southern Everglades.

ENP low wet season prey biomass was insufficient to produce dry season prey concentrations that were adequate to support nesting.

Areas of the ENP with high wet season prey biomass, high dry season prey concentration, and high crayfish biomass in the Rocky Glades, Ochopee Marl Prairie, and Lower Lostman's Slough appeared to have been mostly too distant from coastal colony sites to be important as foraging areas. The high prey population densities and subsequent concentrations that these areas produced thus did not appear to support wading bird nesting in the coastal colonies during 2005.

Reproductive Life History of Native Crayfish Species. Crayfish monitoring data from 2005 illustrate what might be some of the first evidence of the reproductive life history of the native crayfish species in the Everglades. In comparison of densities of crayfish to the actual mass of the animals, general densities were highest when the mass was lowest. This indicates a surge in small-bodied animals (juveniles) in the summer months. Conversely, the highest mass was found when the densities were the lowest; thus indicating capture of fewer, but bigger animals. Until this point, there has not been clear quantitative evidence of when the pulse of juvenile animals became available in the ecosystem.

Importance of Freshwater Fishes in Seasonal Prey Population Density Fluctuations Along the Freshwater-Mangrove Interface. Freshwater fish species accounted for most of the annual and seasonal fluctuations in fish population density and community composition in the freshwater-oligohaline zone of the interface between Everglades marshes and mangrove estuaries between 1990 and 1997. Freshwater species at estuarine sites increased in density during years of low salinity and decreased during years of high

Freshwater fish species accounted for most of the 2005 seasonal change in fish community structure in Rookery Branch.

salinity. Gradual changes in community structure through time suggested that population recovery required a low salinity period of four years or more.

Freshwater fish species accounted for most of the 2005 seasonal change in fish community structure in Rookery Branch, a mangrove-lined creek linking freshwater marshes to estuarine habitats. This change resulted from an influx of freshwater fishes into Rookery Branch as marshes upstream dried. Fish community structure changed comparatively little in other creeks where influxes of freshwater fishes were less evident during the dry season.

These results are consistent with the hypothesis that the collapse of traditional coastal nesting colonies of wading birds is related to prey population declines along the marsh-mangrove interface of the southern Everglades as a result of altered volumes and patterns of freshwater flow (Ogden 1994).

4.2 Relationships of Greater Everglades Module Assessment to Interim Goals

Aquatic Fauna Regional Populations in Everglades Wetlands

The desired restoration conditions for aquatic fauna regional populations are: 1) achieve late wet season population densities, size distributions, and taxonomic compositions of marsh fishes and other selected groups of aquatic fauna consistent with pre-drainage hydrologic and salinity patterns in the Everglades wetlands, 2) shift the distribution of high population densities and larger size classes from artificially impounded areas of the WCAs to persistent pools to be restored in the southern Everglades, and 3) provide high-density patches of prey-availability across the Everglades landscape where wading birds can feed effectively as water levels recede during the dry season. Calculation of the expected benefits of the CERP regarding increased density of marsh fishes and associated aquatic fauna are based on an empirical relationship of fish abundance to hydroperiod (time since the site was last dried out) that has been determined from field studies at long-term sampling sites in the Everglades.

Given the current approach to aquatic fauna IGs, progress toward achieving the goal during any particular year cannot be assessed from monitoring data. Assessment of progress in achieving aquatic fauna IGs during any given year will require model simulations.

Present IGs for aquatic fauna are based on average densities for a 31-year period of record (POR), given the CERP infrastructure that will be in place (e.g., 2010, 2015). For example, the simulated 2010 condition represents the average abundance of fishes produced in all years if the system contained all the projects scheduled for completion by 2010, and it were operated for 31 years given the rainfall patterns observed during the latter half of the twentieth century. Given the current approach to aquatic fauna IGs, progress toward achieving the goal during any particular year cannot be assessed from monitoring data. Assessment of progress in achieving aquatic fauna IGs during any given year, based on MAP monitoring data, will require model simulations. Such simulations will relate aquatic fauna population characteristics during given sampling

years to the hydrologic conditions for the specific years and for appropriate antecedent time periods. Such simulations also will be applied to different geographic locations in the GE wetlands.

System-Wide Wading Bird Nesting Patterns

IGs for wading bird population health include system-wide patterns of nesting, and includes measurements of four variables: numbers of nesting birds, locations of nesting colonies, timing of nesting, and frequency of "supra-normal" colonies. Best professional opinion was used for initial predictions, based on over 50 years of recorded wading bird nesting patterns under previous hydrological conditions.

For the locations of nesting colonies, the desired restoration condition is a substantial increase in nesting by egrets, ibis, and storks in the region of the southern Everglades mainland estuaries. An initial desired restoration condition for these species is a return to greater than 50 percent of nesting pairs in the estuarine region compared to less than ten percent under current conditions. For spoonbills, the desired restoration condition is a realignment of nesting colonies into eastern Florida Bay. The desired restoration condition for timing of nesting applies primarily to the wood stork. Wood storks should initiate nesting no later than January 31 in most years. Wood storks have been initiating nesting as late as February and March in most recent years. For supra-normal breeding events, the desired restoration condition is to recover pre-drainage patterns of "super colony" nesting events. The desired restoration condition has yet to be refined, but in general, it is to have about two supra-normal breeding events during each ten-year time period (less than one event per decade since the 1970s).

The wading bird IGs in their present form can be assessed at five-year increments using data from the current MAP monitoring plan.

The predictions for system-wide wading bird nesting patterns are quantified at five-year intervals. "Total # Pairs" refer to the total number of nesting pairs for the same four species and are based on the mean of three-year running averages. The wading bird interim goals in their present form are easily assessed at five-year increments from the current monitoring plan.

4.3 Lessons Learned–Greater Everglades Module Assessment

The collapse of wading bird nesting colonies in the southern Everglades is attributed to declines in population densities and seasonal concentrations of marsh fishes and other aquatic prey organisms. Therefore the predator-prey hypothesis cluster is used as a proof of concept for the assessment process in the GE wetlands. In addition, the MAP monitoring of the key components of the hypothesis has been implemented, and a full year of data is available for 2005. The lessons learned from this exercise include but are not limited to the following:

There is no indication that the predator-prey hypothesis cluster for wading birds needs to be modified at this time.

- The proof of concept for predator-prey interactions of wading birds in the GE was successful.
- Nearly 29,000 wading bird nests were initiated in GE wetlands during 2005. Traditionally, large colonies of nesting wading birds in the Everglades formed along coastal areas of ENP prior to their collapse. However, during the 2005 nesting season, only 1,990 wading bird nests were initiated in the mainland of ENP, compared to 24,249 in the WCAs during the 2005-nesting season.
- A possible explanation for the low initiation of nesting in the ENP in 2005, despite water recession rates conducive to prey concentration early in the nesting season, is that low wet season prey biomass was insufficient to produce dry season prey concentrations adequate to support nesting.
- Patterns of abundance of prey populations in the southern Everglades (ENP) during the 2005 wet season were largely due high crayfish biomass in the marl prairies to either side of Shark River Slough, and to low fish biomass in the southern half of the ENP compared to areas to the north.
- The latter results (e.g., low fish biomass) support the hypothesis that the collapse of traditional coastal nesting colonies of wading birds is related to prey population declines along the marsh-mangrove interface of the southern Everglades as a result of altered volumes and patterns of freshwater flow

5.0 LAKE OKEECHOBEE

5.1 Summary[4] of Module Assessments

When hurricanes affect LO, strong currents are generated that run parallel to the shore, and along with wind-driven waves, can cause uprooting of SAV. Large north to south seiches were documented during Hurricanes Frances and Jeanne. Similarly, Hurricane Wilma caused large east to west seiches a year later. These seiches piled up large quantities of aquatic plants along the lake shore. Although monthly transect sampling data intimated that the SAV community had been severely affected by all three hurricane events, a direct cause/effect relationship could not be determined because sampling events did not occur in close enough proximity to the passage of the storms. Development of a pre- and post- wind/wave driven sampling program needs to be implemented to better capture SAV responses to episodic wind and wave events.

Routine monitoring of chlorophyll *a* and phytoplankton taxonomy and bio-volume in LO has been ongoing since the mid 1990s. A very large data set currently exists but no data analyses or assessment has been performed.

Emergent vegetation maps based on aerial photography for the entire LO marsh and for the western bulrush fringe has been collected since the mid 1990s and comprises a thorough baseline data set. However, as with SAV data, the emergent vegetation community in LO appears to be very dynamic, responding in a relatively short time frame to changes in water depth, physical perturbations such as hurricanes, and exotic and invasive control operations. Additional research into herbicide treatment effects, seed germination and viability and hydrologic impacts on the recruitment of bulrush and torpedograss are also being pursued to better understand the changes documented by ongoing mapping activities.

At present, there is inadequate LO fish baseline data. Currently, RECOVER is funding a five-year study by the Florida Fish and Wildlife Conservation Commission (FFWCC) to collect fishery data by trawl and electro-fishing on LO. Methods employed are identical to those used by the FFWCC in previous surveys, some of which date back to the early 1990s. The possibility of analyzing the 30+ years of creel data possessed by the FFWCC is also being investigated as a way to acquire earlier baseline information on the sport fishery on LO.

At present there is inadequate LO macro-invertebrate baseline data. Currently, RECOVER is funding a three-year study of LO benthic macroinvertebrate fauna with the purpose of acquiring this baseline data. Study methods and sampling locations are identical to those used in a previous study (1987 to 1991), thus it may be possible to elucidate recent trends in macroinvertebrate population dynamics from this work.

[4] *Specific details and appropriate references for information presented in module summaries are provided in the module-specific assessments.*

A three-year trophic index study looking at the fish, macro-invertebrate and amphibian populations in the three dominant SAV communities and the two dominant emergent vegetation communities in LO is currently underway. It is anticipated that results from this study coupled with results from a recently completed study looking at fish and macro-invertebrates in spike rush and torpedo grass habitat will allow the expansion of the SAV and emergent vegetation assessment tools currently under development to include additional trophic guilds.

Finally an issue of hydrologic connectivity in LO prevails when one considers the relationship between the pelagic, near-shore, and western and southwestern littoral (marsh) zones of LO. Following the construction of the Herbert Hoover Dike, a structure that will remain with little if any modification after the completion of CERP, LO was confined to a smaller footprint, and a new littoral marsh developed to the lake's south and southwest. Another important geographic feature of constrained LO is a series of shoals, reefs, and spoil islands that ring the outer edge of the nearshore zone. When lake levels are in a moderate range, lake topography, in some cases coupled with dense bands of emergent vegetation, hydrologically isolates the interior littoral marsh causing it to function as a pristine, rain-water driven system. Similarly, the geographic features that ring the nearshore zone provide partial isolation of this area from the highly eutrophic, highly turbid pelagic zone, and contribute to the nearshore zone's ability to support a dense SAV community. Under elevated lake stages, pelagic zone water invades both the nearshore and littoral zones causing, among other changes, loss of SAV and bulrush due to decreased light penetration and wind and wave action, and the loss of desirable emergent species and their replacement with nutrient tolerant species such as cattail in the littoral zone. Two LO PMs, (L0 1) Excessive High Lake Stage, and (LO 3) Lake Stage Envelope provide metrics that enforce the preference for moderate lake stages with the intent of maintaining the hydrologic disconnection between these three system components.

5.2 Relationships of Lake Okeechobee Module Assessment to Interim Goals

The current IG/ITs for LO are hydrologic based, with the ultimate goal of using operational flexibility to facilitate benefits to the environment without impacting other uses of LO. Although there are no biologically based IG/IT at this time, the development of goals and targets based on the lake's SAV community would be an important development since the areal extent, density, and species composition of SAV in LO may be the single most important biological indicator of the lake's overall ecological health. The LO SAV sampling program has indicated that SAV can cover more than 40,000 acres when water levels are favorable (e.g., August 2000, 2002, and 2004), as compared to less than

Although there are no biologically based IG/IT at this time, the development of goals and targets based on LO's SAV community would be an important development since the aerial extent, density, and species composition of SAV in LO may be the single most important biological indicator of the lake's overall ecological health.

(<)5,000 acres during periods of prolonged high water levels (e.g., 1996 to 1999). Therefore, the LO Protection Program restoration target is to sustain at least 40,000 total acres of SAV (vascular and non-vascular) with at least 20,000 acres contributed by vascular plants while the proposed RECOVER PM sets this target at 49,000 acres. Under existing lake management constraints, this spatial extent is attained in certain years, although in a relatively high percentage of years it is lower due to sustained high water levels or major physical disturbances (hurricanes). This leads to the inescapable conclusion that an inter-annual variability factor needs to be included in SAV goals and targets to capture the ability of CERP related changes to promote the long term maintenance of quality SAV habitat.

5.3 Lessons Learned–Lake Okeechobee Module Assessment

Based on currently available data, it should be possible to perform assessments on the LO SAV, phytoplankton, and littoral zone emergent vegetation hypotheses clusters. The earliest dates by which assessments could be performed on the macroinvertebrate and fish hypothesis clusters are 2008 and 2010 respectively. From a practical standpoint, the amount of effort required to do an assessment on a single hypothesis cluster makes it unlikely that more than a single cluster can be subjected to an assessment each year; particularly considering current staffing and funding levels. Therefore, it is proposed that each cluster be assessed on a rotating basis once in v=five years in the following order: 1) SAV; 2) Emergent Littoral Zone Vegetation; 3) Phytoplankton; 4) Macroinvertebrates; and 5) Fish.

All hypotheses clusters may not be analyzed annually for LO but rather on a rotational basis.

6.0 SYSTEM-WIDE LESSONS

This pilot assessment has highlighted the following lessons and challenges that transcend the individual modules that are important to the success of CERP:

- Sustainability: Sustainability is a critical issue for CERP. Data used by CERP is acquired from a variety of sources; the sustainability of this program is dependent upon the commitments of many federal, state, and academic institutions. Consequently, there is a need to assure that the necessary agreements (e.g., memorandum of understanding [MOU]) are in place to ensure sustainability of these programs.
- Data Management: A comprehensive data management (DM) program is fundamental to the success of CERP and future assessments. The development of RECOVER's DM program involves a hierarchical integrated strategy that accesses and integrates a wide array of biological, chemical and physical data collected by a wide range of organizations and scientists that is being used to establish a baseline from which future assessments of ecosystem status resulting from CERP implementation. (See additional DM section below.)
- Adaptive Management: The RECOVER assessment process and its supporting projects are designed to assess hypotheses that describe the restoration process. As data is collected and analyzed during this program the principles of the CERP AM process will be used to recommend and institute changes in programs and projects.
- Performance Measures: An important conclusion from this assessment is that there is a need to review the number of PMs currently being used in CERP and their relationship and relevancy to assessing progress to achieving IGs. The development and assessment of module hypotheses clusters indicates that many PMs are no longer needed or relevant to the assessment and decision-making process.
- Interim Goals: This pilot assessment has identified a clear disconnect between the current list of IGs and the hypotheses and PMs currently being used by the modules to assess CERP.
- Societal Values: Although not addressed in this pilot assessment, societal values play an important role in the restoration process particularly as these values influence the prioritization of restoration goals, support for the long-term sustainability of CERP and benefits to the citizens of South Florida.
- Exotic Species: While the topic of exotic species was not explicitly addressed in these proof-of-concept assessments it remains an important issue with potentially broad implications for the success of CERP. The South Florida Ecosystem Restoration Science Coordination Group (Science Coordination Group) has reports on assessing and managing invasive species and has identified it as a key system-wide indicator of restoration success. Similarly, the SFWMD in its 2006

SFER (Chapter 9) discusses the importance of exotic species in South Florida and its potential impact on the restoration.

- Reporting Process: The preparation of this 2006 Pilot SSR has identified the following lessons; the need for a comprehensive DM program; the standardization of the reporting format and data requirements, and analyses from the PIs; an increased role for the PIs in the preparation of the annual SSR reports; and the need for permanent technical editor who is part of the report preparation process.

- System-Wide Connectivity: Connectivity is a system-wide property that is fundamental to the functionality of the South Florida ecosystem. The role and importance of connectivity between the diverse geographic and/or habitat components comprising the modules in MAP can be appreciated when one examines the working hypotheses that form the scientific foundation for assessing the success of the restoration. The reestablished wetland hydrologic connectivity, habitat connectivity, and freshwater-estuarine connectivity are key goals of CERP that need to be monitored and assessed.

- System-Wide Water Quality: As with hydrology, water quality is a persistent theme throughout much of the 2006 SSR. For example, water quality characterization in local or regional areas has been an important component for examining hypotheses relating to SAV dynamics in the SE and LO. There are a number of sources that have compiled water quality information (e.g., Battelle & Waldemar), examined water quality data from a regulatory perspective (2006 SFER, Chapters 2A and 2C (http://www.sfwmd.gov/sfer), and analyses water quality data from notable geographic regions in South Florida (e.g., Harwell et al. 2005 analyzed water quality data for the 220 sq mi A.R.M. Loxahatchee National Wildlife Refuge in the northern Everglades). As recognized in the Restudy (USACE and SFWMD 1999) and most recently by the NRC, a comprehensive system-wide assessment of water quality trends remains a critical information gap requiring attention.

7.0 SYSTEM-WIDE DATA MANAGEMENT NEEDS

The development of RECOVER's assessment program involves a hierarchical integrated assessment strategy that depends on accessing and integrating a wide array of biological, chemical and physical data collected by a wide range of organizations and scientists. In order to establish a baseline from which future assessments of ecosystem status resulting from CERP implementation can be evaluated, initial focus of resources and efforts were on collecting data from appropriate sampling locations. Data collected to this point are dispersed across many PIs, in a variety of information systems with varying degrees of standards for data, documentation and coding. As a result of multiple information systems and standards, integration of information to conduct complete assessments is complicated and will require significant effort on the part of the PIs and the AT.

Data management is essential to the synthesis, analysis, and integration of MAP monitoring data and critical to evaluating the success of CERP.

RECOVER DM is currently automating and formalizing the assessment process at the PI, module, and system-wide levels. At the PI and module levels, the RECOVER DM system intends to leverage and link with DM systems currently in use by individual PIs that demonstrate the required standards and automation of the data life cycle. Otherwise, PIs will utilize the RECOVER DM system currently being designed. The intent of automation at this level is to instill consistency, integrity, and reproducibility at all stages of the data life cycle, including: data input; metadata documentation; quality assurance/quality control (QA/QC); processing and analysis; and data output.

At the module level, it is intended to automate the process of integrating and synthesizing the data and analysis from the individual module components into the module architecture to aid in assessments of PMs, hypotheses, IG/ITs, and CEMs. Formalizing the process and applying a mechanized approach through the DM system at this level assures reproducibility, consistency, integrity and efficiency from year to year.

At the system level, the RECOVER DM system will automate the synthesis of assessment results, the interpretation of the system's status, and facilitate the presentation of the assessment message to the multiple audiences that exist within the RECOVER program.

8.0 SUMMARY

The primary goal of the 2006 SSR–Pilot Study was to conduct a "test of concept" of the MAP-Part 2 technical assessment process that is to be used for detecting and assessing changes resulting from the implementation of CERP. Each module conducted a "test of concept" for a specific hypotheses cluster that focused on estimating trends in baseline/reference condition and assessing the ability to detect change. The results indicate that the "test of concept" was successfully implemented in all modules and that the hypotheses and supporting CEMs are sufficient and do not require modification.

Several lessons emerged from this Pilot Assessment that deserve attention including the need for: comprehensive DM program that provides a seamless integration of diverse types of data from distributed sources, programmatic and fiscal sustainability, a critical review and reduction in the number of the PMs, a review of IGs and their explicit linkage to PMs and relevant hypotheses, and the recognition that "connectivity" is a system-wide property that is fundamental to the functionality of the South Florida ecosystem and that will be altered by the implementation of CERP.

It is important to recognize that this 2006 Pilot Assessment is not intended to provide a comprehensive assessment of the status and condition of the individual modules or the South Florida ecosystem nor draw conclusions or recommendations regarding the "success" in achieving CERP restoration goals. However, the analyses that comprise this 2006 Pilot Assessment have resulted in recommendations for improving the Technical Assessment Guidance process as well as the MAP and CERP.

9.0 ACKNOWLEDGEMENTS

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APPENDIX A-ENVIRONMENTAL CHARACTERISTICS AND LINKS TO SOUTH FLORIDA HYDROLOGY

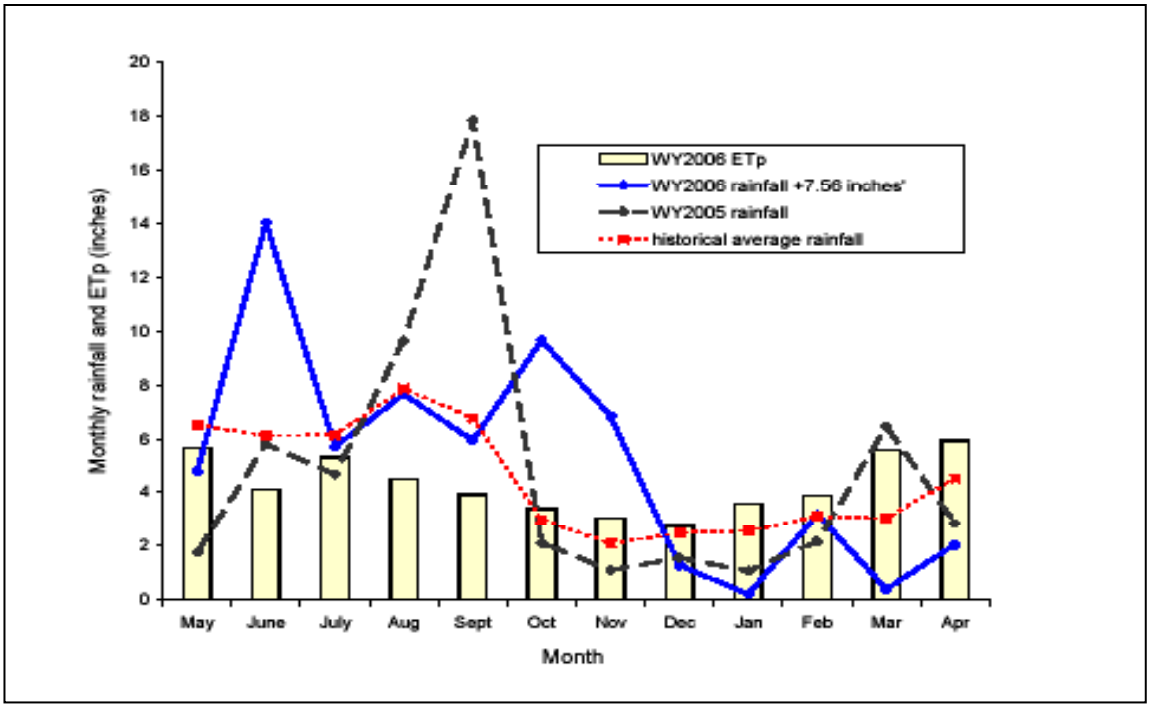

Figure A-1: Monthly rainfall for WY2005 and WY2006 compared with historical average and PET for Martin and St. Lucie counties *(After 2006 SFER, Figure 2.22).*

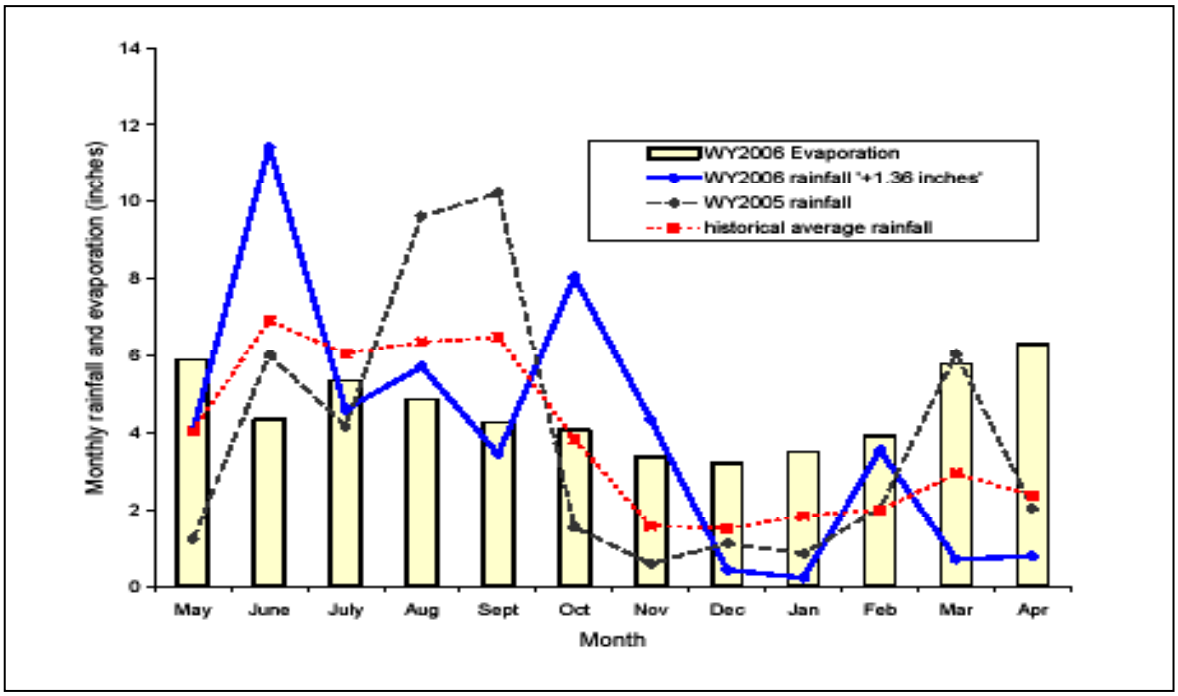

Figure A-2: Monthly rainfall for WY2005 and WY2006 compared with historical average and PET for LO *(After 2006 SFER, Figure 2.17).*

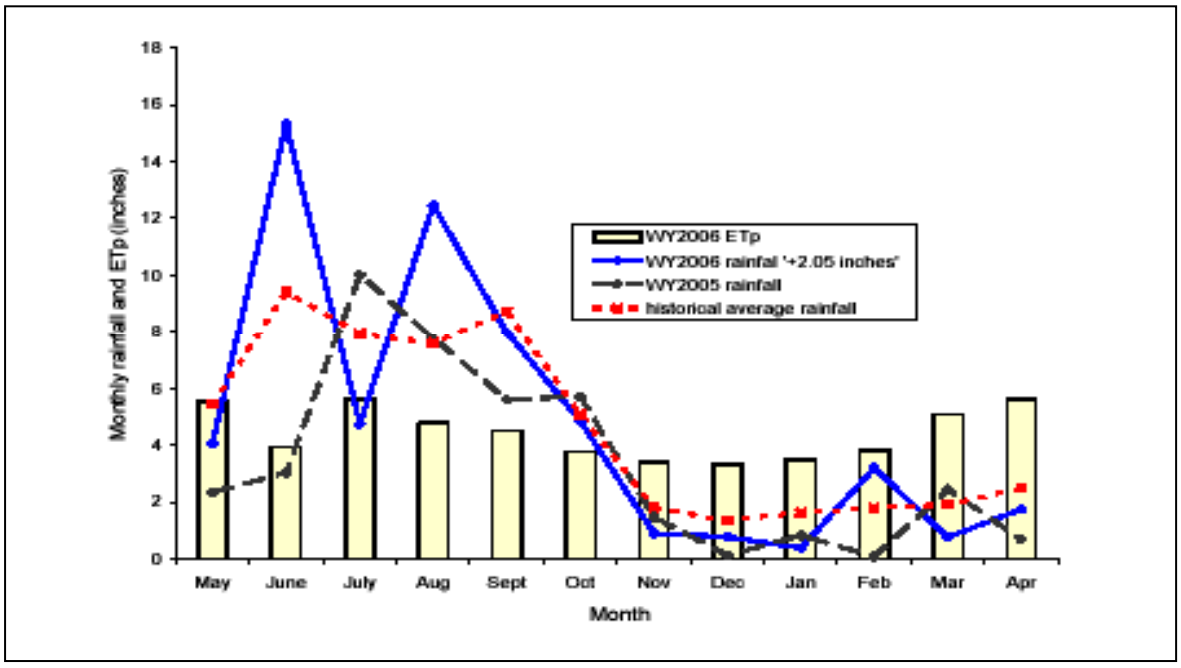

Figure A-3: Monthly rainfall for WY2005 and WY2006 compared with historical average and PET for the ENP *(After 2006 SFER, Figure 2.29).*

Environmental conditions specific to the assessment of individual hypothesis clusters or modules are presented in those sections of this report. Characterization of water quality and hydrology throughout South Florida also can be found in multiple places, including the following:

- South Florida Environmental Report (http://www.sfwmd.gov/sfer).
- Water quality and water management at: http://www.sfwmd.gov/org/ema/dbhydro/index.html;
- Real time data at: http://www.sfwmd.gov/org/omd/rt.html) and,
- USGS data exchange at: http://sofia.usgs.gov/exchange/;
- Streamflow data at: http://waterdata.usgs.gov/fl/nwis/nwis.