Assessment of Coastal Management and Science Needs in South Florida

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Funded by the National Oceanic and Atmospheric Administration Center for Sponsored Coastal Ocean Research (CSCOR)

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February 2007
(revised June 2007)

Contents

1 INTRODUCTION

Resource managers now recognize the need to address threats to natural resources in South Florida by taking action to restore and sustain ecosystems. The Water Resources Development Act of 2000 (WRDA 2000) established a state and federal partnership to implement the Comprehensive Everglades Restoration Plan (CERP). The priority of resource managers is now to implement the restoration activities prescribed by CERP and by earlier restoration initiatives, such as the effort to reduce phosphorous pollution in the freshwater Everglades wetlands. The attention and resources formerly directed toward basic ecosystem research in South Florida are now directed toward the broader goals of this region-wide restoration effort.

NOAA's Center for Sponsored Coastal Ocean Research (CSCOR) has played a key role in supporting coastal ecosystem science in South Florida since at least 1994. This date marks the beginning of the interagency Florida Bay Science Program and NOAA's participation through its South Florida Ecosystem Research Program. The Florida Bay Science program grew out of an ad hoc interagency investigation of causes underlying alarming changes in the ecology of Florida Bay seen in the early 1990s. For the next several years, CSCOR, part of the National Centers for Coastal Ocean Science, participated as a major partner in the program by supporting critical monitoring and basic ecosystem studies in Florida Bay and adjacent coastal areas.

In view of the present focus on ecosystem restoration, it is timely that NOAA should review its research-oriented goals and activities in South Florida. Does the emergence of CERP as a primary focus of interagency cooperation in South Florida signal that it is time for NOAA to shift its emphasis away from funding research to fill gaps in basic ecological knowledge? What opportunities exist for NOAA to support the development of ecosystem-level tools that resource managers need to implement restoration activities? What supporting activities must the NOAA provide in order to forge and maintain productive partnerships with resource management agencies in the region?

In support of this review, the Center for Sponsored Coastal Ocean Research (CSCOR) contracted the Integration and Application Network at the University of Maryland Center for Environmental Science (IAN/UMCES) to gather information from partner agencies and identify strategic opportunities for coastal ecosystem science in South Florida. The IAN/UMCES team conducted interviews with senior scientists and resource managers and reviewed the evolving framework to provide the scientific information needed to support ecosystem management in the region.

This report documents the activities by IAN/UMCES under contract to CSCOR/NOAA and communicates the results of this work. The information presented here was collected over a short period of time during January 2007 through interviews with over 40 individual representing 10 agencies, the Science Oversight Panel of the Florida Bay Science Program, and managers of the CSCOR program. While we endeavor to provide a complete picture of coastal ecosystem science needs in South Florida, this picture is necessarily constructed from only a sample of all of the available information.

1.1 Objectives and Approach

Two objectives guided this effort:

1) to describe current and emerging challenges facing coastal resource managers in South Florida and how they are responding to these challenges; and
2) to identify strategic opportunities where coastal managers can improve their response to these challenges.

We formed a survey team comprised of Drs. Bill Dennison and Bill Nuttle, and Ms. Caroline Wicks. Bill Dennison is the Vice President for Science Applications and heads up the Integration and Application Network at the University of Maryland Center for Environmental Science and has served on the Science Oversight Panel for the Florida Bay Program. Bill Nuttle is a consultant (Eco-Hydrology) who has extensive ongoing experience in S. Florida, including serving as the Scientific Coordinator for the Florida Bay Program for 2 years and also worked at the South Florida Water Management District. Caroline Wicks is a Science Communicator with the Integration and Application Network, based at the Cooperative Oxford Laboratory.

The survey team interviewed people responsible for activities ranging from basic research to directing regional programs at the national level. (see Appendix 1 for a complete list of interviewees.) For the most part, the interviews produced information about how separate agencies respond to the need for scientific information on coastal ecosystems. In addition to the information collected through interviews, the team assembled information on the evolving regional coordination among agencies to implement an ecosystem approach to managing natural resources in South Florida. This information was assembled from reports and websites produced by these coordination activities, and from reviews of these activities conducted by committees of the National Research Council, the Government Accounting Office, and the Congressional Research Service.

1.2 Ecosystem Science in South Florida

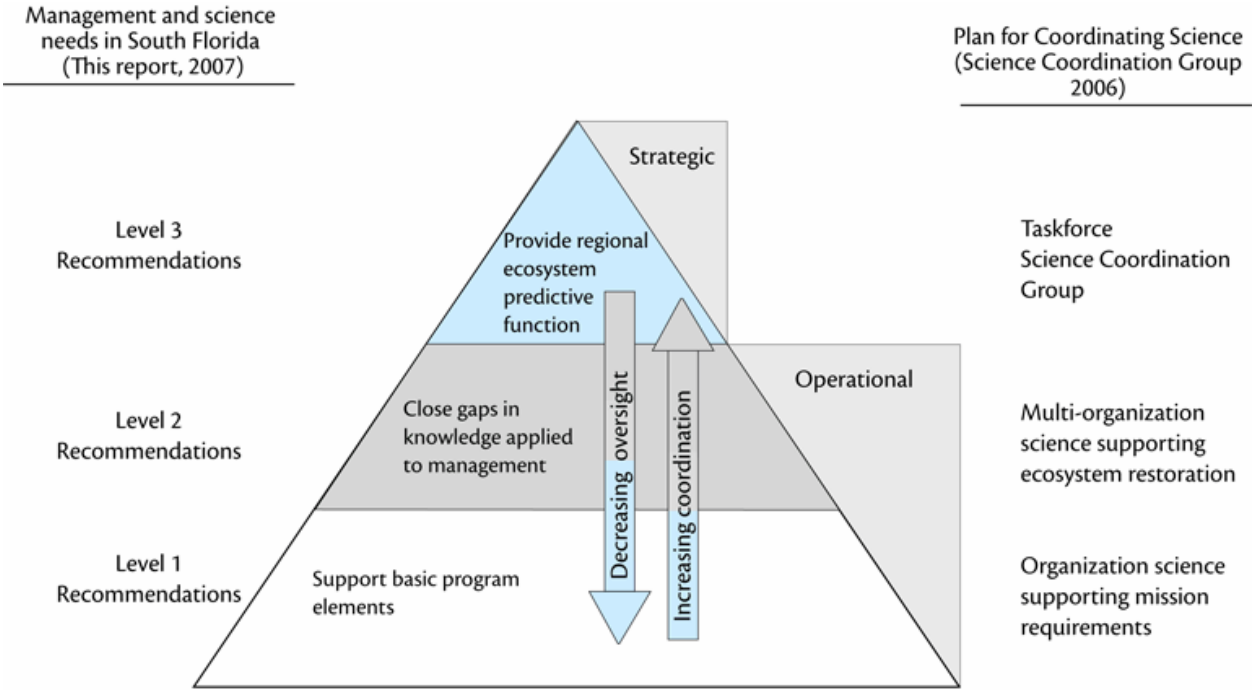
The science activities that support ecosystem management in South Florida are organized on three levels (Figure 1.1). Each level is distinguished by the spatial scale inherent in its associated activities and the consequent need for coordination among agencies. Level 1 activities comprise routine resource mapping, inventory and monitoring, i.e. activities that resource management agencies typically conduct to support their specific mandates. Level 2 activities comprise research and modeling of whole ecosystems – for example, as defined by the physiographic regions used in CERP (RECOVER 2004). Level 3 activities address the entire South Florida region.

Ecosystem research is a level 2 activity. Few agencies have the resources or mandate required to support a comprehensive ecosystem science program; therefore level 2 activities typically involve coordination among several agencies. Examples of coordinated activities at level 2 include the interagency Florida Bay Science Program, the Florida Bay Florida Keys Feasibility Study, which builds on the results of the Florida Bay Science Program, and activities coordinated by RECOVER, which is the arm of the CERP program that defines and characterizes stressors acting on ecosystems in the region and tracks changes in these ecosystems.

Level 3 activities coordinate among various governments, resource management agencies and science agencies to assess the status of ecosystems throughout South Florida. The South Florida Ecosystem Restoration Task Force serves as the main forum for region-wide coordination and communication on ecosystem restoration issues. Within the Task Force, the Science Coordination Group tracks and supports Level 1 and Level 2 science activities.

Developments in the last year or so have reordered the mechanisms for interagency coordination that support the development and application of ecosystem science in South Florida. CERP and the Florida Bay Florida Keys Feasibility Study have gathered momentum. These initiatives now attract much of the attention and resources that cooperating agencies have devoted to the Florida Bay Science Program in the past.

Figure 1.1: Regional ecosystem science organized into three levels (modified from SCG 2006).



2 INFORMATION COLLECTED IN THE INTERVIEWS

This section summarizes the information obtained in the interview on the emerging management challenges and the applied science activities conducted by various agencies, i.e. the answers to questions 2 and 3. Material attached as Appendices 1 and 2 identify the people we interviewed and the role of different agencies in managing coastal resources.

In general, we conducted the interviews to obtain answers to the following questions:

1. What role(s) does your program play in the management of coastal resources in South Florida?
2. What major challenges for coastal management do to you see now and developing over the next 10 years?
3. What are you doing to respond to these challenges? Are you limited by lack of critical scientific information?
4. What can federal agencies do in the future that would address the challenges that you see?

The interviews consisted of face-to-face meetings on 3, 4, and 5 January 2007 and in phone calls the following week. The format was as follows: introductions and a short overview of the project; discussion of coastal management issues structured by the questions introduced above; and time permitting, more wide-ranging, informal discussions.

2.1 Challenges for Coastal Management

This section summarizes responses to the question *"What major challenges for coastal management do to you see now and developing over the next 10 years?"*

2.1.1 Algal Blooms

Algal blooms are a long-standing concern in the coastal waters of South Florida. The persistent blooms that plagued Florida Bay in the early 1990s are credited with motivating an integrated approach to dealing with the region's environmental problems. However, algal blooms, red tides and "blackwater events" have become annual occurrences in the shallow waters along the southwest coast. Red tides have been a long-standing problem along the Southwest coast, with increased public sensitivity to them recently. Blackwater events are due to river discharge that may or may not trigger algal blooms. Major blackwater events have occurred along West Florida in the last ten years, although their sources and impacts vary. These events lead to decreased water quality and negatively impact coral reefs in the Keys. The state of knowledge and controversy over status, trends and causes of red tides and blackwater events along the southwest coast is at a similar stage as the knowledge and controversy over the algal blooms in Florida Bay in 1989-1991.

Algal blooms anywhere in South Florida will affect CERP restoration efforts because the Everglades restoration impacts Biscayne Bay, Florida Bay and the southwest Florida coast. More freshwater (with nutrients) will change the current status of the Card Sound bloom and may increase blooms in Florida Bay and southwest Florida. For instance, XCELER8 has a southwest focus, so the success of those projects will be intertwined with the health of the southwest Florida ecosystem.

2.1.2 Oil and Gas Development

Florida's coastal waters are relatively free of the direct impacts from offshore oil and gas development. This is expected to change over the next 5 to 10 years as oil and gas development activities expand into waters near the Florida coast in the northeastern Gulf of Mexico and in Cuban coastal waters. South Florida's coastal waters are downstream of these expansion areas. Spills are not the only threat, with the actual development - exploration, siting, drilling and production - bringing a suite of issues to be addressed (destroying bottom habitat, degraded water quality, debris, etc.) in coastal Florida waters. For instance, NOVA Southeastern University's Oceanography Center studies coral restoration and is concerned about the impacts of oil and gas development on their restoration projects. Similarly, the Florida Keys National Marine Sanctuary could see impacts from the development, such as degraded water quality and destruction of bottom habitat and from spills. Mitigating these problems once they have occurred is essential. However, determining the impacts of oil and gas development on restoration projects needs to be addressed before the projects are completed. Will the success of a restoration project be hampered by unforeseen impacts from oil and gas development?

2.1.3 Freshwater Flow

Regional efforts under CERP aim to restore more natural conditions to the region's hydrology. If successful, this will translate into reduced freshwater discharge through the Caloosahatchee and St. Lucie rivers and increased freshwater discharge through the southwest Florida coast and, potentially, into Florida Bay and Biscayne Bay. While these changes are generally considered desirable, because they will move the associated coastal systems along trajectories toward pre-development conditions, these changes nonetheless come at a cost. In implementing these changes, managers face the challenge of evaluating expected benefits to coastal ecosystems using metrics that can be compared to those used to measure the costs and that are also scientifically defensible.

While regional predictions of the end result of CERP are uncertain, general ideas of what the impacts of the final freshwater distribution will have are needed. Major questions about the impacts of water redistribution from the northern to the southern estuaries and impacts of freshwater flow on coastal resources are still unanswered. Further, there is uncertainty of when decision deadlines are set due to lack of publicly available information on CERP committee activities. While CERP should be following an adaptive management strategy which allows for changes in management directions based on ever-evolving restoration activities, there are specific topics with respect to freshwater flow that need to be addressed in the next several decades of CERP activities.

2.1.4 Nutrients in Runoff

Ongoing rapid development has irreversibly altered the landscape of South Florida. Efforts under CERP to restore more natural distribution and timing to the region's hydrologic system proceed without regard to restoring water quality to its predevelopment characteristics. Indeed, it seems highly unlikely that this can be done given the magnitude and extent of changes in land use that has occurred in the region.

Managers need data and forecasting tools to help them identify and mitigate potential impacts of altered water quality interacting with altered freshwater discharges into coastal systems. Florida DEP is responsible for developing this type of information as part of their responsibility to estimate total daily maximum loads (TMDLs) allowed to enter coastal waters. However, TMDL determination for a water body is triggered by first classifying the water body as "impaired." Only a few coastal water bodies in Florida are currently listed as impaired; Florida Bay and Biscayne Bay are not included on this list.

Wastewater reuse is a regional topic because it falls under water quality problems. CERP relies on wastewater reuse as a strategy to increase water supply for both municipal and natural areas. Management agencies are considering this a viable option when the basic scientific data on the water is not available. Some of the concerns are (1) the current standards for nutrients in wastewater discharge are not compatible (and are higher) than the standards deemed to be protective of South Florida oligotrophic wetlands and estuaries, and (2) it is not known what the effect of emerging pollutants of concern (EPOCs) will be on coastal systems and there are currently no standards for these pollutants.

2.1.5 Sea Level Rise

While current rates of relative sea level rise are moderate (2 mm/y) for South Florida, there are several issues of concern. Recent evidence of accelerated ice melting rates for Greenland and West Antarctica Shelf are leading to revised projections of sea level rise, and more rapid rates of relative sea level rise are likely. Effects of rising sea levels have already been observed. Freshwater wetland "marsh collapse" has occurred throughout the region and may be due to rising sea level, storm surge and hurricane activity. The Southwest coast is particularly vulnerable to rising sea level due to exceedingly low topographic gradient.

Several agencies are interested in the effects of sea level rise, but they are either hesitant to work on a politically charged topic, or do not have the funding to explore this research question. The SFWMD is very interested in the effects of salinity on freshwater vegetation and have already conducted studies with this in mind. However, these studies are based around the impacts of water flow in canals, not SLR. NPS would be an agency that needs to address this, particularly for CERP restoration projects, but has not done so yet. NPS is the primary agency working in the southwest Florida area, where SLR will have a large impact. Any restoration project in South Florida will have to address SLR, but due to the current lack of information on the effects of SLR on these restoration projects, the projects move ahead anyway with no consideration for SLR impacts.

2.1.6 Climate Change

Climate change touches nearly all aspects of coastal resources (changes to flows, timing, balance between freshwater and saltwater, temperature and bleaching, temperature and salinity effects on growth and survival of living resources). The topic of climate change was mentioned most commonly in the context of confounding effects on existing ecosystem restoration and management activities. For example, the draft science plan compiled by the Task Force's Science Coordination Group (SCG 2006) identifies the need to "assure compatibility of restoration plans and expectations with global and regional climate change." Beyond these concerns lies this more fundamental question, "What will be the direct effects of climate change

on coastal resources and coastal communities?" The answer to this question could precipitate plans to abandon coastal communities and reorder priorities for restoration and management of coastal ecosystems.

2.1.7 Episodic Events

Episodic events, such as hurricanes, are important drivers on South Florida coastal systems. The response of these systems and how one episodic event can trigger another, such as a red tide event, needs to be evaluated. It is difficult to predict or characterize the effects of such events with existing models. Information on how to characterize and model the occurrence of episodic events and how to evaluate their significance/impact on South Florida is needed. All agencies could be involved with this, but especially those that have the modeling capabilities for such a task.

2.2 Agency Science Activities

This section summarizes the information collected in the interviews and from other sources in answer to the questions "*What are you doing to respond to emerging coastal challenges?*" and "*Are you limited by lack of critical information?*" We organize this information by the types of activities conducted: inventory and monitoring; forecast models; and synthesis, assessment and evaluation (Table 2.1). A comprehensive program of ecosystem science will conduct activities in all three categories.

With two exceptions, no single agency has both the mandate and the resources to mount a comprehensive ecosystem science program. The two exceptions are the South Florida Water Management District (SFWMD) and NOAA; there two agencies have complementary responsibilities for terrestrial (i.e. freshwater) resources and marine resources in the region. All agencies rely on cooperative arrangements with other agencies for access to comprehensive ecosystem science. CERP provides a mechanism, through RECOVER (see Section 3.3.3) for coordinating terrestrial ecosystem science. No comparable mechanism exists to coordinate ecosystem science to support restoration and management of marine resources.

SFWMD manages water flows and storage in the regional hydrologic system to supply water to municipalities, prevent flooding, and protect fish and wildlife. To meet these goals, SFWMD conducts extensive monitoring throughout South Florida; it developed and maintains a regional hydrologic simulation model; and it routinely evaluates present and forecasted conditions to inform day-to-day operations and for long-term planning.

As an agency, NOAA has a similar breadth of responsibility over marine resources as SFWMD has for terrestrial resources, and it conducts a similar range of activities. Where SFWMD collects its management responsibilities and supporting activities under a single regional authority, the SFWMD governing board, NOAA divides its science and management activities between a number of operating units; e.g. AOML, NMFS, Florida Keys National Marine Sanctuary, Rookery Bay, etc. The activities of the Department of the Interior in South Florida are similarly divided among units of the National Park Service, the Fish and Wildlife Service, and the U.S. Geological Survey. CERP and RECOVER provide a mechanism for coordinating the efforts of separate agencies within the Department of Interior, but there is no comparable

external mechanism for coordinating the activities among NOAA's separate operating units in South Florida.

2.2.1 Inventory and Monitoring

Inventory and monitoring activities provide essential data on the location, extent and state of coastal resources. Managers rely on this information directly to inform day-to-day decisions, such as setting restrictions and advisories triggered by water quality by water quality conditions along beaches and in fisheries. Monitoring information is also essential for the development and application of forecast models that support proactive restoration and resource management decisions. Inventory and monitoring activities are often conducted as a level 1 activity, in support of agency mandates. Even so, many interviewees expressed concern that many monitoring activities lack long-term, sustainable support. Monitoring activities in the Florida Keys National Marine Sanctuary appear to be particularly vulnerable to the vagaries of year-to-year fluctuations in committed funding.

Inventory and monitoring activities conducted as part of mandated responsibility for management of coastal resources include the following:

- National Park Service conducts inventory and monitoring of resources within the bounds of its three coastal parks; Everglades National Park, Biscayne National Park, and the Dry Tortugas National Park.

- U.S. Geological Survey monitors freshwater discharge and nutrient concentrations in inflows to Florida Bay and the mangrove estuaries along the southwest coasts; i.e. Shark River, Lostman's River, and Chatham River.

- NOAA/FKNMS monitors water quality, benthic resources and fisheries resources within the bounds of the Florida Keys National Marine Sanctuary. These monitoring activities are conducted in cooperation with other agencies such as EPA, Florida DEP, the USACE, and NOAA/MANAGEMENT AND SCIENCE.

- NOAA/NERRS monitors estuarine water quality in the Rookery Bay National Estuarine Research Reserve to understand how human activities and natural events can change ecosystems.

- NOAA/NMFS supports monitoring of key fisheries, including habitat, in the region, such as the shrimp fishery off the Dry Tortugas, and it leads the monitoring within the FKNMS.

- NOAA's National Data Buoy Center operates, and maintains a network of data collecting buoys and coastal stations.

- SFWMD conducts water quality and ecological monitoring in Florida Bay, Biscayne Bay, St. Lucie River, the Caloosahatchee River estuary, and along the southwest coast.

- Florida FWC conducts water quality monitoring to track the occurrence of red tides and plankton blooms along the southwest and southeast coasts (http://research.myfwc.com/). FWC also monitors key fisheries, such as the lobster fishery in the Keys.

- Various agencies of county governments; e.g. Collier County (ES), Monroe County (MRD), Miami-Dade County (DERM), Broward County (BRD) and Palm Beach County monitor water quality and nearshore coastal resources.

Inventory and monitoring activities conducted in support of interagency cooperation includes the following:

- Southeast Florida Coral Reef Initiative coordinates support for conservation and management of coral reefs in reef resources from Miami-Dade County, through Broward, Palm Beach and Martin Counties. Projects include the mapping of the coral reef tract and identification of the benthic habitats; a biomarker study observing the impacts of pollution on coral reefs; identification and implementation of best management practices to limit pollution; determine the source and extent of pollution originating from groundwater sources, outfall pipes, atmospheric sources, and ocean inlets.

- NOAA's National Centers for Coastal Ocean Science (NCCOS) developed the South Florida Ecosystem Research and Monitoring Program (http://www.aoml.noaa.gov/sfp/) to coordinate ecosystem science activities among NOAA's various operating units in South Florida. The program monitors water quality conditions in nearshore waters (Biscayne Bay and Florida Bay) and on the southwest Florida Shelf.

Table 2.1: Agency response to coastal challenges

	Inventory and Monitoring	Forecast Models	Synthesis, Assessment, and Evaluation	Agencies
Florida Shelf and southwest coast	Freshwater inflow, water level, currents, salinity, nutrients, plankton blooms	HYCOM	RECOVER	NPS, DEP, RB/NERR, FWC, ES, NOAA, USGS, SFWMD, USACE
Florida Bay	Freshwater inflow, water level, salinity, nutrients, plankton blooms, seagrass, benthic communities, sport fish	EFDC (with TIME and HYCOM), FATHOM, various empirical	Florida Bay Florida Keys Feasibility Study, RECOVER	NPS, SFWMD, DEP, FWC, NOAA, USGS, USACE
Florida Keys and reef tract	Water level, salinity, nutrients, plankton blooms, seagrass, benthic communities, sport fish	HYCOM, EFDC, other models for research	Florida Bay Florida Keys Feasibility Study	NPS, NOAA, EPA, DEP, FWC, USACE
Biscayne Bay	Freshwater inflow, water level, salinity, nutrients, seagrass, benthic communities, sport fish	RMA-10, EFDC (with TIME), other models for research	Biscayne Bay Feasibility Study, RECOVER	NPS, SFWMD, DEP, FWC, DERM, USACE
Florida east coast	Freshwater inflow, plankton blooms	HYCOM	(not determined)	DEP, FWC, BRD, SFWMD

BRD – Broward County Biological Resources Division
DEP – Florida Department of Environmental Protection
DERM – Miami-Dade Country Department of Environmental Management
EPA – U.S. Environmental Protection Agency
ES – Collier Country Environmental Services
FWC – Florida Fish and Wildlife Commission
FWS – U.S. Fish and Wildlife Service
FKNMS – Florida Keys National Marine Sanctuary (NOAA)
MRD - Monroe County Marine Resources Department
NPS – National Park Service (Big Cypress Preserve, Everglades National Park, Dry Tortugas National Park, Biscayne National Park)
RB/NERR – Rookery Bay National Estuarine Research Reserve (NOAA)
SFWMD – South Florida Water Management District
USACE – U.S. Army Corps of Engineers
USGS – U.S. Geological Survey

2.2.2 Forecast Models

Forecast models are essential tools for ecosystem management, but these tools are not yet fully developed for application anywhere in South Florida. The interviews uncovered a general level of frustration with the slow progress in bringing sophisticated models online as practical tools for management. Problems and frustration with implementing ecosystem models for management extend beyond the present modeling efforts in South Florida (Nuttle 2000).

Efforts within the Florida Bay Florida Keys feasibility study to implement a state-of-the-art hydrodynamic/water quality model for Florida Bay has fallen short of expectations. Implementation of such a model has been the focus of research and development coordinated by the Florida Bay Science Program for over 10 years. Results of water quality calculations reported in December 2006 suggest that there has been little improvement in forecast skill by the present model compared with results obtained in a separate modeling effort about 5 years ago.

Management agencies have not yet embraced ecological forecasting as an ongoing activity tied to day-to-day management of natural resources, i.e. in the mode that the SFWMD maintains the South Florida Water Management Model (SFWMM) to support management of the region's water resources. Instead, ecosystem managers approach the development and application of models as one-time activities, usually as a component of a planning study. SFWMD supports the development and application of the Florida Bay hydrodynamic/water quality model as a component of the Florida Bay Florida Keys feasibility study, and there is no commitment to maintain the model for further use beyond the end of this study in 2008.

In the absence of a Florida Bay hydrodynamic/water quality model, managers rely on a variety of less sophisticated forecasting tools (reviewed by Marshall et al. 2006, Table 2.2) to support decision-making and planning that affects the bay's ecosystem. Managers use the SFWMM to forecast how regional hydrologic conditions will respond under alternative water management practices. Then, they extrapolate changes in estuarine salinity from the simulated regional hydrology, using the tools reviewed by Marshall et al. (2006), and infer ecological conditions from this estimate of salinity.

NOAA supports the development and application of a regional version of the HYCOM ocean model at the University of Miami (Figure 2.1); (http://hycom.rsmas.miami.edu/overview/SoFLA_HYCOM.pdf). In contrast to the status of the Florida Bay model within SFWMD, the South Florida HYCOM modeling effort is associated with a broader effort within NOAA to develop oceanographic forecasting tools.

2.2.3 Synthesis, Assessment, and Evaluation

Synthesis, assessment, and evaluation comprise a range of activities that support both short-term decision-making as well as long-term planning. Resource managers make day-to-day decisions that have significant implications for ecosystems in South Florida, but they lack the information and analysis tools required to make these decisions based on the restoration goals that are being pursued in long-term planning by CERP and by the South Florida Ecosystem Restoration Task Force. For example, managers must evaluate applications to develop vacant land or to increase water withdrawals from canals and aquifers to meet expanding municipal demands. Short-term

decisions should support long-term goals and strategies, and the implementation of an ecosystem approach to management must address the information and decision support tools needed for both types of decisions.

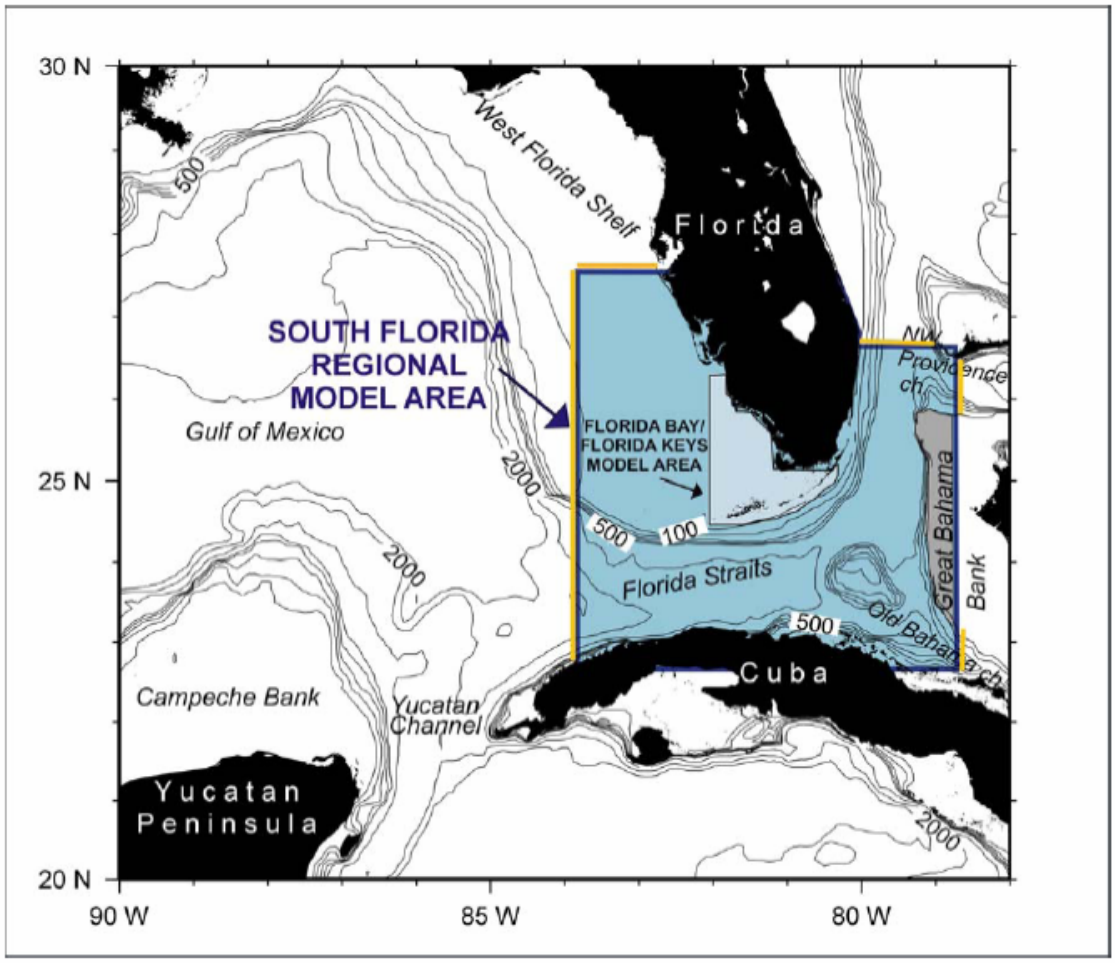
Interviewees requested NOAA's assistance to develop scientifically based tools and information to help them address short-term resource management decisions that fall outside of the CERP planning process. Help is needed in identifying ecological performance measures and restoration endpoints that are supported by a body of ecological research. Interviewees also asked for information and tools that can be used to establish the economic value of coastal resources, such as sport fisheries, that would benefit from restoration activities proposed as part of CERP. This information is needed to address a deficiency in the Corps' project planning guidelines as these have been interpreted for application within CERP (see Section 3.3.2).

Table 2.2: Summary of Salinity Models and Supporting Hydrologic Models Currently in Use For Simulating Florida Bay and Southwest Gulf Coast Salinity (adapted from Marshall et al 2006)

Model Name	Model Type	Simulated Parameter	Spatial Domain	Grid Size	Agency/ program
SFWMM[1]	Freshwater Hydrology	Stage, Flow	Everglades	3.2km X 3.2km	SFWMD for regional water management planning
PHAST[2]	Wetland Basin	Flow	Lower Everglades and Mangrove Zone	Regional	Everglades Park, SFWMD for assessment of Modified Waters Deliver
MLR[3]	Statistical	Salinity	Florida Bay, Whitewater Bay, southwest Gulf coast, Manatee Bay, Barnes Sound	N/A	Everglades Park, Corps of Engineers for CERP/RECOVER
FATHOM[5]	Mass Balance	Salinity	Florida Bay, Manatee Bay, Barnes Sound	open-water basins	Everglades Park, SFWMD for Florida Bay minimum flows and levels
EFDC[6]	3-D Hydrody-namic	Salinity	Florida Bay, Whitewater Bay, southwest Gulf coast, Manatee Bay, Barnes Sound	Variable	SFWMD for Florida Bay Florida Keys Feasibility Study
SICS/ TIME[7]	2D/3D Coupled surface and ground-water	Stage, Flow, Salinity	Florida Bay (SICS), southwest Gulf coast (TIME)	0.3km X 0.3km (SICS, 0.5km X 0.5km (TIME)	SFWMD and USGS for Florida Bay Florida Keys Feasibility Study
SoFLA-HYCOM[8]	3-D Hydrody-namic ocean circulation model	Flow magnitude and direction	Gulf of Mexico, Florida Straits	6-7km X 6-7km	SFWMD and NOAA for Florida Bay Florida Keys Feasibility Study

[1] http://www.sfwmd.gov/org/pld/hsm/models/sfwmm/index.html
[2] Nuttle and Teed 2002
[3] Marshall, 2005
[5] Cosby et al. 1999, Nuttle et al. 2000, Cosby et al 2005
[6] Hamrick and Moustafa, 2003
[7] Swain, et al 2004 (SICS), Langevin, et al 2002 (TIME)
[8] Kourafalou, 2005

Figure 2.1: Map showing the domain of the SoFLA-HYCOM coastal ocean model developed for the Florida Bay Florida Keys Feasibility Study (Kourafalou, 2005)



3 REGIONAL COORDINATION OF ECOSYSTEM SCIENCE

Since 1994, NOAA has pursued its mission at the subregional level through partnerships forged in the Florida Bay Science Program and within NOAA with the Florida Keys National Marine Sanctuary. An assessment of current management and science needs must take into account the evolving programs for coordinating ecosystem research at the subregional level, such as Florida Bay and adjacent coastal systems, and regionwide through activities of the Task Force and partners in the CERP. This section reviews the evolution of these programs and identifies the emerging ecosystem science needs.

The survey team finds that the Florida Bay Science Program is significantly reduced in its ability to formulate and direct a comprehensive program in Florida Bay and adjacent coastal waters. The Program Management Committee suffers from the loss of key personnel; both co-chair positions are vacant.

One of the incumbents, AOML's Peter Ortner, played an important role linking NOAA as a partner in the Florida Bay Program and as a "silent partner" on the Science Coordination Team (now the Science Coordination Group) of the Task Force and various other committees on which he served. Peter is one year from retiring from NOAA. He is no longer active in the coordination of regional ecosystem science activities, and no one has emerged to assume his roles on the PMC and within NOAA as the *de facto* agent in South Florida.

The declining effectiveness of the PMC is the direct consequence of partner agencies reallocating time and resources to coordinate activities of CERP and the Task Force. Regional coordination through these activities offers the administrative advantage of clear mandates established by Congress and the Florida legislature supported by budget authority. The Florida Bay Program never moved much beyond its status as an ad hoc, voluntary effort by science managers.

Coordination of regional ecosystem science by CERP and the Task Force has proven to be problematic. Management and financing of CERP follow the project-planning model that the Corps has employed for decades to build dams and dig canals. This model is ill suited for the purpose of ecosystem restoration (NRC 2004, 2006)

3.1 Florida Bay Science Program (PMC)

The survey team heard from several sources that the Program Management Committee of the Florida Bay Science Program has been minimally functional in the year since it hosted its last science conference. In particular, the PMC has not responded to the review performed by its external oversight panel during the conference. Members of the PMC are pessimistic that they will be able to implement any of the panel's recommendations due to declining agency support for elements of the Florida Bay Science Program and consequently a decline in the ability for the PMC to influence the direction of future research and science activities. In spite of its current problems, the Florida Bay Program offers an example of how ecosystem science can be pursued successfully by collaboration among a set of partner agencies.

The Florida Bay Program began as an informal, ad-hoc response to identify factors contributing to the onset and persistence of plankton blooms that appeared suddenly in the bay around 1989. The coincidence of these blooms with extensive dieoff of seagrasses in the bloom-affected areas heightened public concerns. In response, a group of senior agency scientists and science managers assembled available information and identified a set of questions to serve as the basis for a coordinated program to identify the causes. The Department of the Interior convened a panel of outside experts know as the Boesch panel to review this information at a conference/workshop meeting organized by the ad hoc group.

This approach proved successful in quickly identifying key unknowns and in building an ecosystem research program through cooperation among partner agencies, beginning in 1994. Over the next 10 years, the program repeated the pattern of coordinated research and monitoring to address questions endorsed by the Science Oversight Panel (the successor to the Boesch Panel, see Table 3.1). The program organized a science conference held approximately every 18 months, and periodic external review of the program by the Science Oversight Panel convened during the science conferences. These panel reports were influential in gaining agency acceptance for science program initiatives developed collaboratively by the PMC. In later years, the PMC recognized the need to develop means of communicating the results of its research outside of the tradition method of publication in reviewed scientific journals. This need was met, in part, through the reports of the Science Oversight Panel, through a newsletter series developed in concert with The Nature Conservancy and Florida Sea Grant, and in various synthetic activities culminating in a 2003 report synthesizing available scientific information about the Florida Bay ecosystem. The results of this effort laid the foundations for the Florida Bay Florida Keys Feasibility Study that was authorized by WRDA 2000 in the initial phase of CERP.

Initiation of the Florida Bay Florida Keys Feasibility Study by SFWMD and the Corps marks the beginning of the declining influence by the Florida Bay Science Program. The development of a comprehensive hydrodynamic, water quality, and plankton bloom model was always seen as a central, organizing activity within the Florida Bay Science Program. Development and implementation of the Florida Bay model is currently funded and managed through the Feasibility Study; however the Feasibility Study has always been separate from the Florida Bay Program. Consequently, the agency partners in the Florida Bay Program face the difficult choice of how to allocate limited resources, particularly staff time, between participation in the Florida Bay Program and the CERP-authorized Florida Bay Florida Keys Feasibility Study. The decline of the Florida Bay Program has been the result.

This decline reduces the ability of partner agencies to assess ongoing changes in the ecosystem, identify causes and evaluate the consequences. An example is the plankton bloom that developed at the junction of Florida Bay and Biscayne Bay following the 2005 hurricane season; this bloom still persists in southern Biscayne Bay. The expertise and resources allocated to the Feasibility Study are not available because they are constrained by the objectives and timeline for project completion established when the project management plan (PMP) was written. The immediate interest of resource managers appears limited to establishing the degree to which either water management operations or road construction activities may have triggered the bloom. Instead of mobilizing a comprehensive assessment looking at both the onset and persistence of this bloom, investigations have focused on identifying likely contributing factors

that caused the bloom. Questions about why the bloom has persisted for so long in southern Biscayne Bay go unanswered. As a consequence, resource managers are missing an opportunity to learn something about the physical and ecological processes in a coastal ecosystem that will be directly affected by two high priority CERP projects, the C-111 spreader canal and the Biscayne Bay coastal wetland restoration project.

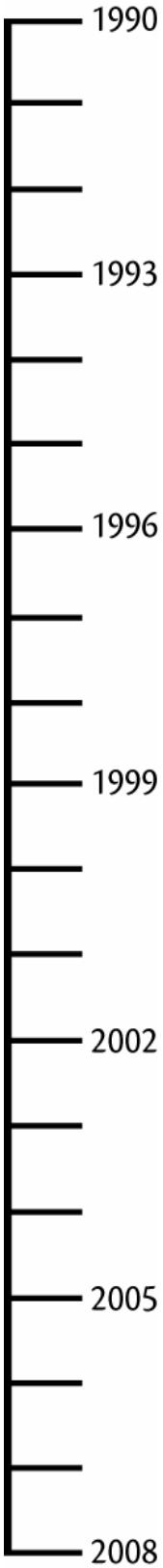
3.2 South Florida Ecosystem Restoration Task Force

The South Florida Ecosystem Restoration Task Force operates at the level of the entire South Florida Ecosystem (Level 3 in Figure 1.1). The Task Force helps to coordinate science programs among members, but it does not have a direct role in developing the details of ecosystem science nor does it implement a science program. The Task Force may be a potential pathway for communicating major findings from ecosystem science and their implication directly to the highest levels of all the agencies participating in restoration.

Congress formed the South Florida Ecosystem Restoration Task Force in 1996 to coordinate policies and programs and exchange information between organizations involved in the restoration and protection of the South Florida ecosystem. CERP accounts for only about half of the combined ecosystem management effort by state and federal agencies in the region. Other components of the regional restoration effort include the Modified Water Deliveries to Everglades National Park and C-111 Project, the Kissimmee River Restoration Project, the Multi-Species Recovery Plan, and the Special Report on the Role of Federal Agencies in Invasive Exotic Species Management with Regard to Everglades Restoration.

Starting in 1998 the Task Force initiated review and assessment of regional restoration activities and plans by independent, national experts working through the National Research Council, i.e. CROGEE. Since 2004 a second NRC committee, funded by CERP, replaces the NRC/CROGEE panel. Although similar to the Florida Bay Program's oversight panel in that both provide an injection of informed critique from outside of their respective programs, the NRC/CROGEE panel serves a different function for the Task Force (and CERP) than that of the SOP within the Florida Bay Program. The NRC committees have the broader scope to review and assess restoration activities; this scope encompasses the ecosystem research activities that support restoration planning along with new engineering technologies proposed for its implementation. The narrower mandate for the SOP focuses entirely on the quality of the science, synthesis, and strategic directions for the ecosystem research.

Table 3.1: Evolution of the Florida Bay Science Program



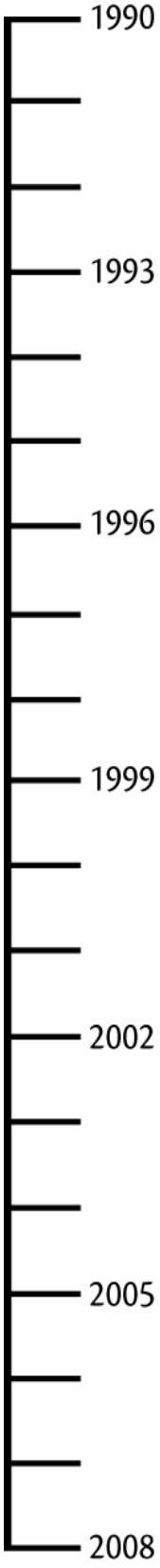
1990	
1993	Boesch Panel report on causes of blooms in Florida Bay initiates Florida Bay Science Progam Florida Bay Science Plan - initial program charter
	Florida Bay and Adjacent Marine Systems Science Conference (1995)
1996	Florida Bay and Adjacent Marine Systems Science Conference (1996)
	Strategic Plan for the Interagency Florida Bay Science Program - focuses research on five central questions. Program expands to incorporate adjacent coastal areas in Biscayne Bay and along the Southwest coast.
1999	Florida Bay and Adjacent Marine Systems Science Conference (1998) Florida Bay and Adjacent Marine Systems Science Conference (1999)
	Florida Bay and Adjacent Marine Systems Science Conference (2001) For first time, Science Conference incorporates "synthesis" of knowledge on each of the five strategic questions.
2002	Biscayne Bay Strategic Science Plan
	Program produces report "Synthesis of Research on Florida Bay" http://www.eco-hydrology.com/wkn_contents.pdf Florida Bay and Adjacent Marine Systems Science Conference (2003)
2005	Florida Bay and Adjacent Marine Systems Science Conference (2005)
	Current status - The program no longer exerts effective influence over the research agenda in Florida Bay and adjacent coastal waters. Agency resources for Florida Bay research have declined since 2000, and much of the remaining resources are being directed toward the Florida Bay Florida Keys Feasibility Study, e.g. support for model development and application.
2008	PMC plans to hold Florida Bay Science conference in 2008.

Efforts by the Task Force at coordinating ecosystem science throughout the region have achieved mixed results. Initially, the Task Force assigned this responsibility to the Science Coordination Team of the Working Group, which is comprised of senior resource managers in the organizations that make up the Task Force. The Science Coordination Team initiated a biennial conference, the Greater Everglades Ecosystem Restoration (GEER) conference, on the applied science for ecosystem restoration in South Florida. The conference plays an important communication role within the community of earth and ecosystem scientists working in South Florida and between the scientists and resource managers. In other critical respects, the Science Coordination Team was less successful in its mandate. In a review of the Science Coordination Team's effectiveness, the Government Accounting Office (GAO 2003) noted serious shortcomings in regional coordination efforts and concluded that the Task Force "has yet to find an effective mechanism" for carrying out its responsibilities to coordinate a regional science program. It is notable that the GAO delivered this criticism, not the NRC/CROGEE panel.

The Task Force responded to the GAO's criticism by elevating the coordination of science to the level of a working group, i.e. reporting directly to the Task Force, and charging the new Science Coordination Group with formulating a regional science plan. The plan (SCG 2006) compiles lists of science needs by subregion and within each subregion by ecosystem, represented by conceptual ecological models. The results, reproduced here for the Northern Estuaries subregion (Table 3.3) and the Southern Estuaries subregion (Table 3.4) resemble shopping lists of needed tasks and information rather than a coherent science plan. In contrast, the science plan compiled by the Florida Bay Science Program, with input from its oversight panel, is organized around a set of five central questions and hypotheses related to each of these questions.

The status of the Science Coordination Group's plan is uncertain; at its meeting in December 2006 the Task Force rejected the Science Coordination Group's revised science plan.

Table 3.2: South Florida Ecosystem Restoration Task Force



1990	Water Resources Development Act 1994, Congress directed the Corps to review reports on the Central and Southern Florida Project to determine whether the project could be changed to improve the South Florida ecosystem.
1993	Federal and state agencies form ad hoc group to coordinate Corp's review of regional water management and facilitate input by other interested agencies.
1996	Water Resources Development Act (WRDA) of 1996 formally established the South Florida Ecosystem Restoration Task Force (Task Force) to coordinate and facilitate the efforts of the many federal, state, and local agencies and tribes participating in restoration projects. Task Force established a Science Coordination Team (SCT), giving it responsibility for recommending research plans and priorities and to facilitate the integration, synthesis, and application of the best available scientific information for restoration
1999	NRC expert panel (CROGEE) established to provide the Task Force with scientific overview and technical assessment of the restoration activities and plans
2002	GAO critical review – “Task Force is responsible for coordinating scientific activities for restoration, but has yet to establish an effective means of doing so.” Task Force responds by reorganizing, elevates science coordination to working group status.
2005	Task Force rejects draft science plan presented by new Science Coordination Group.
2008	

Table 3.3: Task Force/Science Coordination Group - Northern Estuaries Tasks (Caloosahatchee and St. Lucie estuaries, northern Biscayne Bay)

- Develop a multi-scalar sampling approach to SAV mapping in the Northern Estuaries that defines the appropriate scales of resolution necessary to support the assessment hypotheses.
- Develop a continuous monitoring program for water quality (WQ), salinity and physical parameters (e.g., sediments, PAR, light attenuation) at the appropriate spatial and temporal scale to support species-specific spatial extent of SAV in the Northern Estuaries as part of the RECOVER MAP.
- Develop species-specific SAV maps and identify the relationships between SAV species and infaunal communities to WQ and salinity.
- Map and characterize the extent of suitable SAV substrate in the Northern Estuaries, including defining how the suitability of any area may change over time.
- Develop remote sensing spectral signatures for seagrasses.
- Identify what species of epiflora and epifauna inhabit different types of SAV beds/communities.
- Develop species-specific SAV models that can be applied to selected water bodies.
- Develop WQ models that include a sediment transport component that is complete, calibrated, and useful for making predictions in the Northern Estuaries.
- Develop an oyster mapping program that incorporates clarified oyster goals into the oyster monitoring efforts to include distribution, abundance and other components, in addition to the spatial magnitude (i.e., acres), and revise the RECOVER MAP to include oyster mapping.
- Develop a continuous WQ and contaminant monitoring program for assessing oyster hypotheses.
- Develop critical salinity targets for the various life stages of the oyster (e.g., impacts of low salinities during spawning, spat formation, or larval stages) in relation to restoration.
- Develop a monitoring program for the communities associated with the oyster reefs in order to understand the ecological relationships among oysters, benthos, and finfish.
- Develop bathymetric maps for investigation of bottom type and fish/fauna population dynamics.
- Adapt existing fish monitoring techniques to develop a long-term continuous fish monitoring program.
- Implement benthic monitoring in the seagrass beds, in addition sampling soft sediment environments.
- Implement benthic sampling beyond the current sampling in St. Lucie Estuary and Loxahatchee.
- Develop a program to understand the role of multiple stressors on fish over time in the Northern Estuaries; specifically, how these stressors relate to abnormalities (e.g., disease, lesions, etc.) and the relationship of these abnormalities to the freshwater discharges.
- Evaluate contaminant research, monitoring, and modeling and their relation with restoration activities.
- Research/determine effects of nutrient loading and other external drivers that control the occurrence of red tides and other harmful algal blooms.
- Develop research to compare current and historical assessments of Northern Estuaries.

Table 3.4: Task Force/Science Coordination Group - Southern Estuaries Tasks (Southwest Coast, Florida Bay, Florida Keys, Biscayne Bay)

- Fund the development of a coupled water circulation and water quality model for Biscayne Bay, comparable to those for Florida Bay, as described in the Southern Estuaries MAP, Florida Bay Feasibility, and Florida Bay Plans.

- Fund the ongoing salinity, water quality, ecological, and circulation monitoring being conducted within the Southern Estuaries as part of MAP (CERP).

- Enhance biogeochemical monitoring in the Southern Estuaries as part of a comprehensive integrated water quality study of the entire watershed, to include the following subtasks:
  • Establish monitoring of groundwater and atmospheric nutrient flux into the Southern Estuaries
  • Develop baseline information on the distribution of toxics and contaminants within the Southern Estuaries and in the adjacent coastal watersheds, emphasizing flow pathways and sources contemplated by CERP, and conduct a comprehensive risk assessment for potential ecological hazards
  • Determine occurrence of EPOCs in alternative sources of freshwater and evaluate effectiveness of treatment technologies in removing or reducing EPOC concentration
  • Conduct research into the biogeochemical processes for methylation of mercury (and consequent bioavailability) across a range of salinity regimes
  • Conduct research on the importance of algal mats with regards to nutrient flux and primary production in Biscayne Bay and Florida Bay, including the degree to which increased mats may be indicative of progressive system eutrophication.

- Evaluate, initiate, and/or improve research and monitoring, targeting environmental requirements of key indicator species and undersampled habitats, to include the following subtasks:
  • Evaluate manatee monitoring and research programs to determine if the information being collected is sufficient to establish a functional relationship between freshwater discharges into the Southern Estuaries and the abundance and distribution of manatees
  • Undertake additional laboratory experiments relating salinity tolerances upon Biscayne Bay fish species
  • Expand the faunal monitoring domain to match the SAV domain within the Southern Estuaries, including Whitewater Bay
  • Expand assessment of historical distribution of oysters in Biscayne Bay

- Assure the compatibility of restoration plans and expectations with global and regional climate change, to include the following subtasks:
  • Link regional physical models to global climate change models
  • Run project evaluation models under different climate scenarios
  • Conduct research into the geomorphological implications of continuing current climate change trends over the current decades

3.3 Comprehensive Everglades Restoration Plan

The 2000 Water Resources Development Act authorized the Corps of Engineers to begin work on the Comprehensive Everglades Restoration Plan (CERP) as a 50-50 partner with the South Florida Water Management District. CERP comprises over 60 separate projects that will alter the infrastructure and operations of regional water management in South Florida. The overriding goal is to restore the natural hydrology in the Everglades while at the same time addressing the need for water supplies and flood control by an expanding population. Implementation of CERP dominates the resource management agenda in South Florida, accounting for about half of all federal and state funding devoted to ecosystem restoration (GAO 2003).

CERP does not adequately support critical functions required by ecosystem management. Only a fraction of the projects that encompass the comprehensive plan have the Congressional authorization needed for implementation. Finally, CERP gives relatively little consideration to the restoration and management of estuarine and coastal marine ecosystems.

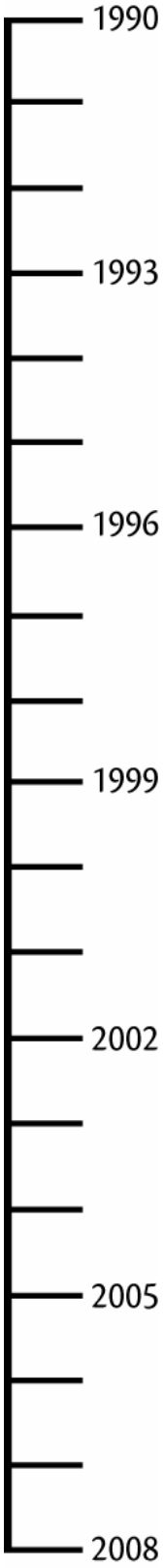
This assessment derives from information the survey team collected in the interviews and from reviews of the regional ecosystem restoration effort conducted by GAO and several NRC committees. In particular, our assessment considers the following topics:

- limited focus on hydrologic restoration and water management issues;
- divided and confused management within CERP;
- lack of provision for critical ecosystem management functions; and

3.3.1 Limited Focus

CERP is not a comprehensive response to the need for ecosystem restoration in South Florida outside the boundaries of the Central and Southern Florida Project. The focus of CERP is limited to implementing a specific set of changes to the Central and Southern Florida Project, the regional system of canals, levees and water control structures jointly developed and operated by the Corps and the SFWMD. WRDA 2000 authorizes the Corps and SFWMD to proceed with planning a set of projects identified in the feasibility study completed by the Corps in 1999 (Table 3.5). These projects are known collectively as the “yellow book” projects. CERP is a response to environmental problems arising from regional water management that were generally recognized in the mid-1990s when the feasibility study, e.g. the Restudy, began.

Table 3.5: Comprehensive Everglades Restoration Plan



1996	WRDA 1996 authorizes feasibility study of Central and Southern Florida Project - this is the "Restudy" that becomes the blueprint for CERP.
1999	Corps delivers Restudy report
	WRDA 2000 authorizes CERP, RECOVER, Florida Bay Feasibility Study
2002	FBFK Feasibility Study initiated to determine modifications that are needed to successfully restore and protect the water quality and ecological condition of the Bay and Keys reef tract. Programmatic Regulations - require reporting on "interim (ecosystem) goals and targets" every 5 years
2005	RECOVER - Monitoring and Assessment Plan describes CERP monitoring needs. National Research Council external review panel established for CERP (replaces Task Force's CROGEE panel). Acceler8 program initiates changes. CERP - first 5-year progress report to Congress, RECOVER - Draft Interim goals and targets document establishes ecosystem performance measures for estuaries RECOVER - Update to Monitoring and Assessment Plan CERP System-wide Performance Measures
2008	FBFK Feasibility Study - Feasibility Scoping Meeting (model development complete) August 2007 FBFK Feasibility Study - complete draft report October 2008

The CERP projects collectively address only a portion of the stressors that affect coastal ecosystems, i.e. changing freshwater flows, and this only in selected estuarine and coastal areas. Stressors act on coastal ecosystems from three generally defined sources – terrestrial, atmospheric and oceanic (Jameson et al. 2002). Of the terrestrial stressors that Jameson et al (2002) identify as important for the Florida Keys National Marine Sanctuary (stormwater runoff, pesticides used for mosquito control, residential wastewater, marina operations, and natural stressors), CERP addresses none. CERP addresses widely-recognized problems affecting Florida Bay only indirectly. WRDA 2000 authorized the Florida Bay Florida Keys Feasibility Study, which is to be completed in 2008, to identify further changes to the region's canals, levees and water control structures that will correct problems in the bay that were known when the feasibility study began in 2002.

CERP does not provide resource managers with a general, region-wide approach for dealing with climate change and sea level rise. Nor does CERP provide water managers with a mechanism for dealing with other issues not addressed in the Restudy. At the time of this survey the issues of climate change and rising sea level are much discussed by political leaders and in the press. It appears that the report just released by the Intergovernmental Panel on Climate Change marks a general acknowledgement that global warming is occurring. The threats posed by an accelerated rise in sea level warrant a comprehensive response that focuses on the coastal economic assets and ecological resources that are at risk. CERP addresses the effects of climate change and rising sea level only as these phenomena might alter the performance of the yellow book projects (CERP 2004). Indeed, all of the resource managers interviewed about how their agencies are responding to the issues of climate change and rising sea level provided a similarly cautious, politically neutral response.

3.3.2 Divided and Confused Management

Implementation of CERP requires resource managers to operate simultaneously at the subregional scale, defined by the project areas (http://gis.evergladesplan.org/ProjectLocator5.0/), and at the entire South Florida region scale. These two levels correspond to level 2 (subregional) and level 3 (regional) in the regional organization of ecosystem science, Figure 1.1. CERP managers have opted to adopt a different management approach at each scale. Project planning and implementation follows the Corps' well-established project management guidelines. Management and evaluation of the evolving regional water management system relies on relatively new and untried adaptive ecosystem management. The overall result is a divided and confused management of CERP.

Several recent reviews of the Corps planning process have dealt at length with its shortcomings as the basis for implementing adaptive management of natural resources (NRC 2004, 2005). The existing planning process serves the purpose of designing and building structures and facilities designed to meet performance objectives that can be more or less fully described in advance. Objectives for ecosystem restoration and management require a different type of engineering, one that engages the engineer in a continuous process of observing the system, evaluating the performance of the project, and modifying its design as needed to meet the objectives. This adaptive management approach is only partially implemented within CERP.

The Corps' long-established planning guidelines impose a standard sequence of milestones that assure compliance with federal reporting requirements that apply to all Corps projects. Briefly, the first steps in the sequence begin with the formation of an interagency project development team (PDT) and proceeds through development of a project management plan (PMP) and development of a project implementation report (PIR). The PIR provides a description of alternative designs and evaluates project benefits. It is only after acceptance of the PIR that a project is authorized to proceed to detailed design and construction, and even then Congress may not allocate funds to complete the project.

In order to advance to the stage of a completed PIR, the PDT must evaluate the benefits of the project that balance its cost. However, neither WRDA 2000 nor the Corps' planning guidelines define what environmental benefits can be counted and how to evaluate these benefits (NRC 2006, page 64). At issue is how the PDT should evaluate the benefits of achieving ecosystem restoration goals and the implied costs of foregoing these goals in pursuit of others. The interviews generated several suggestions that definitions of restoration endpoints, the scientific basis for selecting ecological performance measures, and evaluation of economic benefits of coastal resources are needed. These appeals reflect the extent of confusion and frustration over the lack of direction within CERP, with the Corps' planning guidelines, on how to evaluate the benefits of ecosystem restoration.

3.3.3 Critical Ecosystem Management Functions

Critical elements required to support ecosystem management are as yet incomplete even as component projects are planned to come online within the next two years. RECOVER is the element within CERP dedicated to implementing the elements of adaptive ecosystem management. RECOVER is responsible for overall coordination of CERP through system-wide monitoring, modeling and assessment. These activities are implemented through interagency cooperation on a set of committees devoted to each function, i.e. monitoring, modeling, assessment and evaluation. (http://www.evergladesplan.org/pm/recover/recover_map_part2.aspx)

CERP makes no provision for the resources necessary to sustain critical ecosystem management functions. RECOVER has formulated a system-wide monitoring and assessment plan, the MAP, but funding allocated for monitoring and assessment in WRDA 2000, $10 M per year, is inadequate to cover the activities prescribed in this plan. Similarly, RECOVER has compiled a preliminary list of system-wide modeling needs (http://www.evergladesplan.org/pm/recover/recover_docs/sys_mdl/rec_mod_nds_rpt_mainreport.pdf), but RECOVER has no funds with which to pursue satisfying these needs.

Instead of supporting the development and application of forecast models as a system-wide activity in support of assessment and evaluation, modeling is supported out of the project budgets as part of the project planning and design activities. This approach suffers from the same drawback noted in Section 2, i.e. how to integrate these models into a sustained program of adaptive management that continues after a project is complete? For example, the Florida Bay Florida Keys Feasibility Study is developing a hydrodynamic and water quality model, at great cost of money and time from staff on cooperating agencies, but this investment is at risk because CERP contains no mechanism to maintain and apply this model as an assessment tool beyond the

end of the feasibility study. RECOVER does support the application of existing regional-scale models, i.e. the South Florida Water Management Model and the related Natural System Model, to perform regional assessments. And there is a set of associated issues related to coordinating the application of models' operation at two different scales (region-wide and at the project scale).

3.3.4 Likelihood of Major Changes to CERP

It appears that current efforts to implement CERP are unsustainable, and the CERP will undergo major changes within the next 3 years or so. Major changes have already begun. In its first biennial report (NRC 2006), the NRC committee for Independent Scientific Review of Everglades Restoration Progress, the successor to CROGEE, summarizes the extent of changes that have already occurred in CERP's master plan:

> "Of the 21 pilot projects and project components or phases currently scheduled in the MISP [Master Implementation Schedule Plan] for completion in the 2005-2010 period […] 10 were originally scheduled for this period, 4 were scheduled for later completion, 6 were scheduled to be completed by 2004, and 1 represents a newly scheduled project phase."

The state of Florida introduced the Acceler8 program in 2004 supported by additional state funds for restoration above those already committed to cover half the estimated cost of CERP. The advertised purpose of Acceler8 is to "complete eight key environmental projects ten years ahead of schedule." With this infusion of additional funds the state of Florida is effectively taking control of the pace and overall direction of the CERP program (Table 3.6). Additional federal funds have not materialized as promised; Congress has not passed another Water Resources Development Act bill since the legislation authorizing CERP in 2000.

It is unlikely that the current level of investment of agency resources in CERP - staff time as well as money - can be sustained to support a program receding into irrelevance with each passing year. In the first 5-year progress report to Congress, the Corps and SFWMD managers report that the major accomplishments of CERP to date have been to assemble the management structures required to support planning and implementation of around 20 individual projects scheduled for completion in the next 5 years. This means that by 2011 CERP will have only begun to address the water resources and ecosystem management needs identified by the Restudy in 1999 and related to problems recognized years before that.

3.4 Florida Oceans and Coastal Resources Council

The Council was created in 2005 to develop priorities for ocean and coastal research and establish a statewide ocean research plan, but as yet the Council lacks funds to implement its program. The group will also coordinate public and private ocean research for more effective coastal management. The Council is comprised of three non-voting members and fifteen voting members appointed by the Department of Environmental Protection (DEP), Florida Fish and Wildlife Conservation Commission (FWC) and Department of Agriculture and Consumer Services (DACS). In the most recent (12/18/06) Research Plan (Florida Oceans and Coastal Resources Council 2006, http://www.floridaoceanscouncil.org/), the Oceans Council divides research needs of coastal management into three areas - mapping, monitoring, and modeling – with these overarching topics covered by thirteen research categories ranging from habitat

mapping to public health issues to aquaculture. It recommends an Integrated Data Management and Dissemination plan to improve access and storage of research and resource information and stresses the importance of data interpretation and communication. The Research Plan also prioritizes funding for the Council and for ecosystem management in Florida into four areas: council administration and operation, integrated data management and dissemination, real-time interdisciplinary observing systems, and research (water quality, ocean and coastal ecosystems, and tools and technology).

3.5 Review comments by Florida Bay Science Program Scientific Oversight Panel

The draft report was distributed to the following current and former members of the Scientific Oversight Panel: Drs. Bill Boicourt, Don Boesch, John Hobbie, Ed Houde, Steve McCutcheon and Hans Paerl. It should be noted that one of the report team members (Bill Dennison) has been serving on the SOP for the past 3 years. A conference call was conducted with the report team and the following members of the SOP: Drs. Bill Boicourt, John Hobbie and Steve McCutcheon. Major points that were raised in SOP discussions are summarized below.

The SOP emphasized the critical need for long-term monitoring and long term modeling in South Florida in view of the large-scale CERP efforts. While funding for water quality monitoring appears relatively stable, seagrass and coral monitoring is less secure. In terms of initiating a regional ecosystem predictive function, having the right people is a key element of developing a successful program and the time scales of efforts should be on the scale of multiple years. The state of the science for predicting and understanding the various algal blooms in South Florida (e.g., red tides, blackwater events, current Barnes/Card Sound blooms) is still rudimentary; instead models of benthic/pelagic connections would be more fruitful. SOP made a suite of comments concerning the way the report was structured and delivered, including reviewing recommendations of previous SOP reports. Members of the SOP wanted to express their overall support for the findings of the report.

Table 3.6: Restoration projects authorized under CERP (WRDA 2000) and listed under Florida's Acceler8 program. (Highlighted projects affect coastal areas.)

Authorized under WRDA 2000	Listed under Acceler8	Planned Completion
Florida Bay Florida Keys Feasibility Study*		2008
C-44 basin storage reservoir	C-44 reservoir and stormwater treatment area	2009
Everglades Agricultural Area storage reservoir	Everglades Agricultural Area storage reservoir	2009
WCA 3A/3B seepage management	Water Preservation Areas	2008
C-11 stormwater treatment area		2009
C-9 stormwater treatment area		2009
Taylor Creek/Nubbin Slough stormwater treatment area (Lake Okeechobee)		n.d.**
Tamiami Trail bridge		n.d.**
North New River Improvements		n.d.**
C-111 spreader canal	C-111 spreader canal	2008
	C-43 reservoir	n.d.**
	Everglades Agricultural Area stormwater treatment area expansion	n.d.**
	Picayune Strand restoration (Southwest coast)	2009
	Biscayne Bay coastal wetlands	2008

*Technical aspects of study expected to be completed by late 2007.
** Information not found.

4 COASTAL MANAGEMENT AND SCIENCE NEEDS IN SOUTH FLORIDA

The study team identified eight projects that need to be pursued in South Florida (Table 1.1). These projects address critical ecosystem management needs identified in the interviews.

We organized the eight recommended projects into three categories based on where they fit in the framework for regional ecosystem science (Figure 1.1). This effectively ranks the projects in order of increasing involvement required by management in South Florida, from level 1 (supports) to level 3 (leads).

Level 1: The most basic level of involvement is to ***support critical program elements***, largely ongoing mapping and monitoring.

Level 2: A more involved level of involvement would ***close critical gaps in knowledge applied to management***, and examples include investigating factors related to onset and persistence of blooms on the southwest Florida Shelf or developing methods for defining ecological goals for coastal ecosystems.

Level 3: The most involved level is to provide a ***regional ecosystem predictive function*** by directing synthesis, forecasting and assessment activities.

The following sections provide a general description of the projects at each level of involvement and the program-level of support that will be required. The team's detailed concept for each of the eight projects is summarized in Table 4.1.

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Table 4.1: Management and science needs in South Florida

Management and science needs	Endpoints/timeline	Benefits/mandates	Ecosystem management	Partners
Support mapping/monitoring of coastal resources - This activity will provide financial resources to meet basic mapping and monitoring ongoing in the Florida Keys Marine Sanctuary and needs identified in the CERP Monitoring and Assessment Plan (MAP) and in the draft science plan compiled for the Task Force.	Extends limited coverage of existing maps showing location and spatial extent of coastal resources. Supports ongoing programs to monitor conditions in coastal ecosystems.	Additional bathymetric data needed in Florida Bay to support implementation of hydrodynamic model; Maps needed to document location and spatial extent of valued benthic habitats in Florida Keys Marine Sanctuary; Continued fisheries monitoring is needed to document efficacy of "no take" zones adopted in Sanctuary.	Provides information required to document coastal resources under management and evaluate the success of management activities. Information is critical to implementation of adaptive management approach.	NPS, FWS, FKNMS, NMFS, USGS, USACE, FFWC
Implement a water quality model for Biscayne Bay - This activity will address the critical need to implement a water quality model for Biscayne Bay needed to forecast future changes in the bay in response to continuing changes in land use in its watershed, anticipated move to "water reuse" strategies in wastewater treatment, and changes in freshwater supply expected with implementation of CERP projects.	Assemble a team to implement an existing estuarine water quality model working in close cooperation with teams from other agencies, e.g. USGS, NPS, and SFWMD, working to implement supporting elements of an integrated linked watershed/estuarine model.	This model will be useful to project planning directly for two CERP/ Acceler8 projects (C111 Spreader Canal and the Biscayne Bay Coastal Wetland Restoration) and in the system-wide modeling and evaluation of CERP coordinate by RECOVER.	Provides the essential tool necessary to characterize stressors on the Biscayne Bay ecosystem that are related to development and regional water management and to describe their impact on the bay.	All agencies and academic institutions – NPS, SFWMD, FWS, FIU, FKNMS, NMFS, NSUOC, USGS, USACE, FFWC, DEP

Table 4.1: Management and science needs in South Florida

Management and science needs	Endpoints/timeline	Benefits/mandates	Ecosystem management	Partners
Investigate synergistic effects of changing quantity and quality of freshwater discharge - This activity will investigate and articulate the likely response of coastal resources to changes in the quantity and quality of freshwater discharge acting synergistically.	Review and synthesize available information on stressor pathways and regional coastal impacts related to changes in freshwater quantity and quality. Conceptualize possible pathways and ecosystem response to synergistic impacts. Evaluate to identify synergistic impacts that are most likely or represent greatest risk to resource.	Addresses a deficiency in regional restoration effort that treats the restoration of the quantity and the quality of inflow as separate objectives under separate legal and administrative mandates. Provides managers with an assessment of risks related to interaction between changing quantity and quality of inflows – Can these be safely ignored?	Promotes a holistic approach to ecosystem management by anticipating the combined, interacting effects of two stressors.	NSUOC FKNMS USGS NPS NASA

Table 4.1: Management and science needs in South Florida

Management and science needs	Endpoints/timeline	Benefits/mandates	Ecosystem management	Partners
Assess implications of climate change and sea level rise for management of coastal resources - This activity will support an interdisciplinary team to assemble a comprehensive, quantitative assessment of the present and likely future impacts of accelerating climate change and rising sea level on region's coastal resources and its implications for current resource management programs.	Review and synthesize available information on stressor pathways and regional coastal impacts related to climate change and accelerated sea level rise; document ecosystem response to climate and sea level changes; evaluate to identify pathways with likely highest impacts; identify critical unknowns in forecasting trends in stressors and ecosystem response; 18 months to complete study; 3 months external review; month 22 workshop to solicit comments; month 24 communication of results	Current CERP and Task Force restoration activities address only terrestrial-based stressors related to human activities; This project will provide a comprehensive account of expected impacts of climate change and rising sea level; benefits extend to other interests in Caribbean region; template for regional coastal risk assessments in other areas of U.S.	provides for balanced assessment of stressors/risks acting on coastal ecosystems; addresses question of how/whether management of terrestrial-based stressors can be effective; aids in identifying adaptation strategies for coastal resources	SFWMD, NPS, Miami-Dade County DERM, DEP
Develop method for defining default ecological goals for coastal ecosystems - This activity will develop a default approach to defining the restoration endpoint or "reference state" for coastal systems where sufficient historical information or unimpacted analog site is lacking.	Assemble a team to examine the problem of defining goals/endpoints for restoration of estuarine systems where information on historical conditions is either lacking or does not apply, propose a general approach to the problem and identify/compile information required to implement the proposed approach.	Provides essential information required for implementing ecosystem management in coastal areas with little or no prior information on condition of ecosystem and in areas where management endpoint is different from historical conditions in ecosystem.	Evaluation and adaptive management require managers to define "reference state" for ecosystem but frequently information not available to do so	NSUOC, SFWMD, NPS

Table 4.1: Management and science needs in South Florida

Management and science needs	Endpoints/timeline	Benefits/mandates	Ecosystem management	Partners
Develop method for calculating socio-economic value of coastal resources - This activity will develop approach/information needed to evaluate the economic benefits anticipated from restoring and/or mitigating harm to coastal resources such as fisheries. A principle objective for this work is to implement recommendations from several recent NRC panel reviews for changes to the Corps project planning process that are needed to implement an adaptive management approach to resource and/or ecosystem management.	Assemble a team to examine the problem of defining evaluating socio-economic benefits of goods and services provided by coastal resources, e.g. support of commercial and sport fisheries, propose a general approach to the problem and identify/compile information required to implement the proposed approach.	Provides essential information required in planning restoration activities and in decisions on funding on-going activities, such as monitoring, to support management to sustain coastal resources.	Information is required to evaluate expected return on investment of limited public resources into restoring and preserving coastal ecosystems. Existing approach for planning and operation of major water resources infrastructure, i.e. the project planning process used by the Corp, does not address ecological endpoints and is generally incompatible with an adaptive management approach.	

Table 4.1: Management and science needs in South Florida

Management and science needs	Endpoints/timeline	Benefits/mandates	Ecosystem management	Partners
Establish center for synthesis, forecasting and assessment activities - This activity bridges the traditional divide between "research" and "resource management" by establishing a regional center/activity to conduct synthesis, forecasting and assessment activities applied to coastal resources in South Florida and the Caribbean.	This builds on and extends NOAA's activities on one of the other identified opportunities, e.g. SW Shelf or climate change.	South Florida's coastal resources are subject to influence by human activities and natural processes that occur on national and international scales. Development of this center for South Florida can be viewed as a "proof of concept" for possible application/development in other US coastal regions.	Synthesis, forecasting and assessment are essential to support an adaptive management approach to resource/ecosystem management. The proposed center will complement these capabilities being developed by RECOVER within CERP by focusing on the region's coastal resources.	All agencies and academic institutions: NPS, FKNMS, USGS, Miami-Dade County DERM, FWCC, DEP, SFWMD, FIU, NSUOC

4.1 Support Critical Program Elements

This is a critical activity that supports all other elements of ecosystem management. Many mapping and monitoring programs are already in place to support agency mandates. In particular, the FKNMS monitors coral, seagrasses, and fish numbers in the waters of the Keys. These activities are central to its sanctuary mission, particularly to establishing the efficacy of the application of "no take" zones as a tool for fisheries management. Yet, there is little or no long-term funding for monitoring by FKNMS.

The partners for this opportunity are most likely FKNMS and NPS. FWS and NMFS both play a role in the FKNMS, so they would also be involved. CERP could be involved with the mapping and monitoring of the Everglades and that could be tied into the mapping of FKNMS.

4.2 Close Critical Gaps in Knowledge Applied to Management

At level 2, the team recommends a set of projects that would each address critical gaps in knowledge needed to support coastal ecosystem management:

- **Investigate factors related to onset and persistence of blooms on southwest Florida Shelf** - This activity will support an interdisciplinary team to assemble existing information on frequency and extent of red tides, blackwater events and other bloom phenomena on the southwest Florida Shelf, articulate and evaluate hypotheses as to their cause and impacts, and identify critical information resource managers need to respond to these phenomena.
- **Implement a water quality model for Biscayne Bay** - This activity will address the critical need to implement a water quality model for Biscayne Bay needed to forecast future changes in the bay in response to continuing changes in land use in its watershed, anticipated move to "water reuse" strategies in wastewater treatment, and changes in freshwater supply expected with implementation of CERP projects.
- **Investigate synergistic effects of changing quantity and quality of freshwater discharge** - This activity will investigate and articulate the likely response of coastal resources to changes in the quantity and quality of freshwater discharge acting synergistically.
- **Assess implications of climate change and sea level rise for management of coastal resources** - This activity will support an interdisciplinary team to assemble a comprehensive, quantitative assessment of the present and likely future impacts of accelerating climate change and rising sea level on region's coastal resources and its implications for current resource management programs.
- **Develop method for defining default ecological goals for coastal ecosystems** - This activity will develop a default approach to defining the restoration endpoint or "reference state" for coastal systems where sufficient historical information or unimpacted analog site is lacking.
- **Develop method for calculating socio-economic value of coastal resources** - This activity will develop approach/information needed to evaluate the economic benefits anticipated from restoring and/or mitigating harm to coastal resources such as fisheries. A principle objective for this work is to implement recommendations from several recent NRC panel reviews for changes to the Corps project planning process that are needed to implement an adaptive management approach to resource and/or ecosystem management.

These projects address knowledge gaps identified in the interviews. Some provide information needed by managers for project planning and implementation within CERP. Others relate to information on topics outside of CERP's mandate, i.e. information on the dynamics of coastal marine ecosystem and on atmospheric and oceanic stressors. Each of the projects in this category requires critical analysis of scientific information, and several projects extend this requirement to predicting the behavior of coastal ecosystems.

Many of these projects would include all agencies as potential partners, e.g. climate change and water quantity/water quality. However, each project would most likely work best if partnered with one or two primary agencies, then draw from all agencies for individual components. Additionally, individual programs would work best with different opportunities. For instance, establishing historical reference points or reference communities would greatly benefit CERP partners. The Task Force would also work well any project that involved restoration.

4.3 Center for Synthesis, Forecasting and Assessment

Synthesis, forecasting and assessment activities bridge the traditional divide between "research" and "resource management." These activities go beyond monitoring and regulation and address new concerns and associated critical gaps in knowledge needed to support a management response, c.f. Section 4.2 above. The RECOVER program, within CERP, is designed to conduct these activities in support of restoration and management of freshwater resources in South Florida. The lack of a complementary mechanism to conduct synthesis, forecasting and assessment activities focused on the management of coastal resources represents a critical gap in regional ecosystem restoration and management in South Florida.

NOAA could provide this critical management function by establishing a center, with cooperation from partner agencies, to facilitate synthesis, forecasting and assessment activities aimed at providing critical scientific information for coastal management. Interviewees from all agencies mentioned the general lack of coordination between agencies and projects on coastal management. The Florida Bay Science Program was cited as a counterexample where interagency coordination had been achieved to address an issue of concern (apparent ecological collapse) with good result. Many voiced dismay over the recent decline of the Florida Bay Science Program. Interagency participation in such a center could be modeled on the Florida Bay Science Program but with the scope of the center expanded to include all of the coastal areas in South Florida.

An interagency center that connects research, monitoring and management would improve the effectiveness of existing coastal resource management in South Florida. The activities of such a center would integrate individual research and coastal restoration projects, such as those components of the CERP that address coastal restoration goals, by facilitating coordination between separate agencies. By taking the lead in establishing such a center CSCOR would extend its role in South Florida beyond simply managing a sponsored research program. New activities would include assisting in maintaining regional forecast models and communicating results of research and modeling to managers and policy makers. The center would need at least one full time employee to direct the operations of the center, but would also need a lot of time and effort from a large cadre of scientists.

Communication of the results of synthesis, forecasting and assessment activities would be a major activity of the center. Having a communications team would be necessary for the center to become a key element in South Florida ecosystems. An important first step in fulfilling the communications function would be to continue the annual Florida Bay Science Conference, by working with a downsized PMC, but expanding the scope of the conference to incorporate all coastal areas of South Florida.

A center for coastal ecosystem synthesis, forecasting and assessment would benefit all stakeholders, but especially those managers directly involved in South Florida restoration and assessment. The partners in the center would be all agencies with responsibility for coastal resources, especially National Park Service, USGS, Miami-Dade County DERM, FKNMS and FWCC. NPS could be the primary partner for connecting different CERP projects together. Several agencies would need to be involved in connecting different Biscayne Bay projects together. The Task Force should be a major partner in this endeavor as their draft science plan and Science Coordination Group are already organized.

5 CONCLUSIONS AND RECOMMENDATIONS

Gaps in coastal management and science in South Florida derive from an imbalance in the attention given to ecosystem management applied to terrestrial (wetland) and coastal resources. There is no coordinated, regional program for ecosystem management of coastal resources comparable to CERP. In the absence of such a program the default is to approach the protection and management of coastal resources as merely the downstream extension of the restoration and management of the Everglades ecosystems and freshwater resources. However, this downstream approach ignores the distinctive character and behavior of coastal ecosystems, the interconnections between these ecosystems, and their vulnerability to oceanic processes (i.e. the Gulf Loop Current and Mississippi River discharge) in a variable and changing climate.

The emerging challenges documented in this assessment lead to the recommendation that coastal managers in South Florida adopt a comprehensive, coastal ecosystem approach.

The three opportunities that the survey team believes to be optimal are continued funding for monitoring programs, directed synthesis, assessment and forecasting and southwest Florida ecosystem in peril. These opportunities are the most critical for the continued health and restoration of the South Florida regional ecosystem. Funding for monitoring programs would benefit specific local programs, but would have a regional impact based on the collective works of information. The southwest Florida ecosystem is an untapped regional-scale ecosystem that needs to be addressed. At this time, there is a lack of information and understanding of the basic drivers of this system. A synthesis and assessment center would provide a regional focus for local programs and projects. All these opportunities also provide interdisciplinary management by involving local, state and federal agencies and by involving researchers and managers.

Continued funding for monitoring programs would involve the least amount of direct involvement in the projects. This would be a situation where these monitoring programs already have established parameters, criteria and protocols, but need more funding to continue with the program or to add vital components to them. This was identified as a problem at every agency we visited. As mentioned before, many of the holistic monitoring programs have been splintered into individual projects due to funding loss and management disorganization. All agencies are feeling the crunch when it comes to continued funding for basic monitoring needs.

The southwest Florida ecosystem is an opportunity to establish basic monitoring in an area of South Florida that does not have a lot of previous data or information. There are many scientific questions that need to be addressed in this area and with little involvement at this time, setting up a management strategy would be ideal. Most management comes after intensive study, where much of the data is not directly applicable to management. However, southwest Florida could change this, with directed scientific study that answers management questions specific to that region.

Establishing a center for synthesis, assessment and forecasting would be an excellent opportunity for NOAA to assume a leadership role in developing ecosystem-based management at a regional scale. The challenges involved with this opportunity are that it would require the right personnel (leadership, coordination, communication skills mandatory) and a considerable effort in facilitating interactions between agencies and within programs (CERP, etc.).

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Appendix 1 – People Interviewed

Agency	Name	Program and/or title
CSCOR/OAR	Peter Ortner	Atlantic Oceanographic and Meteorological Laboratory
FKNMS	Dave Score	Superintendent
NMS Program: SE Region	Billy Causey	Director
NPS/SFNRC	Bill Perry	Ecologist
NPS/SFNRC	Bob Johnson	Center Director
NPS/SFNRC	Carol Mitchell	Deputy Director
NPS/SFNRC	David Hallac	Chief, Biology Branch
National Park Service/I & M	Matt Patterson	Monitoring Program Coordinator
FFWC	John Hunt	Program Administrator
FIU/SERC	Jim Fourquean	Associate Professor
Miami-Dade County/DERM	Susan Markley	Chief of Natural Resources Division
NSUOC	Dick Dodge	National Coral Research Institute, Dean
NSUOC	David Gilliam	National Coral Research Institute, Assistant Professor
NSUOC	Charles Messing	Professor
NSUOC	Pat Blackwelder	Assistant Professor
NSUOC	Bernard Riegl	National Coral Research Institute, Associate Professor
NSUOC	Sam Purtis	National Coral Research Institute, Assistant Professor
NSUOC	Kevin Kohler	National Coral Research Institute, Senior Programmer
NSUOC	Alex Soloviev	Associate Professor
NSUOC	Brian Walker	National Coral Research Institute, Research Assistant
NSUOC	Kevin Helmle	National Coral Research Institute, Research Assistant
NSUOC	Alisen Moulding	National Coral Research Institute, Research Scientist
MBL	John Hobbie	Director of the Ecosystem Center, Member of SOP
SFWMD	Chris Madden	LTER, Senior Scientist
SFWMD	Dave Rudnick	FB/PMC, Senior Supervisor
SFWMD	John Maxted	Environmental Scientist

SFWMD	Joel Van Arman	Chief Scientist
SFWMD	Melody Hunt	Coastal Division, Senior Scientist
SFWMD	Peter Doering	Coastal Division, Chief Scientist
SFWMD	Rick Alleman	Lead Environmental Scientist
UMCES	Don Boesch	President of UMCES, Chair of Scientific Oversight Panel
UMCES	Bill Boicourt	Professor, Member of SOP
UMCES	Ed Houde	Professor, Member of SOP
UNC	Hans Pearl	Professor, Member of SOP
USEPA	Steve McCutcheon	Member of SOP
USFWS Field Office	Patrick Pitts	
Patrick talked to the following people in his office:		
USFWS Field Office	Steve Tracksler	Chair for RECOVER evaluation team
USFWS Field Office	Todd Hopkins	Supervisor of CERP Southwest team
USFWS Field Office	Spencer Simon	Head of Trust Resource Office
USFWS Field Office	Jeff Howe	Coastal Program
FFWC	Ken Haddad	

Agency Abbreviations
CSCOR/OAR - Center for Sponsored Coastal Ocean Research/Office of Oceanic and Atmospheric Research
FKNMS - Florida Keys National Marine Sanctuary
NPS/SFNRC - National Park Service/South Florida National Resources Center
NPS/I & M - National Park Service/Inventory & Monitoring
FFWC - Florida Fish and Wildlife Commission
FIU/SERC - Florida International University/Southeastern Research Center
Miami-Dade County/DERM - Department of Environmental Resources Management
NSUOC - Nova Southeastern University Oceanography Center
SFWMD - South Florida Water Management District
UMCES – University of Maryland Center for Environmental Science
UNC – University of North Carolina at Chapel Hill
USEPA – United States Environmental Protection Agency
USFWS - United States Fish and Wildlife Service

Appendix 2 – Agency Profiles

This section identifies (potential) NOAA partner agencies in South Florida and describes the role each plays in the management of coastal resources. This summarizes answers to the question *"What role(s) does your program play in the management of coastal resources in South Florida?"*

Overall list with agencies interviewed indicated by *

Federal:
Other agencies within NOAA (AOML*, NMFS, Florida Keys Marine Sanctuary*, Rookery Bay National Estuarine Research Reserve)
National Park Service (Everglades*, Biscayne Bay, Big Cypress and Dry Tortugas*)
Fish and Wildlife Service*
Environmental Protection Agency
U.S. Army Corps of Engineers
USGS

Florida state agencies:
South Florida Water Management District*
Florida Department of Environmental Protection
Florida Fish and Wildlife Commission* (FWRI)

Local agencies:
Miami-Dade Department of Environmental Resources Management*

University Programs:
Southeastern Nova University – National Coral Reef Institute*
Florida International University – Southeast Environmental Research Center (SERC)*
University of Miami - Cooperative Institute for Marine and Atmospheric Studies (CIMAS)*

Within NOAA there are several agencies that take part in the health and restoration of the South Florida ecosystem. For instance, the Atlantic Oceanographic and Meteorological Laboratory (AOML), under the Office of Oceanic and Atmospheric Research (OAR), is primarily focused on scientific research and data collection. Basic scientific knowledge of coastal ocean processes, including monitoring data, is processed at this laboratory.

The National Marine Fisheries Service is involved in basic research, applied scientific research, management and planning and implementation of management decisions in South Florida. They are part of the South Florida Ecosystem Restoration Initiative, specifically in the restoring and protecting of coastal ecosystems.

The Florida Keys National Marine Sanctuary (FKNMS) is charged with the protection and conservation of the resources of South Florida within the Sanctuary. Scientific research and monitoring, management and planning and implementation are all part of the FKNMS's

mandates. Additionally, the Sanctuary also fulfills a regulatory role within the boundaries of the Sanctuary.

The National Park Service (NPS) is a partner agency of NOAA. The parks in South Florida include Everglades National Park, Biscayne National Park, Big Cypress National Preserve and Dry Tortugas National Park. NPS is involved in scientific research and monitoring through its Inventory and Monitoring program, the Comprehensive Everglades Restoration Program and the Critical Ecosystem Studies Initiative. Additionally, it is charged with applying this research to management and planning of the parks.

The United States Fish and Wildlife Service is primarily a scientific and management agency. It is charged with conserving and protecting America's wildlife. It oversees endangered species and National Wildlife Refuges. In South Florida, FWS is part of CERP, including participating in the evaluation and assessment teams (charged with performance measures as they relate to system-wide CERP, including different sub-areas, modeling and forecasting, success of CERP). The FWS's Coastal Program deals with relatively small on the ground turn dirt restoration projects.

Environmental Protection Agency – did not talk to them. EPA is charged with protection of human health and the environment on which humans depend on. As a federal agency, it is divided into regional offices, and Florida is located within region 4. EPA does some scientific research, but is more important in the management and planning, implementation, and regulation and enforcement areas. Significant contribution to FKNMS science in past and continuing

US Army Corps of Engineers – did not talk directly to them. ACE deals with the implementation of management and planning decisions. They do not generally conduct scientific and monitoring research. They have regulatory authority over navigable waters. In South Florida, ACE is critical to CERP, providing much of the engineering power behind it.

USGS-water resources research, monitoring

The South Florida Water Management District (SFWMD) is a key partner agency in South Florida. The District plays a role in all four corners of the agency spectrum. The District is involved in every aspect of water resource research, management and use. The District is a key player in CERP, involved in monitoring the current water regime, as well as studying the impacts of Everglades restoration. It manages and plans for all weather events, including hurricanes and droughts. Every week management decisions are implemented on water quantity. They also have regulatory authority over water use in South Florida and the dredging and filling of wetlands.

Florida Department of Environmental Protection is the state agency involved in the protection and management of Florida's water, air and land. They are not involved in science as much as management and planning, implementation and regulation and enforcement. They are partners in CERP, are billed with cleaning up air and water quality and conserving sensitive lands. They have regulatory authority over Florida's air and water quality, including pollution.

Florida Fish and Wildlife Commission is an oversight panel that works with many other agencies to protect and conserve the wildlife of Florida. The roles of the agency are primarily coastal issues, such as regulatory authority over fisheries and impacts of fisheries and fisheries gear. Additionally, they manage marine habitat and provide data gathering, monitoring and scientific information. They play a significant role as technical advisors to the state. They have regulatory authority for endangered and threatened species and manage several species for the federal government.

Miami-Dade County Department of Environmental Resources Management (DERM) is a local agency that is involved with the management, implementation and regulation of environmental resources within Miami-Date County, including Biscayne Bay. They do basic monitoring of water quality, air quality and land use of the county. They have regulatory authority over water use, quality and pollution in the county.

Nova Southeastern University Oceanography Center (NSUOC) is an academic research center and is funded by NOAA. The work at the center focuses on the reef tract and Biscayne Bay, but scientists study other areas as well. Topics include ecosystem health assessments and restoration, primarily of corals and benthic invertebrates, predictive modeling, large-scale mapping and fisheries. The Center advises the management agencies on how to use applied science to accomplish management goals.

Florida International University, Southeastern Research Center is a research institution focused on the southeastern United States and Caribbean area. The main focus is academic research, including the Long-term Ecological Research program (LTER) in the Everglades, water quality, seagrasses, periphyton, freshwater biogeochemistry and microbial ecology.